AAIB

Air Accidents Investigation Branch

AAIB Bulletin 9/2017

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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:	Airbus A319-111, G-EZEW
No & Type of Engines:	2 CFM CFM56-5B5/P turbofan engines
Year of Manufacture:	2004 (Serial no: 2300)
Date & Time (UTC):	30 June 2016 at 1008 hrs
Location:	On departure from Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 144
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	8,500 hours (of which 6,500 were on type) Last 90 days - 164 hours Last 28 days - 43 hours
Information Source:	AAIB Field Investigation

Synopsis

When the co-pilot, who was the Pilot Flying (PF), asked for the landing gear to be retracted, the Pilot Monitoring (PM) retracted the landing gear and flaps. Realising his error, the PM told the PF to select TOGA[1] thrust. The PM moved the flap lever back to position 1, when instructed by the PF to reselect the flaps, and the slats began to extend. The flight continued without further incident.

History of the flight

G-EZEW was operating a flight from Bristol Airport to Lisbon Airport, Portugal, with six crew and 144 passengers on board. The co-pilot was the PF and the commander was the PM. The reported weather conditions included surface wind from 230° at 8 kt, more than 10 km visibility, broken cloud at 1,600 ft agl, a temperature of 15°C and a QNH of 1009 hPa.

The aircraft began its takeoff from Runway 27 at 1007 hrs with the flap lever in position 1, giving a slat and flap configuration known as CONFIG 1+F (leading edge slats extended to 18° and trailing edge flaps extended to 10°). The PF began to rotate the aircraft at 140 kt CAS[2]

Footnote

1 TOGA: Takeoff/Go Around. Aircraft often take off with a thrust setting below the maximum available (TOGA thrust). If necessary, TOGA thrust can be selected at any time

2 CAS:Copmted Airspee[d]

and it lifted off at 147 kt CAS. The PM called 'POSITIVE CLIMB' to which the PF responded 'GEAR UP'. The landing gear was selected UP four seconds after lift-off and, three seconds later at approximately 190 ft radio altitude (RA) and 157 kt CAS, the PM moved the flap lever to position 0, causing the slats and flaps to begin to retract.

The aircraft pitch attitude began to increase, airspeed began to decrease and, at a height of 370 ft RA, the PF applied a nose-down corrective pitch input which prevented the CAS from decreasing below 153 kt. As the aircraft climbed through 550 ft RA the flaps were fully retracted, the slats were retracting through 7.5° and the CAS was increasing through 160 kt. The PM told the PF what he had done and announced "SET TOGA"[3], to which the PF responded by moving the thrust levers to the TOGA detent.

After the flaps were selected up, the PF saw the VLS[4] indication on the PFD[5] "shoot up" to 180 kt, 30 kt above the current speed (Figure 1). He asked the PM to extend the flaps again and the PM moved the flap lever back to position 1, which caused the slats to begin to extend. The aircraft was at 710 ft RA and 183 kt. The VLS indication reduced below the instantaneous airspeed and, when the aircraft accelerated to S speed[6], the PF moved the thrust levers to the CLB detent to reduce thrust to the climb setting. The PF asked for the slats to be retracted, which the PM did at approximately 850 ft RA and, passing 870 ft RA, the autopilot was engaged and the climb continued.

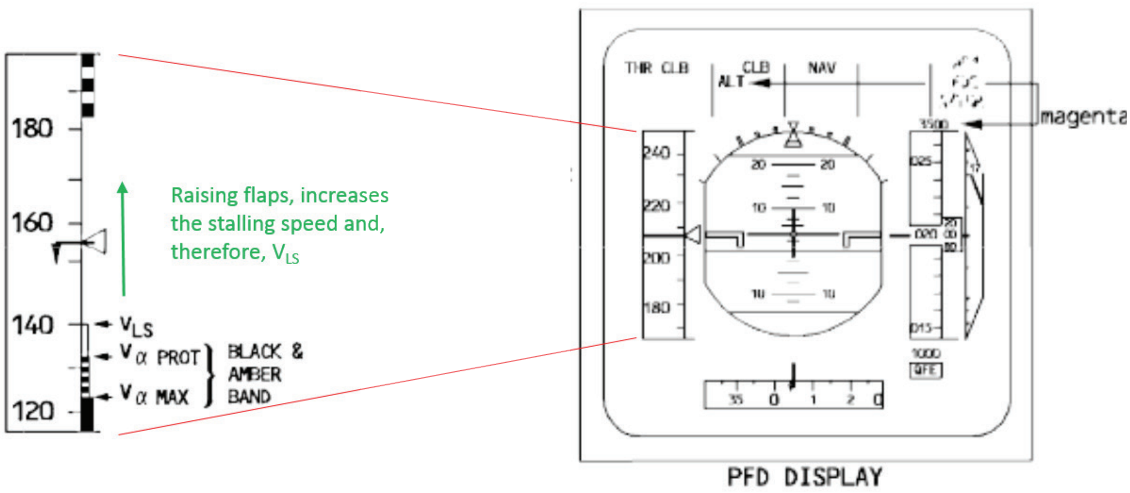


Figure 1

The V_{LS} indication moves up the airspeed scale on the PFD when the flaps are raised

[3] TOGA: Takeoff/Go-around (thrust)
[4] VLS: the lowest selectable speed
[5] Primary flight display
[6] S Speed: see Aircraft characteristic speeds below

Recorded data

The following relevant parameters were recorded:

- When the flap lever was set to position 0, at 190 ft RA and 157 kt CAS, the pitch attitude was 15.1° nose-up and the angle of attack (AOA) was 7.3°.
- During slats and flap retraction, the CAS reached a minimum of 153 kt, at which the pitch attitude reached a maximum value of 17.2° nose-up and AOA reached 9.1° (reaching its maximum recorded value of 9.3° shortly afterwards). When the aircraft reached the clean configuration (slats and flaps fully retracted), the CAS was recorded as 171 kt.
- As the aircraft passed 550 ft RA the AOA was 7.5°, decreasing to a stabilised value of 7.2° to 7.3°.

Aircraft technical information

Aircraft characteristic speeds

V_{LS} is calculated by the Flight Augmentation Computer (FAC) and displayed on the PFD as the top of a vertical amber strip along the airspeed scale. V_{LS} corresponds to:

a. 1.13 times the stalling speed during takeoff
b. 1.28 times the stalling speed in the clean configuration

The manufacturer calculated that the stalling speed of the aircraft in the clean configuration was 156 kt at a gross weight of approximately 63,000 kg.

'S speed' is the lowest speed at which flaps should be selected to position 0 and is displayed as a green letter 's' on the airspeed scale of the PFD.

Flap system logic

When the flap lever is moved to position 0 from CONFIG 1+F after takeoff, the flaps and slats begin retracting at the same time if the CAS is above 154 kt. In flight, when the CAS is above 100 kt, moving the flap lever from position 0 to 1 commands CONFIG 1 rather than CONFIG 1+F, extending the slats but not the flaps. If, after takeoff (and above 100 kt), the flap lever is moved from position 1 to 0 and then back to 1, the slats and flaps begin to retract but, although the slats will extend again, the flaps will continue to retract.

Alpha/Speed lock function (slats)

The Alpha/Speed lock function inhibits the retraction of slats at high AOA (alpha) or low speeds. If AOA exceeds 8.5° or the airspeed reduces below 148 kt, retraction of slats from position 1 to position 0 is inhibited. It is no longer inhibited when AOA reduces below 7.6° and speed exceeds 154 kt.

After the flap lever has been moved to position 0, this protection is not active even if the AOA exceeds 8.5° or the airspeed decreases below 148 kt.

Operator's report on the incident

Information from the pilots

During their pre-flight briefing, and subsequently during the morning, the pilots had discussed a previous flap mis-selection event that occurred during takeoff from the same airport. The commander stated that he had been thinking about that event while waiting for the instruction to raise the flaps, and wondered later whether these thoughts and the earlier discussions had been a trigger for him selecting the flaps to position 0 before being asked to do so.

Operator's Analysis

The operator's report noted that, when the flap lever reached position 0, the AOA was 7.3° and the CAS was 157 kt. Consequently, the Alpha/Speed lock protection did not activate, and the flaps and slats moved as selected. When the flap lever was selected back to position 1, the slats began to extend again but the flaps did not, in accordance with normal flap system logic. There was no specified procedure for crews to follow in these circumstances but, in this case, the recovery action was effective: reducing the AOA, increasing thrust and extending the slats.

The operator's report stated:

> 'The combination of the fact that [the PM] had been thinking about the previous event, perhaps rehearsing how it could have happened, and that he was anticipating the flap 0 call from [the PF], became a trigger and led [the PM] to actually action that sequence in reality by selecting the flap lever to zero.'

Previous event

In its report into a similar incident in 2016[7], the operator referred to the routine procedure of retracting flaps after takeoff, commenting:

> *'Tasks which are highly practised, routine and largely physical actions are more vulnerable to action slips than more cognitively demanding tasks. These well-practised tasks are linked with automatic processing where [we can do the task] 'without thinking'. Our ability … to automate our processing [allows] us to develop expertise and create the cognitive capacity to process more complex tasks. However, it can also leave us vulnerable to making errors in relatively simple tasks.'*

The operator noted that the flap mis-selection was not an isolated event, indicating that flight crew are vulnerable to this type of slip, and consequently undertook a study into other events involving inadvertent flap retraction after takeoff.

Footnote

[7] See AAIB Bulletin 8/2016; G-EZTZ

Study into flap mis-selection after takeoff

The Airbus A319 has a further protection known as Alpha Floor[8], which applies maximum thrust regardless of pilot input if the AOA is too great. The operator determined that neither Alpha/Speed Lock nor Alpha Floor protection had been triggered in any of the events reviewed, noting that this was reassuring. However, it commented that there were other risks associated with the aircraft being in a low energy state near to the ground, including the possibility that crew members would become confused leading to a loss of situational awareness. In addition, the operator was not clear how much performance margin would remain in the event of a loss of thrust in one engine or a requirement to increase the climb angle to avoid an obstacle.

The manufacturer studied the events and concluded that, in the circumstances examined where the Alpha Lock function had not been triggered, the aircraft had sufficient performance to maintain a climb and accelerate. None of the operator's events, or other similar events of which the manufacturer was aware, had triggered the Alpha Floor protection. The manufacturer stated that:

a. Had the flap lever been moved to position 0 with the aircraft at higher climb angles or lower speeds, the Alpha/Speed Lock function would have inhibited slat retraction.
b. Aircraft climb performance following early flap retraction would exceed that demonstrated in the case of an engine failure after takeoff.
c. Should an increased climb rate be required with the aircraft at a very high angle of attack, the Alpha Floor protection would activate to provide TOGA thrust.

The manufacturer stated that the takeoff performance calculations used by the operator, when properly computed and applied, combined with the protections above, would allow the aircraft to climb safely should there be a repeat of this type of event even when combined with other adverse factors, such as obstacle or terrain avoidance.

Operator safety action

Following its review into flap mis-selection after takeoff, the operator took or proposed the following safety action:

a. It reviewed its current training and guidance to support crews in handling the aircraft in a low energy state at low altitude.
b. Crews would be trained in 'active monitoring', focussing on switch selections and lever movements.
c. It amended its SOPs for flap and landing gear selection to ensure the correct lever is identified before being moved.
d. It would develop training to help crews manage distractions (which had played a role in some events).
e. It would raise awareness amongst pilots of the events reviewed through a dedicated flight safety communication.

Footnote

8 Alpha-floor protection automatically selects TOGA thrust when the aircraft reaches a very high AOA.

Subsequent event

On 19 March 2017 one of the operator's A320 aircraft, G-EZWM, was taking off from Nice Airport when the PM, when asked by the PF to retract the landing gear, responded "gear up" but moved the flap lever to position 0 with the aircraft 105 ft above the runway. The PF noticed a large increase in $V_{LS,}$ which alerted him that the flaps were retracting, and exclaimed "Flaps!" He selected TOGA, and the PM raised the gear, but the flap lever remained at position 0. The flaps and slats retracted fully but, after TOGA was selected, the aircraft accelerated "rapidly" and climbed.

In discussion after the event, the crew could not explain definitively why the mis-selection might have happened but noted that the PM had just finished the training introduced by the operator to combat this sort of action slip. They wondered whether the PM, by actively trying not to make a mis-selection, brought about that very outcome.

Conclusion

The operator realised that the flap mis-selection event to G-EZEW was not an isolated event and carried out a study into similar incidents with assistance from the manufacturer. The operator was concerned about the risk associated with aircraft being in a low energy state near to the ground, including performance risks and the possibility that crew members would become confused leading to a loss of situational awareness.

Information from the manufacturer indicated that properly-computed takeoff performance calculations, combined with the aircraft's Alpha/Speed Lock and Alpha Floor protection functions, would allow the aircraft to climb safely following a flap mis-selection event, even when combined with other, adverse, factors. Aircraft climb performance following early flap retraction would exceed one engine inoperative climb performance.

The operator began to focus training effort on avoiding the mis-selection of switches and levers, and amended its SOPs with the same intention. However, a similar event occurred to a pilot shortly after he underwent that training and he wondered subsequently whether, by focussing on not making the action slip, he had brought it about. This hypothesis would be supported by the comment of the pilot of G-EZEW in this report who stated that, while waiting for the instruction to raise the landing gear, he had been thinking about an earlier mis-selection event by another crew at his home base.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZWX
No & Type of Engines:	2 CFM56-5B4/3 turbofan engines
Year of Manufacture:	2014 (Serial no: 6192)
Date & Time (UTC):	28 November 2016 at 1303 hrs
Location:	En route Edinburgh to Hamburg
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 172
Injuries:	Crew - None Passengers - None
Nature of Damage:	Static inverter overheated
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	6,316 hours (of which 4,138 were on type) Last 90 days - 142 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

During the en route climb, the flight crew noticed smoke and fumes in the cockpit and donned their oxygen masks. Shortly after, the ECAM AVIONICS SMOKE caption was displayed and the aircraft diverted to Newcastle Airport. During the descent, the smoke appeared to dissipate after the crew carried out the Quick Reference Handbook (QRH) avionics smoke drill. The aircraft landed without further incident.

The source of the smoke and fumes was traced to the cockpit additional electrical supply static inverter, which had overheated. This was the third failure to have occurred on the operator's fleet of Airbus A320 aircraft since August 2014. The operator was not aware that the aircraft manufacturer had issued a technical publication in March 2016 that identified the cause of the problem, and that the supplier had issued a Vendor Service Bulletin in October 2016 that recommended the replacement of the capacitor involved in the failure mode. A batch of 2,058 units was affected. The failed static inverter on G-EZWX was one of this batch. The investigation also identified an undocumented feature of the interphone emergency call function related to communication re-establishment after a handset reset; awareness of this feature could improve communication management between the cockpit and cabin crew.

History of the flight

The aircraft was on a scheduled flight from Edinburgh Airport to Hamburg Airport, Germany, with 172 passengers and six crew members on board. At 1303 hrs, 11 minutes into the flight, the aircraft was passing FL230 in the climb when the commander and co-pilot became aware of smoke and fumes in the cockpit. Both crew donned their oxygen masks, which coincided with the AVIONICS SMOKE caption being displayed on the ECAM. The commander took control of the PF duties and radio communications with ATC, whilst the co-pilot carried out the QRH SMOKE/FUMES/AVNCS SMOKE drill.

At about the same time that smoke and fumes appeared in the cockpit, several cabin crew at the rear of the aircraft also noticed fumes in the cabin. This was shortly followed by the commander making an "attention, crew at all stations"[1] PA announcement, alerting the cabin crew to a potential emergency. The commander then declared a MAYDAY to ATC, advising that they had smoke and fumes in the cockpit, and were diverting to Newcastle Airport, which was 47 nm ahead of the aircraft's track. On a few occasions, the crew had to repeat themselves due to difficulties hearing each other when using the oxygen masks. The commander also had to repeat part of the MAYDAY transmission as the controller did not initially understand him.

About a minute after the co-pilot had set the avionics EXTRACT and BLOWER to OVRD, the smoke in the cockpit started to dissipate. The co-pilot then selected the interphone emergency call function to ascertain the status of the cabin crew and provide a NITS[2] brief to the cabin manager (CM). The CM, who was now seated at the forward attendant station, heard three interphone call 'chimes' in the cabin and answered the call by lifting his handset from its cradle, but he could not hear the co-pilot. However, the co-pilot was able to hear the CM speaking, and started to brief him before he realised that he was not being heard. This was coincident with the CM hanging up his handset. During this failed attempt to communicate and about the same time as the aircraft started a descent to Newcastle, the AVIONICS SMOKE caption extinguished on ECAM.

The interphone emergency call initiated by the co-pilot continued to remain active, and about a minute later, the commander and co-pilot heard one of the cabin crew speak on the interphone trying to get their attention; this cabin crew member was seated at the attendant station at the rear of the aircraft. Due to a slight delay in responding, the cabin crew member hung up the handset just as the co-pilot answered. The CM made a PA announcement to the passengers using the handset at the forward attendant station, advising them to remain seated and await further instructions.

The commander asked the co-pilot if he had spoken to the cabin crew, and advised him that they were now only about ten minutes from landing. The co-pilot stated that he was still having difficulties in speaking with them, but would try again; the sound of a cockpit switch selection and a single 'chime' were recorded on the CVR.

The CM, upon hearing the interphone call chime in the cabin, removed his handset from its cradle and pressed and released the EMER CALL button on the keypad before speaking

Footnote

[1] The operator's procedures described that on hearing this announcement, cabin crew should immediately interrupt their duty and stow away any catering equipment, before returning to their stations and fastening their harness to await further instructions from the cabin manager or pilots.

[2] Nature, Intention, Time and Special Instructions.

into it. The co-pilot responded and two-way communications was finally established. A NITS brief was provided to the CM, who then briefed the cabin crew before he made a PA announcement to the passengers, advising them that they were making a precautionary landing at Newcastle Airport. Three minutes elapsed between the time that the co-pilot first activated the interphone emergency call function and when two-way communication was established with the cabin crew.

The approach and landing at Newcastle were uneventful. The aircraft was met by the RFFS on the taxiway, where the aircraft was stopped and the engines shut down. The RFFS carried out an inspection of the aircraft, during which fumes were still noticeable in the cockpit and the aircraft was electrically powered down as a precaution. The passengers were disembarked using stairs and taken to the terminal by buses.

Recorded information

A complete record of the incident flight was available from the aircraft's CVR and FDR; pertinent information has been included in the history of flight. The selections and status of the cabin interphone system is not recorded on the FDR.

Aircraft examination

The source of the smoke and fumes was traced to the cockpit additional electrical supply static inverter[3], which had overheated. A replacement item was installed and the aircraft subsequently returned to service.

Static inverter

The cockpit additional electrical supply static inverter converts 28VDC input power to 115VAC/60Hz output power, which is provided to three outlets in the cockpit to enable the charging of electronic devices, such as Electronic Flight Bags. The static inverter is in the avionics bay, installed below the cockpit floor near the co-pilot's footwell. By design, the cockpit floor is not sealed and so smoke or fumes generated in the avionics bay may enter the cockpit. The static inverter has been standard equipment on Airbus A320 family[4] aircraft since the end of 1999, and may also be installed on Airbus A330, A340 and A380 aircraft types.

Static inverter failures

The operator of G-EZWX experienced its first failure of a cockpit additional electrical supply static inverter on 28 August 2014. This was reported in AAIB Bulletin 12/2014, and involved G-EZWM, an Airbus A320 aircraft, which diverted to London Gatwick due to smoke and fumes in the cockpit. Inspection of the static inverter found that damage centred on a capacitor, C306, which had overheated and failed. This resulted in the release of a '*strong acrid electrical type*' smell. At this time, the static inverter manufacturer considered that the failure was an isolated occurrence.

Footnote

3 Part Number 1-002-0102-1830, serial number AA11136801.
4 This includes the A318, A319, A320 and A321 aircraft types.

In January 2015, the operator had a second static inverter failure. This unit was fitted to Airbus A320, registration G-EZWK, which diverted to Amsterdam whilst en route from Berlin to Bristol, due to smoke and fumes in the cockpit. On both occasions, the crew had donned their oxygen masks.

The aircraft manufacturer had received reports, including those from other operators, of eight other static inverter failures between August 2014 and December 2016. Of the total of 11 failures (including that of G-EZWM, G-EZWK and G-EZWX), eight had occurred between August 2014 and March 2016. The reports submitted to the aircraft manufacturer indicated that the failures had all occurred in flight, with at least seven resulting in diversions.

Notification of static inverter failures to operators

On 9 March 2016, following the first eight failures, the aircraft manufacturer issued Technical Follow-up (TFU) 24.00.00.114, '*Premature failure of the Cockpit Additional Supply Static Inverter*'`. This noted that 's*ome operators of the A320FAM aircraft experienced premature failure of this static inverter which led to smoke/burn smell in the cockpit*'[5], and that the fault had been isolated to capacitor C306 (the same component identified during the G-EZWM investigation in August 2014). This capacitor had been identified as not having received an individual quality screening prior to fitment, with a batch[6] of 2,058 static inverters affected. The vendor had yet to develop a solution and no remedial action was provided in the TFU at that time.

On 13 October 2016, VSB 1830-25-37, '*Equipment – Cockpit Additional Electrical Supply – Static Inverter – Capacitor C306 replacement,'* was published on the vendor's website, which recommended the static inverter to be removed for modification. On 19 October 2016, TFU 24.00.00.114 was updated by the aircraft manufacturer to reflect that VSB 1830-25-37 was available and noted that operators could modify their affected static inverters free of charge.

Technical Follow-up notices and Operator Information Transmissions

TFUs form part of the aircraft manufacturer's technical documentation that is provided to operators. In July 2014, the aircraft manufacturer rationalised its documentation processes, including TFUs, following recommendations from operators. It communicated these changes to TFUs in Operator Information Transmission (OIT) 999.0017/14 which stated that it would ensure that there is a clear segregation between:

- 'Instructions,' which were defined as 'documents which enable operators to perform an action on their aircraft' and
- 'Information,' defined as 'documents that help customers to support and improve the operation of their aircraft.'

Footnote

5 *'A320FAM'* refers to the A320 family of aircraft.
6 Part number 1-002-0102-1830, serial numbers from AA11135265 to AA11137323 (manufactured between 10 September 2012 and 25 November 2014).

The TFU was defined by the aircraft manufacturer as a type of document providing '*Information*,' not '*Instructions*.'

The aircraft manufacturer further advised that:

- '*TFU gives operators follow-up information, from the time an issue is identified to the time that the solution has proven its efficiency in the field. However, TFU may make recommendations to apply instructions that are included in other relevant publications such as Service Bulletins or AMM/ TSM tasks*'[7]'

and that:

- 'an OIT *'is issued to communicate quickly to operators information on in-service events or findings reported to Airbus, that have substantial implications on the Airbus fleet operations, and to provide relevant advices or recommendations in order to address or mitigate them.'*

Operator's TFU and VSB review process

TFU's may be accessed by operators using an online electronic database which can be configured to provide automatic notifications when a new TFU is issued, or track the status of an existing one. The operator of G-EZWX used a maintenance management software system called AMOS[8], which formed part of its airworthiness control. Technical documents, such as Airworthiness Directives, Service Bulletins (SBs) from the aircraft manufacturer, and OITs were imported into AMOS by the operator. This information was then reviewed by its engineering department, who would implement the necessary action. However, TFUs were not imported into AMOS, nor routinely reviewed by the operator.

The operator of G-EZWX did not receive notification from the static inverter manufacturer that VSB 1830-25-37 had been issued in October 2016, as it had not registered with this vendor to receive updates. The operator advised that it relied predominantly upon communications from the aircraft manufacturer to identify VSBs that required follow-up action.

On 1 December 2016, three days after the incident to G-EZWX, and following discussions with the aircraft manufacturer's on-site representatives, the operator became aware of TFU 24.00.00.114 and VSB 1830-25-37.

Decision to issue TFU by the aircraft manufacturer

On 2 December 2016, the operator of G-EZWX asked the aircraft manufacturer why the cause of the static inverter failures was communicated in a TFU, rather than an Alert

Footnote

7 AMM (Aircraft Maintenance Manual) and TSM (Trouble Shooting Manual).
8 AMOS is a proprietary software system that is in use at over 140 other operators.

Operator Transmission (AOT), an OIT or an SB[9], which it considered more appropriate in relation to the '*severity of the outcome;*' noting that:

> *'failure of the capacitor due to overheating resulting in a smoke smell event should be classified as a safety issue and hence should have been clearly communicated to the operators.'*

The aircraft manufacturer advised that its initial analysis, following the first eight failures, had determined that a TFU was the most appropriate means of communicating the information related to the overheating of the Static Inverter capacitor 306, and, from October 2016, related to the availability of the VSB 1830-25-37. The analysis had taken into account aspects such as failure mode, availability of crew procedures and impact on airworthiness and safety.

The aircraft manufacturer further advised that it had continued to reassess the situation and had decided in September 2016 that it would issue an OIT to '*broaden awareness* amongst operators. The OIT 999.0096/16 '*Failure of the Cockpit Additional Electrical Supply System'* was submitted for internal review on 20 October and issued to all operators on 15 December 2016. This OIT highlighted that the reason for the failure of the static inverter had been identified and VSB 1830-25-37 had been published to address this.

The AAIB contacted another UK operator that operated a large[10] fleet of the Airbus A320 family of aircraft. It had a similar understanding of TFUs, had similar internal processes to deal with them and TFUs did not form part of its routine technical document review process. This operator had several of its aircraft fitted with static inverters from the affected batch and only became aware of the issue following receipt of OIT 999.0096/16.

Cabin interphone system

The Airbus A320 is equipped with a Cabin Intercommunication Data System that incorporates the functions of the cabin and cockpit interphone and passenger address systems. The cabin and cockpit interphone system allows telephone communications between all cabin crew attendant stations and the cockpit. Communication at each cabin attendant station is made using a handset. G-EZWX was fitted with one handset at the forward cabin crew attendant station (Figure 1), and two handsets at the rear attendant stations.

In the cabin, interphone calls can be made from an attendant station to another attendant station or the cockpit, by making the appropriate selection on the handset's keypad (Figure 2). The handsets are also used to make passenger announcements in the cabin.

Footnote

[9] An AOT and an OIT are used when it is necessary to communicate quickly with operators, and provides a means to raise the awareness of operators to information issued which is related to significant in-service events. An SB issued by the aircraft manufacturer provides instructions, and can be used to cross-reference to VSB's issued by a vendor.

[10] More than 100 aircraft.

On G-EZWX, a call can be made from the cockpit to either the forward attendant station, aft attendant stations, or all attendant stations simultaneously. These options are selected by pressing and releasing the FWD, AFT or EMER pushbutton switches on the overhead panel in the cockpit. For a pilot to listen to an interphone call in the cockpit, the CAB (cabin) reception knob on the pilots' audio control panel (ACP) must be selected ON. For the cabin crew to hear the pilot speaking over the interphone, the pilot must select the ATT (attendant) transmission key on the ACP to ON, and then set the INT/RAD switch on the ACP to the RAD position, or depress and hold the sidestick radio transmit selector, whilst speaking into the boom or oxygen mask microphone.

The cabin interphone system prioritises calls initiated from the cockpit, which override calls made from the cabin.

An interphone call to an attendant station handset is 'connected' when the handset is unlatched and removed from its cradle. If the 'connected' handset is then placed back onto its cradle, or the RESET button on the handset's keypad is pressed and released, the handset is 'disconnected' from the call. This is referred to as a handset that has been 'reset'.

Figure 1

G-EZWX forward attendant position handset in its cradle

Figure 2

G-EZWX forward attendant position handset keypad

Cabin interphone - normal operation for calls between cabin and cockpit

Under normal operation, calls from the cabin attendant stations to the cockpit are initiated by pressing and releasing the CAPT button on the handset keypad. When selected, the ATT key on all ACP's are illuminated and a buzzer sounds[11] once in the cockpit. In the cabin, the 'CAPTAIN' message is displayed on the corresponding attendant station Attendant Indication Panel (AIP).

Calls from the cockpit to the cabin are initiated by selecting either the FWD or AFT attendant station call switches on the cockpit overhead panel. When selected, the red lights illuminate on the corresponding forward or aft area call panel, a single hi-low chime sounds in the relevant section of the cabin and a 'CAPTAIN CALLS' message is displayed on the adjacent AIP.

Cabin interphone - emergency operation for calls between cabin and cockpit

In an emergency, a call can be made from one attendant station handset to all other attendant stations and the cockpit, enabling simultaneous communications between crew members. This is initiated by pressing and releasing the EMER CALL button on the handset. When selected, the buzzer in the cockpit sounds three times and the EMER pushbutton switch and all ACP ATT keys flash repeatedly. In the cabin, red lights flash at both forward and aft area call panels, three hi-low chimes sound in the cabin and the 'EMERGENCY CALL' message is displayed on all AIP's[12].

The emergency interphone function is initiated from the cockpit to all cabin attendant stations by pressing and releasing the EMER pushbutton on the overhead panel. This results in red lights flashing at both forward and aft area call panels, three hi-low chimes sounding in the cabin and the 'CALL EMERGENCY' message displayed on all AIPs.

An emergency interphone call from the cockpit is cancelled under the following conditions:

- when all attendant station handsets have been 'reset', or
- after two minutes, if the cockpit ACP has not been configured to transmit on the interphone channel by selection of the ATT key, or
- after approximately five minutes if the emergency call is not connected to an attendant station handset.

Cabin interphone - testing

A test of the emergency interphone system on G-EZWX found no defect in its operation. However, it was found that when an emergency call from the cockpit was initiated and the forward attendant station handset was then lifted from its cradle, connecting it to the call, and the handset was then 'reset' (disconnected) by either placing it back onto its cradle or by pressing the RESET button on its keypad:

Footnote

[11] The buzzer is inhibited during takeoff and landing.
[12] Depending upon configuration, the message may only be displayed on the AIP adjacent to the handset where the call was initiated.

- It was possible to make a PA announcement to the cabin from the forward handset whilst the emergency interphone call from the cockpit was still in progress.
- It was not possible to make a call to the cockpit by selecting the CAPT button on the forward handset's keypad until the emergency interphone call was cancelled.
- It was not possible to call an attendant station handset at the rear of the aircraft from the forward handset unless the handset at the rear had also been reset, or until the emergency interphone call was cancelled.
- Pressing and releasing the EMER CALL button on the forward handset's keypad resulted in this handset being 'reconnected' to the emergency call, enabling the re-establishment of communication with the cockpit.
- Pressing and releasing the FWD pushbutton on the overhead panel in the cockpit, whilst the emergency call function was still active, resulted in a single hi-lo chime in the forward cabin. If the forward handset was then removed from its cradle, it was connected to the call from the cockpit.

Cabin interphone – documentation and training

Documentation provided by the operator to its cabin and cockpit crews did not include information on how to re-establish communications from a 'reset' handset to an emergency interphone call initiated from the cockpit or cabin. The operator's documentation was based on that provided by the aircraft manufacturer.

The AAIB investigation noted that specific use of the emergency interphone call function was not included in cabin crew training.

Analysis

Static inverter failure

There have been a number of failures of static inverter associated with a particular batch of an internal component. Following identification of the first eight failures, the aircraft manufacturer provided information to operators in the form of a TFU. The aircraft manufacturer's decision to use a TFU as the most appropriate communication method was based on a number of factors, including operational procedures being in place to remove smoke and fumes released into the cockpit.

A TFU does not require operator action and is a document that '*helps customers to support and improve the operation of their aircraft.*' As no follow-up action is required, the operator of G-EZWX, like another UK operator, did not conduct regular reviews of TFUs as part of its airworthiness control processes. This contrasts with important information provided in Airworthiness Directives, Service Bulletins and Operator Information Transmissions which are likely to require operator action and so are subject to regular review.

On 13 October 2016, just over a month prior to the failure on G-EZWX, the static inverter manufacturer made VSB 1830-25-37 available on its website and, six days later, the aircraft manufacturer updated TFU 24.00.00.114 to incorporate this information. However, the operator was not aware of this VSB and did not review the updated TFU, as the operator relied predominantly on the aircraft manufacturer to communicate such information by means of an OIT or SB to indicate that action might be required. After the incident, the manufacturer's on-site representatives made the operator aware of both the TFU and VSB.

On 15 December 2016 the aircraft manufacturer issued OIT 999.0096/16 '*Failure of the Cockpit Additional Electrical Supply System'* to all operators. This OIT was issued to "*broaden awareness"* that the reason for the failure of the static inverter had been identified and VSB 1830-25-37 had been published to address this. One other UK operator, which had a number of its own aircraft affected, only became aware of the issue upon receipt of this OIT.

Smoke in the cockpit and the emergency use of oxygen by flight crews are considered to be safety issues by ICAO and, in Annex 13 Attachment C, cite them as possible examples of a Serious Incident. Following the G-EZWX event, the operator queried the aircraft manufacturer's use of a TFU in this instance as it had concerns that the identified mechanism of the '*capacitor failure due to overheating resulting in a smoke smell event should be classified as a safety issue and hence should have been clearly communicated to the operators.*' The failure of the static inverter on G-EZWX resulted in an unplanned diversion and the flight crew donning oxygen masks. As a consequence of the smoke and fumes released into the cockpit, this particular mode of failure of the static inverter has resulted in a total of seven aircraft diverting.

Cockpit to cabin communications

The co-pilot experienced difficulties in communicating with the cabin crew using the emergency interphone system, and it took three minutes from first selecting the emergency interphone function before two-way communication was eventually established.

It was most likely that the reason the CM had been unable to hear the co-pilot was because the co-pilot had not set his ACP to transmit on the cabin attendant channel, or he had omitted to select the radio transmit switch on his ACP or sidestick whilst speaking into the oxygen mask microphone. This led to the CM hanging up his handset, which disconnected it from the emergency call.

The CM was then able to make a passenger announcement from the forward handset. However, as the emergency interphone call was still active, it would not have been possible for the CM to have initiated an interphone call to either the cockpit or cabin crew at the rear of the aircraft, until the emergency call was cancelled. In the absence of any other action, this would have required the CM to wait for up to two minutes until the emergency call 'timed out.' Pressing the EMER CALL button on his handset would have reconnected the CM to the emergency call immediately; however, the CM was not aware that this was required as it was neither documented nor covered in training.

Three minutes after having initially tried to establish communications with the cabin crew, a button press in the cockpit accompanied by a single call chime was recorded on the CVR. The CM removed his handset from its cradle and pressed and released the EMER CALL button on the keypad before speaking into it. Communications were then established between the CM and co-pilot. The single call chime, followed by communications being established with the CM indicates that the co-pilot had selected the forward attendant call button at this time. This call was prioritised over calls initiated from the cabin and it was therefore not necessary for the CM to have selected the EMER CALL function on his handset to connect the call.

It is important that communications between flight crew and cabin crew can easily be established in the event of an emergency and the emergency interphone system is provided to facilitate this. However, testing has shown that the system's operation is not fully documented and its use is not fully understood. The operator of G-EZWX did not provide training to crew on the operation of the emergency interphone system.

The aircraft manufacturer has acknowledged that there is a need for additional information and has launched a review of operational documentation on the operation of the emergency interphone system. This review is due to be completed in July 2017, following which additional information is to be provided to all operators. The operator of G-EZWX has advised that it will update its manuals and training once this information is available.

Safety action taken

- By 9 December 2016, the operator of G-EZWX had removed all affected static inverters from its fleet and those that were held as spares.
- The operator's engineering department is now reviewing all TFUs on a routine basis.

Further safety action

- The aircraft manufacturer has advised that, later in 2017, it will release an Inspection Service Bulletin (ISB) to assist operators in identifying and rectifying any of the affected static inverters.
- The aircraft manufacturer has also advised that it will provide additional information to operators on the operation of the emergency interphone system.
- The operator has advised that, following the provision of the additional information of the emergency interphone system from the aircraft manufacturer, it will include this as part of crew training and update the appropriate internal manuals.
- The operator has also advised that it intends to conduct a review of its processes that relate to VSBs.

Conclusion

Static inverter failure

The source of the smoke and fumes was traced to the cockpit additional electrical supply static inverter, which had overheated. The manufacturer of the static inverter isolated the fault to a component, capacitor C306, which had not received an individual quality screening prior to fitment. A batch of 2,058 static inverters were affected.

The incident on G-EZWX was the eleventh failure reported to the aircraft manufacturer which had resulted in the release of smoke and fumes into the cockpit. Of the eleven failures, at least seven had resulted in diversions.

The operator was not aware until after the incident that the manufacturer of the static inverter had published VSB 1830-25-37, nor that the aircraft manufacturer had previously communicated the problem with the static inverters in TFU 24.00.00.114. This was because the operator was not registered to receive notifications of VSB's from the manufacturer of the inverter and, like another large UK operator, did not routinely review TFUs.

Following a decision in September 2016, the aircraft manufacturer subsequently issued OIT 999.0096/16 to all operators on 15 December 2016 to "*broaden awareness*" that the reason for the failure of the static inverter had been identified and VSB 1830-25-37 had been published to address this.

Both the aircraft manufacturer and the operator intend further safety action, in addition to that which has already been taken.

Emergency interphone communications

Initial communications between the CM and co-pilot using the emergency interphone system failed to be established, as the co-pilot either inadvertently omitted to set up his ACP to transmit on the cabin interphone channel or did not select the transmit button. The CM was unable to hear the co-pilot and hung up his handset, which disconnected it from the emergency call. Communication was subsequently established with the CM about three minutes later when the co-pilot selected the forward interphone call option.

The investigation identified that neither information nor training was provided to crew on how to re-establish communications to the cockpit in the event that a cabin handset became disconnected from an emergency interphone call initiated from the cockpit.

Whilst an emergency call is in progress, it is not possible to initiate a call to the cockpit from a handset that has been disconnected. However, by selecting the EMER CALL button on the disconnected handset's keypad, the handset is reconnected to the emergency call, allowing communications with the cockpit and other cabin crew who are also on the call. The CM was not aware of this feature, but had he been, communications may have been established more quickly. The emergency interphone system is infrequently used, and therefore it is important that crew have a good understanding of its operation in the event of an emergency.

Both the aircraft manufacturer and the operator intend to take safety action to address this issue.

ACCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8 (Q400), G-PRPC
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2010 (Serial no: 4338)
Date & Time (UTC):	14 December 2016 at 0624 hrs
Location:	On departure from Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 27
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to engine access panel, impact damage to vertical stabiliser and VOR/LOC antennas
Commander's Licence:	Airline Transport Pilot Licence (Aeroplanes)
Commander's Age:	45 years
Commander's Flying Experience:	7,120 hours (of which 142 were on type) Last 90 days – 142 hours Last 28 days – 63 hours
Information Source:	AAIB Field Investigation

Synopsis

Following overnight maintenance work, the outboard engine access panel on the No 1 engine was incorrectly latched shut. This was not identified by the engineer completing the task, by the flight crew during the subsequent pre-departure inspection, or by the ground operations personnel dispatching the aircraft. During takeoff the panel failed at the hinge attachment points and departed the aircraft, striking and damaging the vertical stabiliser, before coming to rest on the runway and its grass verge. A previous incident, where the same engine panel was lost during takeoff, had occurred on the aircraft a month earlier. This report addresses both incidents. Safety action has been taken by the aircraft manufacturer to add labelling and amend the Aircraft Maintenance Manual (AMM), and the operator has revised its maintenance procedures. In addition, two Safety Recommendations have been made relating to flight crew pre-departure inspection procedures and dissemination of safety information to ground crew.

History of the flight

Following a day of routine flying operations on 13 December, the aircraft night-stopped at Manchester Airport and was parked on a remote stand. The operator's contracted maintenance organisation completed a routine daily check on the aircraft that evening. This included checking the oil content of the No 1 engine, accessed by opening the outboard main access panel on the engine nacelle. The check was concluded by approximately 2115 hrs, with the aircraft scheduled to return to service for a 0610 hrs departure the next morning. The aircraft Technical Log entry for the daily check was signed by the engineer at 0010 hrs.

The operating flight crew arrived at the aircraft at 0530 hrs and began their normal pre-flight checks. At 0550 hrs, in accordance with company procedures for the first flight of the day, the commander conducted the pre-departure inspection. As it was still dark, he used a torch to supplement the ambient airport lighting during his inspection. He did not identify any issues with the aircraft and the crew continued with their normal departure routine.

The ground crew, who were responsible for pushing the aircraft back off the stand, subsequently arrived and conducted their own walkround check of the aircraft, also identifying nothing of note. The aircraft was dispatched on time and taxied to Runway 23R for takeoff. At approximately 0624 hrs the aircraft commenced its takeoff roll and then continued on an apparently uneventful flight to Hannover, Germany, landing there at 0752 hrs.

After the aircraft had parked on the stand and the passengers had disembarked, the ground crew informed the cabin crew that a panel was missing from the No 1 engine. The message was relayed to the flight crew, who inspected the aircraft prior to contacting the operator's maintenance control department. The operator informed Manchester Airport operations staff at 0836 hrs, who then conducted an inspection of Runway 23R. The panel was recovered from a grass area to the side of the runway, approximately 440 m from the runway threshold. Sections of the panel hold-open strut were also recovered from the runway and adjacent paved areas in the same vicinity (Figure 1).

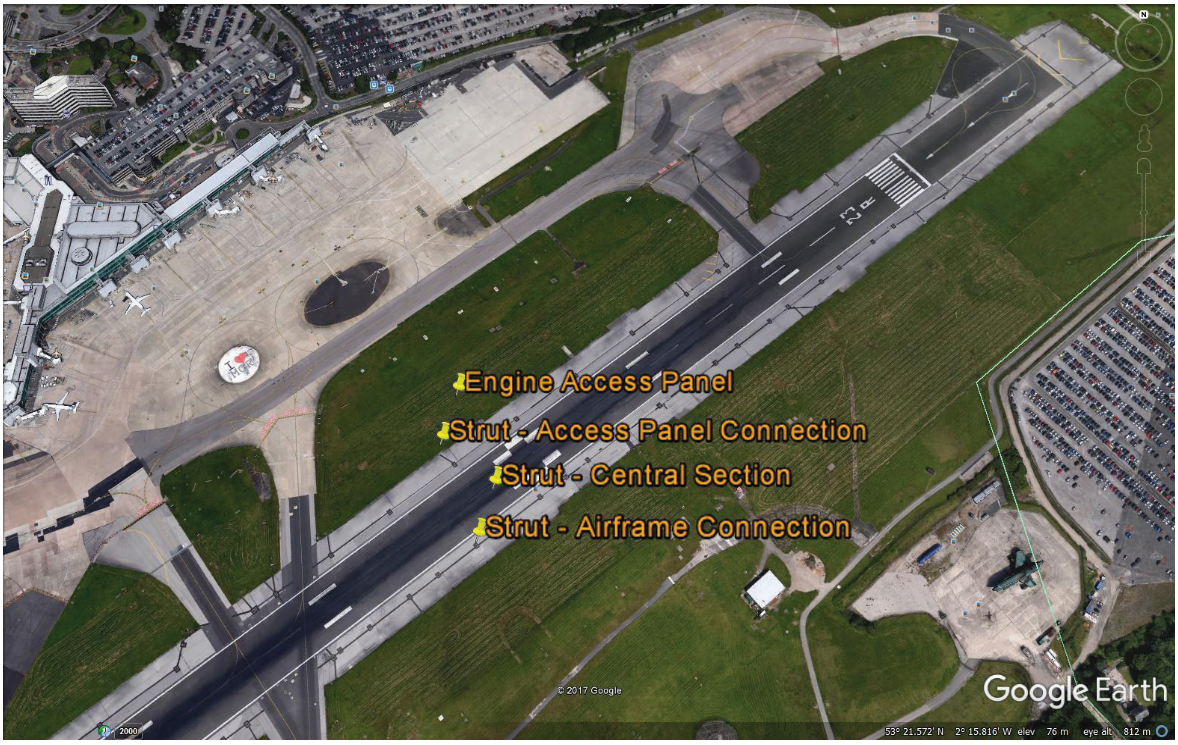


Figure 1

Location of items released from the aircraft during takeoff

Aircraft information

The DHC-8-402 Dash 8 (Q400) is a twin-turboprop, medium-range, passenger aircraft. The main engine bay of each engine nacelle has two large forward access doors, one inboard and one outboard. These access doors are made from a carbon/epoxy composite material with integral foam-filled stiffening ribs. Each door is hinged at the top, has a single telescopic hold-open strut and is secured in the closed position by four quick-release lock pin latches (Figure 2). Each latch, when closed, engages a pin into a receiver mounted within the engine nacelle structure. The outboard door on the No 1 engine and the inboard door on the No 2 engine allow access to service the engine oil system.

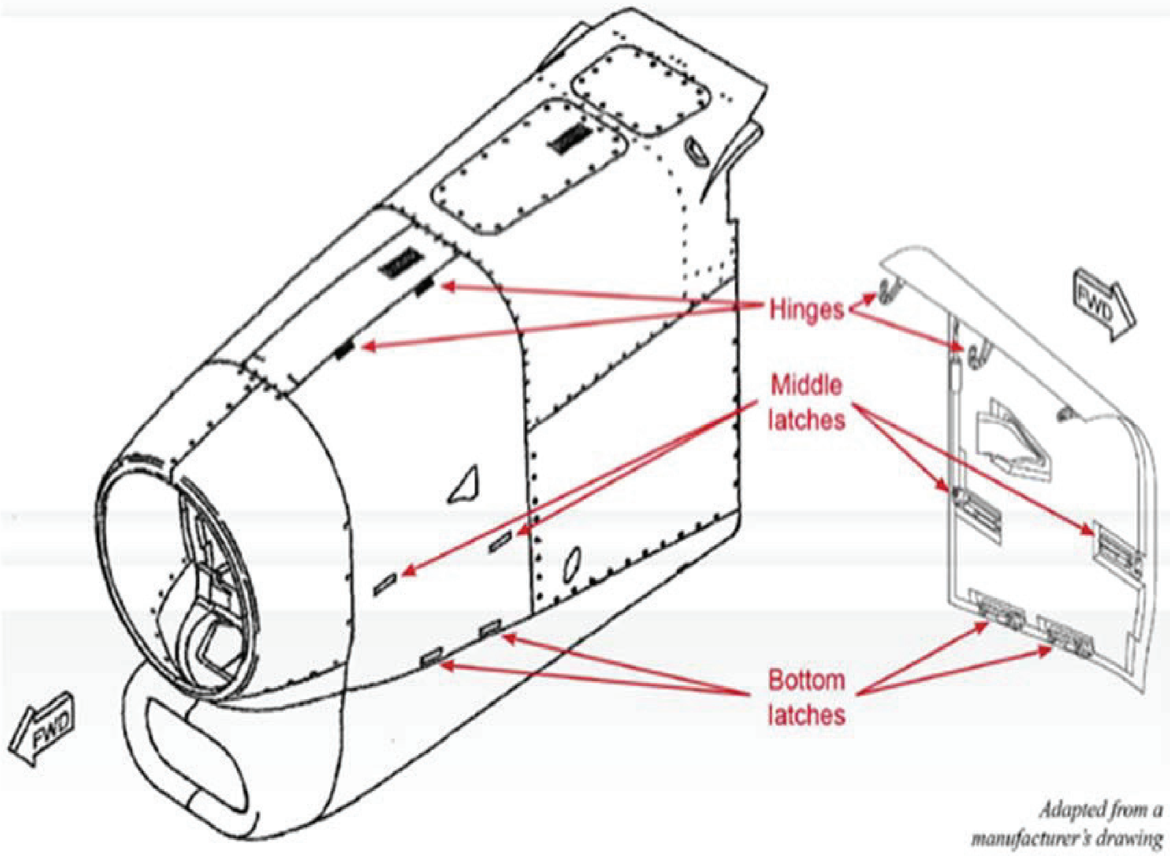


Figure 2

Forward engine bay access panel

Aircraft examination

On inspection of the recovered panel all four latches were found to be in the closed and latched position. There was no damage to the latch bolts or the receiving fixtures on the nacelle (Figure 3).

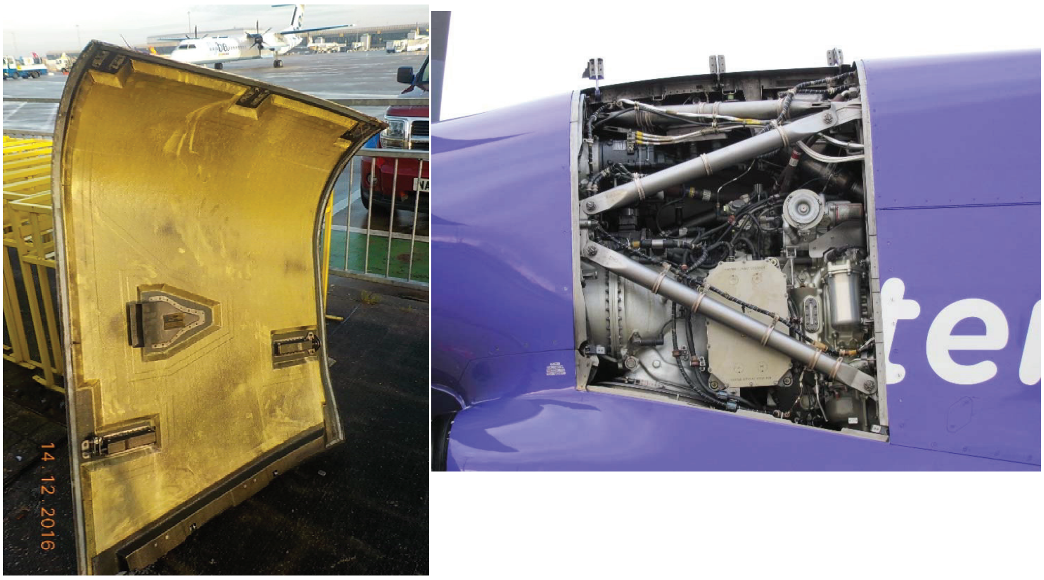


Figure 3

Engine access panel and nacelle

Inspection of the aircraft vertical stabiliser showed puncture holes in the skin on both sides, with impact marks also present on the leading edge de-icing boot. There was also impact damage to both VOR/LOC antennas.

Figure 4

Damage to vertical stabiliser (similar damage occurred on both sides of the vertical stabiliser)

Previous incident on the same aircraft

On 9 November 2016 the No 1 engine access panel was found missing from G-PRPC.

On the day before, it had arrived at Belfast City Airport at 2145 hrs following a day of routine operations. Engineers from the operator's subsidiary maintenance company met the aircraft and completed a routine daily check on the aircraft, which included checking the engine oil contents of both engines. After topping up the No 1 engine with oil, the engineer closed the access panel and completed the remaining parts of the aircraft check. The Technical Log for the aircraft was signed at approximately 0030 hrs.

Later that morning the flight crew arrived to prepare for the first flight of the day. At 0609 hrs the aircraft commander carried out a pre-departure inspection of the aircraft, which did not identify any issues. The ground crew responsible for departing the aircraft arrived at 0615 hrs and also conducted a walkround inspection. At 0643 hrs, the aircraft departed from Runway 22 for a flight to Glasgow Airport.

At 0700 hrs the flight crew from another departing aircraft from the same operator reported a foreign object on the runway. An inspection of the runway was carried out by Airport Operations at the request of Air Traffic Control and an engine access panel was recovered some 300 m from the threshold of Runway 22.

G-PRPC landed at Glasgow at 0715 hrs, at which time the ground handling personnel informed the flight crew that the No 1 engine access panel was missing from the aircraft. Further inspection also identified damage to the left wing leading edge de-icing boot and wing skin panel. The recovered access panel showed that all four latches were closed. There was no damage to the nacelle where the latching bolt receiving features were located.

Following this incident, on 29 November 2016, the operator issued Notice to Engineers (NTE) 22 requiring that:

> *'Following completion of all work either an independent person carries out a walkround inspection to verify all access panels are fitted/secure, or the certifying engineer must return after a notable period of time for a double check of the security of the disturbed panel security. The independent person could be a technician or a pilot, or the notable period of time could be after completion of paper work.'*

The NTE did not require the additional walkround inspection to be recorded in the maintenance paperwork or the aircraft Technical Log.

CCTV footage

Airport CCTV footage was recovered showing the commander's pre-departure inspection, which was done with the aid of a torch. The torch beam could be seen on various parts of the aircraft as the commander went to the nose of the aircraft first, then to the tail, followed by the No 2 engine and the landing gear. The commander then inspected the No 1 engine and the torch light could be seen on the access panel area. The inspection had a total duration of 3 minutes.

No CCTV footage was available for the period when the maintenance check was carried out on the No 1 engine.

Previous incidents on the global fleet

The manufacturer reported that there have been nine other incidents of engine access panel loss in-flight across the worldwide Q400 fleet. In each case there was no damage to the airframe latch bolt receiving fixture, suggesting that the panel latches had been closed incorrectly.

January 2017	Nacelle door detached
November 2015	No 1 nacelle outboard door detached
July 2015	Outboard door detached
August 2014	Nacelle door detached
July 2014	No 2 nacelle inboard door detached
December 2012	No 2 nacelle inboard door detached
April 2010	No 2 nacelle inboard door detached
July 2008	No 1 nacelle - outboard door detached
December 2005	No 1 nacelle inboard door detached

Human factors

Engineering

The maintenance carried out on the aircraft on the evening of 13 December was conducted by a third party maintenance provider under contract to the operator. Following the incident, the maintenance provider's staff based at Manchester Airport stated that they were unaware of the existence of NTE 22 at the time the work was carried out, so had not conducted any additional post-maintenance inspection to check the security of the latches and panels. The operator's safety investigation established that, unlike the operator-owned maintenance subsidiary, there was no procedure in place for contracted maintenance company staff to read and sign NTEs.

The routine daily check requirement was laid out in a set of task sheets where each task, once completed, required sign off by an engineer licensed on type. The list of the tasks commenced with checks to internal systems and components, identified as tasks 1 to 14. The first external check was task 15, which required a full external walkround of the aircraft checking for damage, leaks and panel security. Checking the engine oil content of each engine was listed as tasks 26 and 27. These tasks were highlighted as safety critical and had a requirement for an independent check of the oil cap (or repeat inspection after a period of time, in the case of a licenced engineer completing the task). There was no similar instruction regarding the closing of the panel. Whilst the task stated the oil contents check should be in accordance with the Aircraft Maintenance Manual (AMM), a subsequent review with the aircraft manufacturer confirmed that, at the time of this event, the AMM did not contain any instructions on opening or closing the engine access panel.

The operator's expectation was that each item on the daily check task sheet would be signed for. The individual pages would then be certified complete and an entry would be added to the aircraft Technical Log, stating that the daily check had been completed. The signed hard copies of the task sheets and Technical Log pages should then have been posted to the operator's HQ in accordance with their procedures. The operator's safety investigation identified that the contracted maintenance company was not certifying the individual tasks or task sheet pages, but was just adding an entry directly into the aircraft Technical Log. The hard copy documents were also not being sent to the operator.

Interviews with the engineers involved in both the first and second incidents identified a common technique used to secure the engine access panel. This involved closing the two upper latches first, followed by the two lower ones. Practical assessment of this technique showed that occasionally, as a result of a slight misalignment of the panel, it did not close correctly into the gap in the engine nacelle. Given the height of the panel and shorter distance to the hinge line, it was difficult to apply the necessary force to fully engage the panel at the level of the top latches, when compared to applying a similar force at the bottom of the panel. This could result in the top latches being closed, without the panel being properly located. As a consequence, the locking pin would not be engaged in the receiving fixture on the nacelle side, but the latch would externally look and feel as if it was properly closed. Once the upper latches were closed in this manner, the panel would rest on the upper latch pins. Significant force could then be applied to the bottom of the panel while the lower latches were closed, but the pins would not engage in their receiving fixtures. The only external visual confirmation of the incorrect closure of the panel, was a small gap between the access panel and the surrounding nacelle panels (Figure 5).

Figure 5

Panel gap resulting from an incorrectly latched panel (viewed from the ground under similar lighting conditions to both incidents)

The engineers in both incidents involving G-PRPC were standing on steps to access the engine which meant once the access panel was closed, they were looking downwards at the panel and using a head torch to supplement the ambient lighting on the stand. Figure 6 shows how the perspective of the gap in the panel changes, when viewed under these circumstances. This would have been further exacerbated on the incident aircraft as the surrounding panels were painted purple rather than white, providing much less contrast to the shadow cast by the access panel.

Figure 6

View of the panel gap following incorrect closure, from the perspective of the engineer conducting the task.

The operator subsequently revised NTE 22 post-incident to introduce a procedure where a sticker is placed over the bottom of the panel, when it is closed post-maintenance. This provides visual and tactile confirmation to the engineer that the panel is correctly closed and secured.

Flight operations

The airline procedures for pre-departure inspection of the aircraft were documented in the Operator's Operations Manual Part B4 section 2.5.8 '*External Inspection*,' which stated:

> *'The external checks are normally performed walking clockwise around the aircraft starting at the front passenger door. Crews shall not open any panels as part of the external inspection, unless there is a specific reason to believe that a security threat exists, or the Crew is pre-selecting a refuel figure. Particular attention should be made to ensure that all panels, equipment bay doors, engine cowlings are properly closed and secure and all pitot and static ports are not damaged or obstructed.'*

The inboard and outboard engine access panels were also highlighted as a specific check item in the pre-departure inspection checklist. The operator provided information on what initial and recurrent training was provided for flight crew with respect to the pre-departure inspection. Guidance was provided at several points through the training which was delivered whilst walking around the aircraft:

- During an initial ground school hangar visit
- During base training
- During line training
- Assessed on final line check and then bi-yearly line check.

Following the first access panel loss in November 2016, the operator's Flight Operations department issued Notice To Air Crew (NOTAC) 146/16 - '*Engine Cowling and Hatches Inspection*', to request extra vigilance whilst conducting pre-departure inspections. The aircraft commander from the second incident on G-PRPC confirmed that he had read this document prior to the flight, but commented in interview that as he had previously been a flight engineer it did not contain any information that was new to him.

The commander stated that he was aware that a daily maintenance check had been signed for in the aircraft Technical Log and that this involved opening the engine access panels. When asked how he would normally assess that the access panel was secure, he stated that the latches would be flush. He advised that this was taught to him during his recent Q400 type conversion course, and was shown to him during the hangar visit and during his line training. (The commander had joined the operator five months earlier.)

Whilst the co-pilot had not been present during the pre-departure inspection prior to the accident flight, he stated that the securing of panels, including engine access panels, had been a classroom discussion on his Q400 type rating course. He had not had the opportunity to see a securely closed panel during the course hangar visit, as they had been open for maintenance at the time. He added that he had been shown the pre-departure inspection procedure by a co-pilot during his line training, who had not specifically highlighted the engine access panels as a check item.

Two further NOTACs (63/16 and 64/16) have subsequently been issued by the operator, to provide specific guidance in identifying correct panel and door closure during the pre-departure inspection and to highlight the engineering requirement to use a sticker over the engine access panel to confirm correct closure.

Ground operations

Ground operations personnel usually work for a company contracted to provide a service for the airport and facilitate the 'push back' procedure for aircraft parked on stands. This consists of using an aircraft tug to reposition the aircraft from the stand to a location where the flight crew can safely start the aircraft engines and taxi away under their own control. Typically a two-man team is used, one to drive the tug and a second who connects a headset to the aircraft intercom, allowing them to communicate with the flight crew and coordinate the process. They are not required to have any technical qualifications and often work on numerous different types of aircraft.

Before the aircraft dispatch process commenced, ground operations personnel were required to complete a final walkround check of the aircraft. Guidance for the task was provided in their Ground Operation Manual section 3.4.3.1:

> *'Before pushback can commence a final walkround and external visual inspection of the aircraft must take place. This should include an inspection of the condition of the apron including the removal of any FOD[1]; confirmation that all hold, passenger and service doors, panels and latches are closed and secure; chocks and ground equipment are removed from the aircraft and there are no other obstructions preventing the aircraft pushback onto the taxiway.'*

Ground operations staff did not receive copies of the operator's NOTAC or NTE. The ground handler during the second incident had completed headset training in April 2014. This training included pre-departure checks. The training certificate from this course listed different aircraft types that were covered by the training, but did not include the Q400. The headset training did not specifically refer to the Q400 type, but did include a generic reference to checking that panels and engine cowlings were closed.

Aircraft manufacturer's response

Advisory label

The aircraft manufacturer has commenced development of a modification to add an advisory label to the access panel which provides pictorial guidance on how to ensure the panel is correctly closed and latched (Figure 7).

Footnote

[1] Foreign Object Debris.

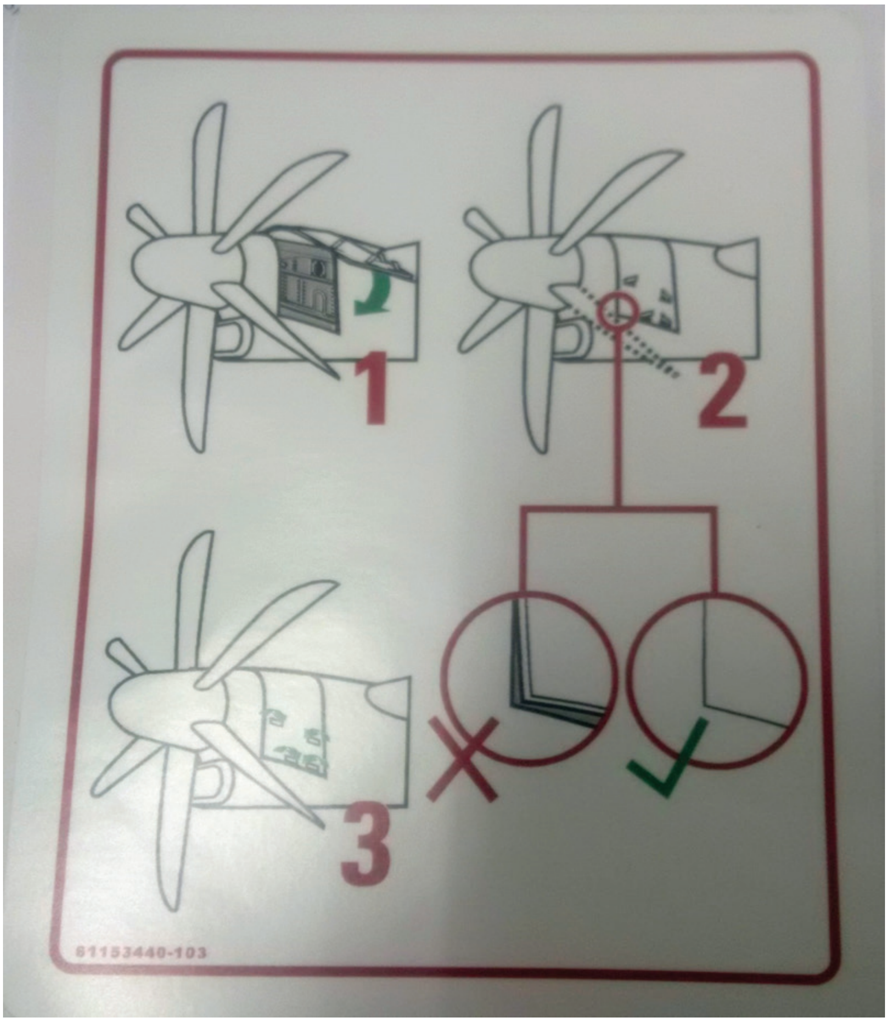


Figure 7
Advisory label modification

AMM Temporary Revision

Since this incident the aircraft manufacturer has issued AMM Temporary Revision 71-197, which includes instructions on how to correctly close the engine nacelle access door.

Analysis

On two separate occasions the outboard engine access panel on the No 1 engine on G-PRPC detached during takeoff. In both cases, the inspections of the panels and aircraft following the event showed that the locking bolts on the panel latches and the bolt receiving features on the nacelle had not failed or been damaged. In addition, the latches on the panels were confirmed to have been fully closed when the panels were recovered. As such, in both events the only explanation for the panels departing the aircraft during takeoff was that the bolts had not engaged in the receivers on the nacelle when the latches were shut. In this event, the aircraft sustained limited damage which did not compromise its ability to complete the flight safely. However, there is the potential for more serious damage to occur and the departure of such a large panel from the aircraft could also endanger people on the ground.

Engineering

The engineers conducting the maintenance daily check prior to both incidents were experienced and well trained staff, who had safely completed the same task many times during the years preceding these incidents. They came from different companies, with separate training organisations and operated at different airports. No significant contributing factors were identified which differentiated these two incidents from any previous occasions that they had completed the same task successfully. The only apparent common links were the technique used to close the panel, the physical positioning of the engineer as this was done and the lighting conditions at the time.

The technique of closing the top latches first, when combined with an access panel which may not immediately fit into its correct position without additional adjustment, appears to have created the conditions for a sequence of events which allowed the engineer to close the latches believing that they had correctly engaged the locking bolts, when in reality this was not the case. The fact that the engineers were then looking down on the panel, which was predominantly illuminated by the beam from a head torch, meant that the main indication of the gap at the bottom of the panel was only visually identifiable by the shadow that was cast. As the surrounding panels were painted purple this may not have been obvious, particularly considering that the engineer was not expecting the panel to be open once the latches were closed, was not specifically checking for the presence of a shadow, and may not have appreciated the implication of the presence of a shadow in this position.

Aircraft manufacturer's safety action

The manufacturer's addition of an advisory label on the panel will assist in raising awareness of the implications of a gap/shadow around the panel. At the time of this accident the AMM did not contain a procedure for opening/closing the panel. Evidence from this investigation suggested that using the technique of shutting the top latches first could, in some circumstances, increase the likelihood of the panel being closed incorrectly and not being secured. It would therefore have been beneficial for an approved technique for closing the panel to be included in the AMM. The aircraft manufacturer has since published Temporary Revision 71-197 to the AMM to introduce these instructions.

Operator's safety action

The operator has modified the daily check task sheet to introduce a final check of engine access panel security. This includes the requirement introduced by the revised NTE 22 to place a security sticker over the panel edge to confirm that there is no gap present. The sticker acts as an additional visual confirmation for flight crew that the panel has been correctly secured. The operator has also introduced a requirement for subcontract maintenance organisations to receive copies of NTEs.

Flight operations

The operator's Operations Manual provides clear guidance on how a pre-departure inspection should be completed, which highlights the need for the security of the engine access panels to be checked. However, there is a degree of inconsistency in the way in which this is taught practically to flight crew during their type training. The results of this were shown in the CCTV footage of the pilot's inspection prior to the first incident, which did not follow the Operations Manual process. It was also identified by the co-pilot's response when questioned about his training experience. If flight crew are not shown the difference between correctly and incorrectly closed panels, misunderstandings such as the belief that closed latches confirm the panel is secure can become accepted custom and practice, and incidents such as this may continue to occur. The improved NOTAC issued by the operator should help to increase awareness amongst their existing flight crew community, but introducing improved and consistent training will provide an opportunity to increase awareness amongst flight crew converting to the Q400. The following Safety Recommendation is therefore made:

Safety Recommendation 2017-014

It is recommended that Flybe Ltd introduces defined and consistently delivered flight crew training on pre-departure inspections for the DHC-8-402 (Q400), compliant with the inspection procedure documented in its Operations Manual. This should include a practical element on the aircraft and a demonstration of correctly secured main engine access panels.

Ground operations

Whilst walkround checks by ground operations crew represent a final opportunity to identify issues such as obviously open access panels, the personnel involved are not technically qualified on type in the same way that engineers and flight crew are. The operator has no control over the quality and content of their training and the service may be provided by multiple companies across all the airports that the operator flies to. As such, their inspection of the aircraft should only be considered a gross check and cannot be relied upon to address issues such as closed but incorrectly secured panels. However, there is potentially some benefit to the operator in increasing general awareness using specifically targeted guidance information relating to safety issues. The following Safety Recommendation is therefore made:

Safety Recommendation 2017-015

It is recommended that Flybe Ltd considers introducing a means of disseminating pertinent safety information to ground operations staff in an appropriate format.

Conclusion

Following overnight maintenance work, the outboard engine main access panel on the No 1 engine was not securely closed by the engineer, due to the latch bolts not engaging in the nacelle receiving features when the latches were closed. Contributory factors may have been a slight mismatch in the closure of the panel and the technique used by the engineer of closing the top latches first. The resulting gap around the panel was not identified by the engineer completing the task, possibly as a consequence of the angle at which he was looking down on the closed panel and the lack of contrast of the shadow cast on the dark coloured engine nacelle.

The aircraft commander did not identify the incorrect closure of the panel during his subsequent pre-departure inspection, neither did the ground operations crew dispatching the aircraft. During the next takeoff, the panel failed at the hinge attachment points and departed the aircraft striking and damaging the vertical stabiliser, before coming to rest on the runway and its grass verge. The investigation identified a lack of consistency in the way flight crew were instructed on completing pre-departure inspections during their training.

A previous accident, where the same engine panel was lost during takeoff, had occurred on the aircraft a month earlier. The circumstances and investigation findings for both accidents were the same. Safety action has been taken by the aircraft manufacturer to add labelling and amend the AMM and the operator has revised its maintenance procedures. In addition, two Safety Recommendations have been made relating to flight crew pre-departure inspection procedures and dissemination of safety information to ground crew, with the intention of preventing recurrence.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F150M, G-BDZC
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1976 (Serial no: 1316)
Date & Time (UTC):	17 October 2016 at 1021 hrs
Location:	Bourn Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (A)
Commander's Age:	58 years
Commander's Flying Experience:	363 hours (of which 9 were on type) Last 90 days - 7 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was seen to take off with 40° flap set. It did not appear to climb and flew at low level above the runway. Approaching a line of trees beyond the end of the runway, the nose pitched up and the aircraft banked left. The left wing dropped and the aircraft descended in a steep nose-down attitude into the ground. The pilot was fatally injured but the passenger survived. The investigation concluded that the pilot had attempted to take off with the flaps unintentionally set to the fully deployed position. The excess drag in this condition prevented the aircraft from climbing.

History of the flight

The pilot started flying at Bourn Airfield in April 2016. He was not familiar with the Cessna aircraft which were available at the flying club so during the next few weeks he was checked out by an instructor, flying in both a Cessna 150 (C150) and a Cessna 152 (C152). He completed 4 hours of dual training, a proficiency check, twenty minutes of solo flight and several subsequent flights, including a land away, accompanied by the same instructor.

On 17 October the pilot planned to take his father-in-law for a flight from Bourn to Enstone, Oxfordshire, and then return. There were two aircraft available for hire at the club. At the time he booked he had stated a preference for the C150 G-BDZC; the instructor thought this may have been because he had previously experienced the seat slipping back unexpectedly in the C152.
The pilot and his passenger arrived at the airfield mid-morning. Another club member was

already there; he had opened up the club house and was planning to fly the club C152 with an instructor. He carried out a pre-flight inspection and refuelled the C152 before assisting the accident pilot with refuelling G-BDZC; he noted that both tanks were refuelled to just below the filler cap. The pilot's own pre-flight inspection was partly observed by the other club member, who noticed that the flaps were deployed for the walkround.

The pilot, with his passenger on board, started the engine and taxied from behind the C152 across to the run-up area, located on an old taxiway to the east of Runway 18 (Figure 1). He remained there a short while and then taxied towards the threshold of Runway 18, out of view of the occupants of the C152.

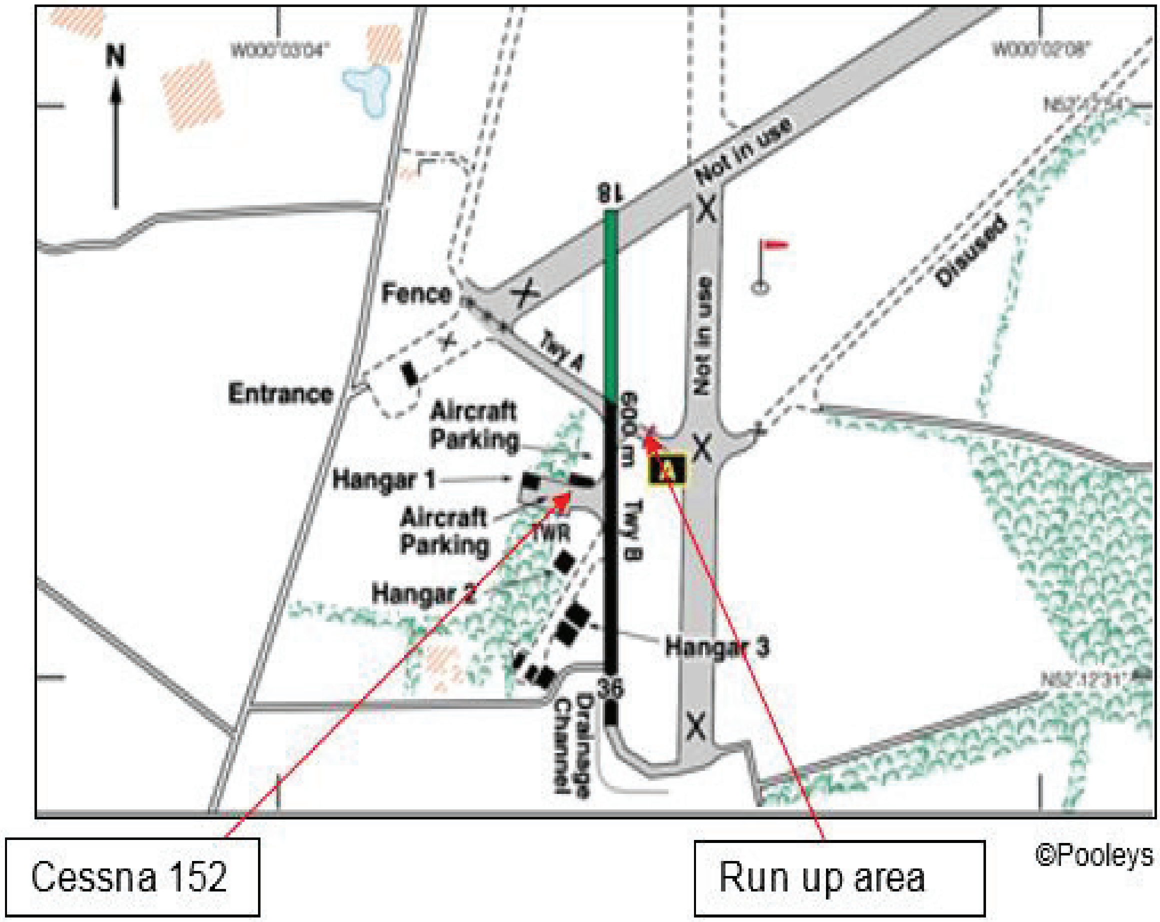


Figure 1

Aircraft parking and run-up areas at Bourn Airfield

The pilot broadcast a radio call to say that he was 'rolling' and the occupants of the C152 then saw the aircraft airborne, just above the runway, but not apparently climbing. They realised, as it passed in front of them, that the flaps were fully deployed. The instructor attempted to make a radio call to warn the pilot, but it was too late to be effective and there was no response. They watched G-BDZC continue towards a line of trees beyond the end of the runway and then saw the nose pitch up and the start of a left turn. The left wing then dropped and the aircraft appeared to enter an incipient spin, descending quickly to the ground.

Several people from the flying club and personnel from an industrial site on the airfield ran across to the aircraft. They were able to assist the passenger from the aircraft, but the pilot was trapped. Attempts were made to turn off the aircraft electrical power but it remained on, and, because of the potential fire risk, it was decided to attempt to get the pilot out. He was unconscious but they released him from the aircraft and pulled him clear. Cardiopulmonary resuscitation (CPR) was administered but they were not able to sustain his breathing. Emergency services arrived at the scene and a paramedic continued to attempt to resuscitate the pilot but without success.

Accident site

The aircraft had come to rest against some trees located on the southern boundary of the airfield (Figure 2). The accident site was some metres to the left of the extended centreline of the runway.

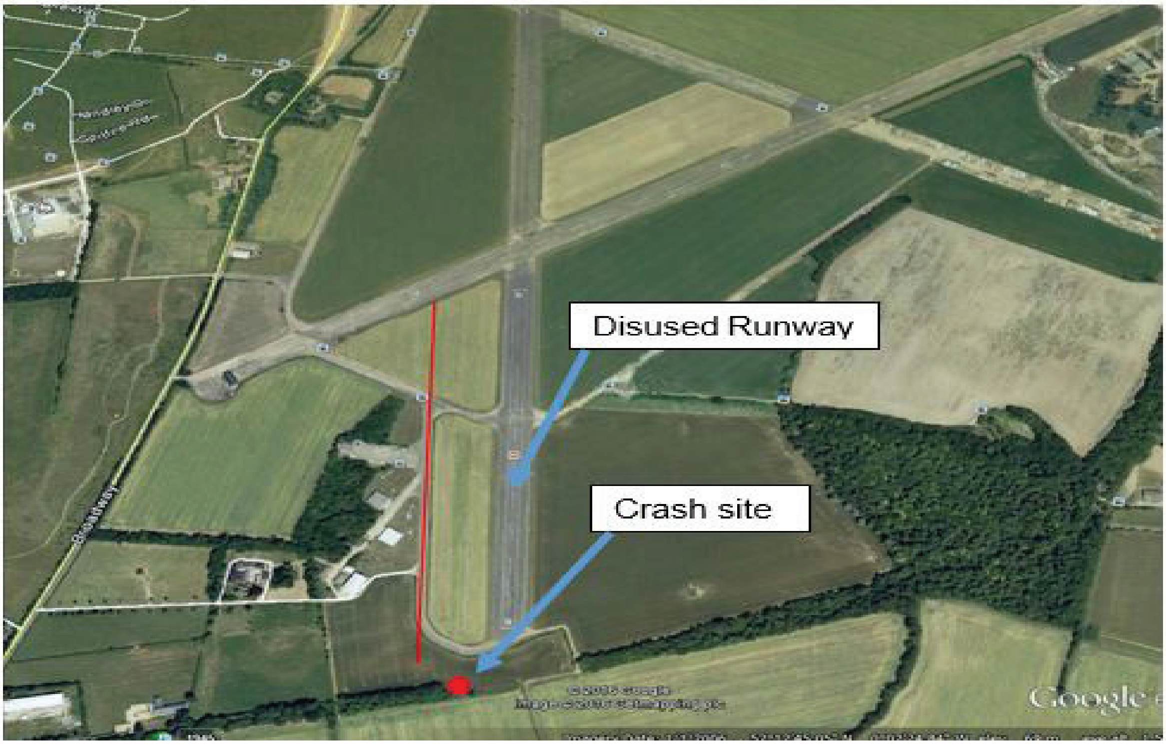


Figure 2

View of airfield showing accident site location relative to the extended centreline of the runway (red line). The 'old', disused runway is visible to the right.

The aircraft had taken off from the repositioned Runway 18, which had been brought into use during the spring of 2016. This was the result of the landowner leasing the old runway to a company that used it for storing ISO containers. The new runway utilised the old taxiway and had a grass extension to the north, giving a total length of 600 m.

The trees on the southern boundary ran in an approximately east-west direction and had a gap in line with the old runway. The aircraft had come to rest in a steep, nose-down attitude against the trees at the western edge of the gap. The trees were up to about 40 ft high and it was apparent that, apart from some light branches and foliage having become dislodged, there had not been a severe impact from the aircraft. Marks on the ground close to the base of the trees indicated that the aircraft had struck the ground in a near vertical attitude on its nose and outboard left wing. It had then rocked over onto the outboard region of the right wing before coming to rest with the tail resting lightly in the upper branches of a tree. It was concluded that the impact with the ground was consistent with the aircraft being in a spin to the left, with the velocity vector primarily in the downwards, as opposed to horizontal, direction.

The forward fuselage was severely compressed during the impact, such that that the left side of the instrument panel had been pushed rearwards into the cabin. The left wing root had been severely disrupted at the junction with the fuselage, with the rear spar attachment having broken. The left wing had remained attached although there had been some movement relative to the fuselage.

The propeller blades displayed evidence of chord-wise scoring, and a propeller 'chop' mark was found on the ground at the impact point, indicating that the engine was developing power.

It was observed that the flaps were at their maximum deflection of 40°. The inboard end of the right flap was in contact with the right hand side of the rear windscreen and the fuselage skin immediately below, causing distortion. There were no scrape marks or abrasion damage to either; it was therefore concluded that the flaps were in this position prior to impact (Figure 3).

Figure 3

As-found flap position, showing damage to rear windscreen and sill structure below

It was found that there was plenty of fuel aboard the aircraft. When the Fire and Rescue Service attended, fuel was reportedly leaking from the right wing tank fuel filler cap; they had stopped the leak using a clay compound. However, it was subsequently found that much of the fuel in both tanks had seeped away via a broken fuel line in the engine compartment.

Although the Alternator/Battery Master switch was found in the OFF position, the turn and slip gyroscope motor could be heard running for approximately eight hours after the accident.

The trim tab was noted to be in line with the elevator and thus in an approximately neutral position.

Following an on-site examination the aircraft was recovered to the AAIB's facility for more detailed inspection.

Aircraft information

General

The C150 is a side-by-side, two-seat training and general use light aircraft. It was in production between the years 1959 to 1977; thereafter it was replaced by the C152. Although it has many similarities with the C152 model, and the two are often considered as a single type, there are some significant differences. Flap selection and indication are different and the C152 has a greater available payload. A study by the General Aviation Safety Council suggests that the accident rate in the UK is higher for the C150 than for the C152[1].

Flaps

The wing flaps on G-BDZC were electrically operated, with a motor-driven actuator in the right inboard wing driving a screw jack. A nut on the jack in turn drove a pulley; cables transferred the pulley rotation to an identical component in the left wing. Control rods were attached to the pulleys and flaps such that pulley rotation resulted in the flaps extending or retracting. Limit switches on the actuator cut the electric power at the fully extended and retracted positions.

A mechanical flap position indication was provided in the left forward door post/windscreen pillar; in addition the flap extension could be seen from within the cockpit. The indicator consisted of a spring-loaded pointer running in a slot in the pillar, with calibration marks from 0° to 40°on the surrounding trim. A cable connected to the pointer ran via a conduit in the left wing root and was attached at its other end to the flap system pulley cable such that flap movement caused the indicator cable, and hence the pointer, to move in proportion.

Wing flap selection on G-BDZC was controlled by a switch on the lower centre instrument panel (Figure 4a). To extend the wing flaps the switch must be held against spring pressure in the DOWN position; when released the switch will return to the centre NEUTRAL/OFF position. To retract the flaps the switch had to be selected and held to the UP position; the switch would return, under spring pressure, to the neutral position when released. It would take

Footnote

1 GASCo study: 'A Study of Fatal Stall or Spin Accidents to UK Registered Light Aeroplanes 1980 to 2008'

approximately 9 seconds to fully extend the flaps in flight and 6 seconds to retract them. The flap switch did not give a visual indication of the selected flap position.

The final production models of the C150 were fitted with a re-designed flap selector with detents for the flap positions and a position indicator located beside the switch. The C152 flap selection and indication is similar (Figure 4b), but the maximum flap travel was reduced from 40° to 30°.

Figure 4a

C150 flap selector switch as fitted to G-BDZC

Figure 4b

C152 flap selector/indicator switch

Aircraft examination

The examination of the aircraft focused primarily on the flap operating system. It was decided to apply power to the flap system electrical circuit in order to operate the actuator. This involved restoring the electrical wiring between the fuselage and the right wing, as it had been necessary to cut them during the removal of the wings before the aircraft was recovered to the AAIB. As a result of structural distortion that occurred in the impact, it was necessary to remove the flap actuator from the right wing.

Prior to applying power, the flap switch was checked for correct operation, with the spring biasing towards the central position being found to be satisfactory. The continuity or open circuit conditions for the switch positions were checked against the appropriate circuit diagram and were found to be correct. Finally, an electrical power supply was connected to the flap switch and it was found that the actuator responded to the flap switch selection and could be moved to its up/down limits, where it was stopped by the limit switches. It could also be halted at any intermediate position.

Elsewhere in the flap system it was noted that the flap position indicator cable had broken close to its attachment to the cable linking the two pulleys. The latter cable had broken during the impact as a result of relative movement between the wings and fuselage. The possibility was considered that the failure of the indicator cable may have occurred prior to impact, which would have caused the pointer to indicate zero flaps regardless of their actual position. The cable failure was subjected to a metallurgical examination, which confirmed that the failure was due to overload and thus had occurred at impact. It is likely this occurred as a result of the failure of the pulley cable; each section either side of the failure would have recoiled due to the release of strain energy, causing a snatch load on the much lighter indicator cable.

Elsewhere on the aircraft it was found that a degree of charring had occurred on a sheath containing a cable bundle behind the left side of the instrument panel. This appeared to be the result of partial penetration by a piece of sheet metal from the fuselage ahead of the left side of the windscreen. Opening up the sheath revealed that the lead connecting the battery to the master switch had been cut and the insulation had burned away over a localised area, exposing the conductor. This damage also extended to an adjacent cable, where the conductor had also been exposed. The damage had effectively bypassed the master switch, with the short circuit accounting for the fact that the electrics could not be turned off by the first responders.

Aircraft performance

The aircraft was subject to additional limitations for performance calculation in accordance with '*CAA Change Sheet 1, Issue 1, to the Cessna 150M 1976 Flight Manual*.' This change requires the addition of 15% to the scheduled takeoff run and distance, and a decrease to the scheduled rate of climb of 150 ft/min. At the maximum weight of 726 kg and in the prevailing conditions the aircraft should have required 520 m takeoff distance to clear a 50 ft obstacle. The distance from the start of Runway 18 to the line of trees is 740 m.

Takeoff performance figures are not provided for other than the flaps-up position, but a note in the Flight Manual indicates that although the ground roll may be reduced with flap 10°, takeoff distance to 50 ft will not be improved. The Flight Manual includes the following note:

> *'Flap deflections greater than 10° are not recommended at any time for take-off.'*

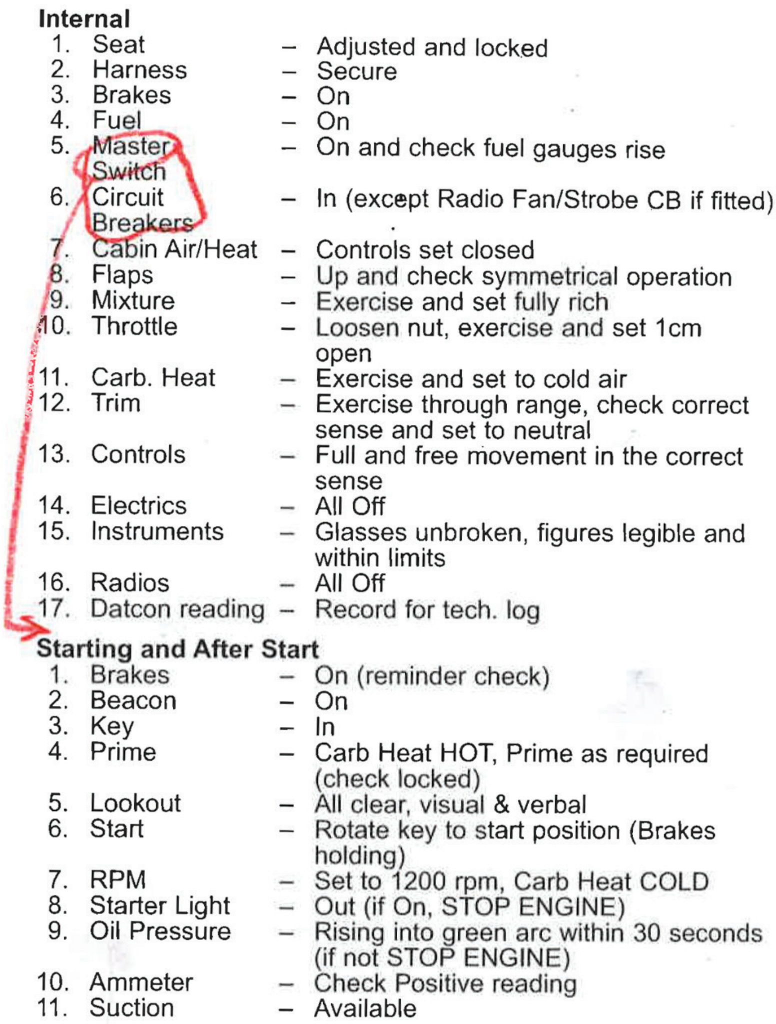
The instructor who had flown with the pilot stated that he thought it was likely that 10° flap would have been selected for takeoff on the grass runway surface. This was the club policy and had been practised during the training and familiarisation flights.

Pilot's checklist

The checklist provided in the Flight Manual does not include an action to deploy the flaps prior to a walkround inspection. However, the pilot's commercially available checklist, like many others commonly in use, does include this action.

The instructor commented that the pilot's use of the checklist was methodical and during training they had some discussions about the layout of his checklist. Specifically, it was discussed that the selection of the master switch on as part of the '*Internal*' checks, before carrying out a long sequence of actions including retracting the flap, might drain the aircraft battery. The instructor noted that the pilot had made some marks on his checklist to highlight the problem. The instructor stated that he had suggested that the pilot should comply with the checklist, but perhaps purchase the one used at the club which had a different pre-start sequence.

The pilot's checklist, recovered from the aircraft after the accident, showed that two items of the '*Internal'* checks had been amended by hand, changing the order of actions prior to engine start (Figure 5).



Internal

1.	Seat	– Adjusted and locked
2.	Harness	– Secure
3.	Brakes	– On
4.	Fuel	– On
5.	Master Switch	– On and check fuel gauges rise
6.	Circuit Breakers	– In (except Radio Fan/Strobe CB if fitted)
7.	Cabin Air/Heat	– Controls set closed
8.	Flaps	– Up and check symmetrical operation
9.	Mixture	– Exercise and set fully rich
10.	Throttle	– Loosen nut, exercise and set 1cm open
11.	Carb. Heat	– Exercise and set to cold air
12.	Trim	– Exercise through range, check correct sense and set to neutral
13.	Controls	– Full and free movement in the correct sense
14.	Electrics	– All Off
15.	Instruments	– Glasses unbroken, figures legible and within limits
16.	Radios	– All Off
17.	Datcon reading	– Record for tech. log

Starting and After Start

1.	Brakes	– On (reminder check)
2.	Beacon	– On
3.	Key	– In
4.	Prime	– Carb Heat HOT, Prime as required (check locked)
5.	Lookout	– All clear, visual & verbal
6.	Start	– Rotate key to start position (Brakes holding)
7.	RPM	– Set to 1200 rpm, Carb Heat COLD
8.	Starter Light	– Out (if On, STOP ENGINE)
9.	Oil Pressure	– Rising into green arc within 30 seconds (if not STOP ENGINE)
10.	Ammeter	– Check Positive reading
11.	Suction	– Available

Figure 5

Pilot's amended checklist

The pilot's checklist was found open at the '*Vital Actions'* and '*Take Off'* page. The '*Vital Actions'* section of the checklist includes an action to select Flap 10° for takeoff. This was in accordance with the club policy.

Weight and balance

According to the most recent Weight and Balance schedule for G-BDZC, dated 10 July 1996, the Basic Empty Weight was 517 kg (1,142 lb) and the Maximum Authorised Weight (MAW) was 726 kg (1,600 lb). The aircraft was fitted with a 49 litre fuel tank in each wing, giving a maximum fuel capacity of 98 litres, of which 13 litres were unusable. Using the best available data, a post-accident weight and balance calculation was completed; 22 kg (48 lb) of baggage recovered from the aircraft was included. The result suggested that the aircraft was within the allowable CG range, but approximately 40 kg (88 lb) above the MAW.

Accident history

GASCo study

The GASCo study of UK stall/spin accidents noted:

> *'There have been 11 accidents on the Cessna 150 but only one on the Cessna 152, with 60% more hours flown by the C152.*

The reasons for this apparent difference in accident rate between the variants was not fully explained, although some of the handling characteristics were further explored. A recommendation made in the report was:

> *'The Cessna 150 and Cessna 152 should not be treated as the same type and in particular pilots transferring from the Cessna 152 to the Cessna 150 should undertake formal Familiarisation Training.'*

Inadvertent deployment of 40° flap

The AAIB has reported on two previous fatal accidents where the unintended deployment of Flap 40° in a Cessna 150 was considered to be a factor. In February 1999, during a practice EFATO manoeuvre demonstrated by an instructor, a C150 aircraft (G-AZLL) stalled and entered an incipient spin with 40° flap set. In September 2015, a student pilot lost control of the aircraft when the flaps were extended to 40° during an attempted go-around.[2]

On 21 June 2013, at Oakland County International Airport USA, a Cessna 172, (registration N9926Q) with four persons on board crashed on takeoff, fatally injuring all those on board. The aircraft had a similar spring-loaded flap selection system to G-BDZC. The accident was investigated by the NTSB and the final report contained the information:

> *'Air traffic control tower personnel saw the airplane lift off the runway and attain an altitude of about 100 feet. A pilot approaching the runway for landing saw the airplane lift off and noticed it was not climbing.'*

and

> *'A post-accident examination revealed that the wing flaps were fully extended (40 degrees).'*

Footnote

[2] https://assets.publishing.service.gov.uk/media/54230004e5274a13140009f3/dft_avsafety_pdf_501786.pdf
https://assets.publishing.service.gov.uk/media/5768089ded915d3cfd0000a6/Cessna_150F_G-ATKF_07-16.pdf

Survivability

Both seats were equipped with lap and diagonal safety harnesses; these were found to be intact after the accident. It was observed that the left side of the instrument panel had been pushed rearwards, which had had the effect of reducing the space between the seat back and the panel. It was considered that the more severe damage to the left side was a consequence of the initial impact being on the left wing.

Meteorology

The Cambridgeshire area was influenced by an unstable air mass. The general weather conditions were clear, with scattered cumulus cloud and a south-westerly airflow. Two people working on top of shipping containers at the airfield, who were experienced at observing wind speed, noted that the wind was gusty; they estimated the wind speed as being up to 18 kt. The METAR from Cambridge Airport, 8 nm to the east, reported a surface wind from 220° at 10 kt, visibility more than 10 km, few cloud at 1,200 ft, temperature 15° C, dewpoint 10° C and pressure 1017 hPa.

Pilot information

The pilot started flying powered aircraft in 1998, having previously flown gliders. He qualified on both Touring Motor Gliders (TMG) and Single Engine Piston (SEP) aircraft; most of his recorded flying was on TMGs. In April 2016 he started flying Cessna aircraft at several clubs in the Cambridgeshire area. He joined the flying group at Bourn in July 2016 and was checked out by an instructor. After completing his checkout he flew a couple of times with the instructor acting as a safety pilot, before deciding to fly on his own with a passenger. He completed a 20-minute solo flight in the C152 aircraft on 1 September 2016 but, prior to the accident, he had not previously flown the C150 without the instructor.

The instructor advised that the pilot had flown from Runway 18 previously. He also noted that during the pilot's training all pre-takeoff checks had been completed with the aircraft at the run-up area, before entering the runway to backtrack for takeoff.

Analysis

General

The aircraft took off but failed to climb sufficiently to clear a line of trees beyond the end of the runway. The takeoff was attempted with 40° flap, probably unintentionally, which led to an inability to climb because of the additional drag. This was exacerbated by the aircraft being above its maximum allowable weight. A gentle turn to the left towards open ground or an early decision to abort the takeoff and land ahead could have prevented the accident. It is likely that the pilot did not realise why the aircraft was not climbing. A late attempt to retract the flap would not have been an effective mitigation, as it takes approximately 6 seconds to fully retract the flaps and flap retraction would have caused a temporary loss of climb performance.

Flap system examination

Examination of the flap operating system revealed no evidence of pre-impact failure, with the flap actuator correctly responding to selections made by the switch on the instrument panel. As a result, it was concluded that the possibility of the flaps making an uncommanded selection to full extension was remote.

The flap indicator system was also examined, as it was considered that a pre-impact failure of the cable attached to the pointer would have given a zero indication even if the flaps themselves were fully extended. However, a metallurgical examination of the cable concluded that the failure occurred as a result of overload applied during the accident sequence.

Preparation for the flight

The flaps were seen to be fully deployed during the pilot's pre-flight inspection and it was not determined whether they were ever retracted subsequently. The flap switch on this aircraft did not give any visual cue of the flap position, unlike the otherwise similar C152 aircraft. Thus, the flap may have remained deployed until takeoff, or it may have been re-deployed prior to takeoff. In the latter case the pilot would not have intended to deploy full flap, so its selection would have been accidental. To deploy the flap to 40° requires a sustained action on the switch for about 9 seconds, so it is unlikely that this would be achieved by an accidental input, although it remains a possibility.

If the pilot had completed the actions as detailed on his amended checklist, that is, the master switch remaining OFF until immediately before engine start, then with no electrical power the flaps would not have retracted at '*Item 8 Flaps - Up and check symmetrical operation.'* In this circumstance it is possible that the position of the flaps and their failure to move when selected UP escaped his notice.

The next opportunity to check the flaps through use of the checklist was as part of the '*Vital Actions*', where the flaps are set at 10° for takeoff. However, there are eleven items in this section of the checklist and a further five items for the '*Take Off'* checklist. It would be easy to overlook one action, and there is the potential for additional distraction with a passenger on board. It is also of note that the majority of the pilot's previous flying had been in touring motor glider aircraft which were not equipped with flaps.

Previous Cessna 150 Flap 40-related accidents

Significant differences exist in the design and operation of flaps between the C150 and the C152 aircraft. The C150 has the facility to deploy 40° flap, but inappropriate use of this flap causes performance penalties and handling problems which can lead to accidents for unwary pilots. The spring-loaded switch, as fitted to G-BDZC and most C150 aircraft, does not give the pilot a visual cue of the selected flap position, unlike C152 aircraft. It is therefore important that this difference is emphasised during pilot training.

There have been two recent accidents in the UK whereby the inadvertent use of 40° flap on the Cessna 150 aircraft has been a causal factor. It is considered that a greater focus during training/type familiarisation on flap selection and indication, and the effect of full flap configuration on aircraft performance and handling characteristics, could prevent further accidents. The following Safety Recommendation is therefore made:

Safety Recommendation 2017-013

It is recommended that the Civil Aviation Authority promulgates to flying instructors the need for specific training to highlight the differences between the C150 and C152 flap switch designs. Training should also include the effect on aircraft performance and handling of Flap 40°.

Conclusion

The takeoff was attempted with 40° flap and in this configuration the aircraft was not able to climb due to the excess drag. It is probable that the flaps were unintentionally left deployed following their extension for the pre-flight inspection.

ACCIDENT

Aircraft Type and Registration:	1) SZD-51-1 'Junior' glider, G-CLJK 2) Cessna 150L, G-CSFC
No & Type of Engines:	1) None 2) One Continental Motors O-200-A piston engine
Year of Manufacture:	1) 1991 2) 1973
Date & Time (UTC):	4 December 2016 at 1231 hrs
Location:	7.5 nm south of Leicester Airport
Type of Flight:	1) Private 2) Training
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 2 Passengers - None
Injuries:	1) Crew - 1 (Fatal) Passengers - N/A 2) Crew - 2 Passengers - N/A
Nature of Damage:	G-CLJK aircraft destroyed, G-CSFC major damage to right wing
Commander's Licence:	1) Glider Pilot's Licence 2) Commercial Pilot's Licence
Commander's Age:	1) 70 years 2) 26 years
Commander's Flying Experience: (G-CLJK)	1,054 hours (of which 1,048 were on gliders) Last 90 days - 12.5 hours Last 28 days - 4 hours
Commander's Flying Experience: (G-CSFC)	1,124 hours (of which 815 were on type) Last 90 days - 112 hours Last 28 days - 26 hours
Information Source:	AAIB Field Investigation

Synopsis

Two aircraft collided in VFR conditions in Class G airspace; neither aircraft was receiving an ATC service. The investigation concluded that neither pilot saw the other aircraft in sufficient time to take effective avoiding action.

History of the flights

Cessna 150 L (G-CSFC)

The aircraft was engaged on a training flight, with a flying instructor and his student on board. The purpose of the flight was to conduct a navigation exercise from Hinton-in-the-Hedges Airfield, where the aircraft was based, to Leicester Airport. The instructor first flew a flight in a different flying school aircraft before joining his student for the flight in G-CSFC to Leicester. The flying instructor had regularly flown from Leicester. In the briefing he informed the student about the gliding activity at the nearby Husbands Bosworth Airfield as the planned route to Leicester would take the aircraft close to, but to the west of, the airfield.

The aircraft took off at 1206 hrs and flew at approximately 2,500 ft on a track of about 025° (M). The weather was described as good, and visibility was reasonable, although this was reduced when flying toward the low sun. During the flight the sun was behind the aircraft. After takeoff, they contacted Coventry Airport ATC and requested a basic service[1], which was provided.

As the aircraft approached the area of Husbands Bosworth Airfield, it was to the east of its intended track, such that the airfield was on the aircraft's left hand side. The student pilot altered heading which took them between the airfield and the town of Market Harborough.

During the flight, the pilots had been monitoring other light aircraft flying in their vicinity and in a similar direction. They were aware of two aircraft to their right and a further aircraft to their left. These aircraft were not close enough to cause concern, but did require monitoring in case their flight paths changed. The pilots also recalled seeing a light helicopter crossing their track ahead, although they were not sure whether this was before or immediately after the accident.

When the aircraft was 7.5 nm south of Leicester Airport, the student pilot looked down at the radio, tuned it to the Leicester air/ground frequency and then transmitted an initial radio call to the operator. He recalled looking at the altimeter to check the altitude and then, on looking up, became aware of the glider almost directly ahead at the same level. The instructor recalled that he had been looking at the aircraft to their right when, on looking ahead, he too became aware of the glider directly ahead. Both pilots of G-CSFC thought that they had become aware of the glider simultaneously.

The glider was seen for only a very short period of time before the instructor made an instinctive control input to pitch the aircraft nose-down and roll left. Both pilots in G-CSFC described the glider as appearing nose-on, in substantially level flight (although the student thought it might have been in a slight nose-down attitude), and at exactly the same altitude. When seen, the glider was at very close range, such that the instructor felt he would have been able to distinguish fine detail on it had the scene been unmoving. The instructor considered that the two aircraft would have collided nose-on had he not taken immediate avoiding action. Neither pilot recalled seeing the glider start any evasive manoeuvring during the short time it was in their view.

Shortly after, there was a loud bang, and it was evident that the aircraft had collided with

Footnote

[1] A Basic Service is an Air Traffic Service provided for the purpose of providing advice and information useful for the safe and efficient conduct of flights. This may include weather information, serviceability of facilities, aerodrome conditions, general airspace activity, and any other information likely to affect safety. The controller may provide traffic information, but the avoidance of other traffic remains solely the pilot's responsibility.

the glider. The instructor then regained straight and level flight, although this required a significant amount of roll control input. From the required control response, and after a visual inspection, the pilots were aware that the aircraft had suffered damage to its right wing. The aircraft continued to Leicester Airport and the instructor reported the collision to the air/ground operator. The aircraft landed without further incident.

Glider SZD-51-1 'Junior' (G-CLJK)

On the day of the accident, the pilot of G-CLJK attended a morning briefing at Husbands Bosworth Airfield. This covered local area warnings and weather information. It also included cautions about cockpit canopy misting and the potential for poor visibility when flying into the low sun.

The weather was described by other club members who flew that day as good, and there was a very light wind from the south-east. The pilot, who was an experienced instructor, initially flew two instructional flights in an ASK 21 glider with another pilot. Both flights were reportedly uneventful.

The pilot had flown a 'Junior' before, but not recently, so he asked another club member to go over some key revision points with him. Among these, the pilot was informed that the radio was not receiving. The pilot confirmed this through a test call. The radio was not required for local flights, and radio calls from gliders are generally only made at times of high traffic density, such as during competitions, and the pilot accepted the radio unserviceability. Canopy misting was discussed and the pilot was told that it had occurred during the previous flight, but had not persisted once airborne. There was also a discussion about the glider's safety harness, which was different from that on some gliders.

The pilot took off in G-CLJK at 1217 hrs on an aerotow launch. The tug pilot reported that the aerotow was uneventful. The glider jettisoned the tow normally at about 3,700 ft, after which the tug aircraft returned directly to the airfield and landed.

The glider then flew in a generally northerly direction until it was about 4 nm north-east of Husbands Bosworth Airfield, at which point it turned right onto a steady track of about 220°(M) that took it back in the direction of the airfield. The glider's vertical profile was consistent with a normal glide descent, without any significant vertical manoeuvring. On this track, the glider was on a collision course with G-CSFC. There was about 24 seconds between finishing the turn and the collision.

Eyewitness accounts

Eyewitness accounts were obtained from occupants of a light helicopter and two light aircraft in the vicinity. Accounts were also taken from three witnesses on the ground, one of whom commented that he saw several aircraft in the area at the same time. Accounts of the airborne witnesses are summarised below.

A witness flying in the helicopter (registration G-ORBK), which had crossed ahead of the path of G-CSFC, saw the collision. He described in-flight visibility as excellent, apart from when flying toward the low sun. He saw several aircraft in the area, which he knew from experience to have a relatively high traffic density. The witness first saw the glider, in straight and level flight, at a similar height and at a range estimated to be less than 0.5 nm. The glider appeared to be flying on a south-westerly heading. He saw a powered aircraft approaching on a northerly heading. From his viewpoint, the powered aircraft appeared to be climbing. He saw another aircraft a short distance behind the first aircraft and, because of their proximity and the nearby gliding site, thought that he was actually seeing a tug aircraft and glider combination.

It quickly became apparent to the witness in G-ORBK that a collision was likely. At the point of collision, an outer section of the glider's left wing folded back, although it initially stayed attached to the aircraft. The powered aircraft dived away, whilst the glider rolled and entered a steep nose-down attitude with a rolling / spinning motion. After two to three seconds, the left outer wing section broke away.

A light aircraft (registration G-BOPA) was following a similar track to G-CSFC, but was 0.4 nm behind it and about 1,000 ft lower at the time of the collision. G-BOPA was the aircraft thought by the witness in the helicopter to be a glider. The pilot's attention was drawn to a movement ahead and to the left, which she soon realised was a glider with part of a wing missing. The glider was descending in what the pilot described as a tumbling motion, until it disappeared out of sight beneath her aircraft's left wing a short time later. The pilot did not watch the glider further, but concentrated on fixing her position in order to transmit an accurate distress call. She did not realise at that stage that the glider had been involved in a collision, and had not been aware of G-CSFC.

The pilot of the other light aircraft, (registration G-BDIE), saw the glider descending whilst spinning, and saw a section of the wing detach after about two to three rotations. He estimated the range at 0.5 to 0.75 nm, and did not see any other aircraft in the area. A passenger in G-BDIE recalled seeing a second aircraft diving away and thought he might have been seeing a glider and tug combination.

Search and rescue activities

Once G-CSFC had been established in safe flight, the instructor alerted the air/ground operator at Leicester Airport to the situation. The pilot of G-BDIE was in contact with the London Flight Information Service Officer when they witnessed the accident, and broadcast a PAN-PAN urgency call at 1231 hrs. Whilst orbiting the accident site to refine the location, the pilot was transferred to the Distress and Diversion (D&D) frequency. The D&D Cell at London Centre alerted the Aeronautical Rescue Co-ordination Centre and it was quickly established that the likely base of the glider was Husbands Bosworth Airfield which, when contacted, confirmed that the crashed glider was likely to have come from there, with one person on board.

An air ambulance landed at the accident site at 1249 hrs, where it was established that the pilot had not survived.

Recorded information

Sources of recorded information

Recorded radar information (Mode A and C[2]) was available for G-CSFC from ground-based sites located at Bovingdon, Claxby, Clee Hill, Debden and Heathrow Airport. When combined, the radar provided an almost complete record of the accident flight, with data starting just after G-CSFC had taken off from Hinton-in-the-Hedges Airfield and ending shortly before it landed at Leicester Airport. The period when G-CSFC and G-CLJK collided was recorded by several of the radars, with data points recorded at a maximum rate of once every five seconds.

Recorded information for G-CLJK was available from a combined electronic flight logger[3] and FLARM unit that was recovered from the cockpit. This provided a complete track log of the accident flight, with GPS-derived position, altitude and pressure altitude recorded once every four seconds.

A combination of radar, electronic flight logger and GPS-derived data from tablet computers[4] was also obtained for other aircraft operating in the vicinity of G-CSFC and G-CLJK at the time of the collision.

The RTF frequencies in use at Husbands Bosworth Airfield and Leicester Airport were not recorded. RTF recordings were available of communications between the D&D Cell and the pilot of G-BDIE.

Summary of recorded data

Figure 1 provides the radar and flight logger-derived tracks of G-CSFC and G-CLJK in the minutes before and after the collision. Figure 2 plots the position of both aircraft, commencing at a separation of just less than 1 nm, with the relative positions identified at eight second intervals and angular sizes of about 0.5° when viewed from each aircraft. Figure 3 plots the relative position of other aircraft at the time of the collision. For clarity, the radar track of G-CSFC has been illustrated in Figure 1, 2 and 3.

The track of G-CSFC recorded by each of the radars correlated closely, corroborating the relative accuracy of the independent data sources. The altitude amsl is derived by correcting for a QNH pressure of 1023 hPa.

When G-CLJK had taken off from Husbands Bosworth Airfield towed behind a tug aircraft, G-CSFC was 12 nm to the south. To the right of G-CSFC were two light aircraft, registration G-BPWG and G-BFLU, and behind G-CSFC was G-BOPA. All three aircraft were flying to Leicester Airport, having departed from different airfields in the south of England.

Footnote

2 Mode A refers to the four-digit ‘squawk’ code set on the transponder and Mode C refers to the aircraft’s pressure altitude which is transmitted in 100 ft increments.
3 LX navigation manufactured FLARM Red Box.
4 Operating a Skydemon navigation software application.

At 1222 hrs, at an altitude of about 3,700 ft amsl, G-CLJK released from the tug aircraft and turned onto a northerly heading, whilst the tug turned away before landing back at Husbands Bosworth. G-CLJK continued on a northerly course whilst gradually descending at about 120 ft/min. G-CSFC was 7 nm to the south of G-CLJK at this time.

At 1225 hrs, G-CSFC altered course slightly, turning left onto a track between Husbands Bosworth Airfield and the town of Market Harborough. G-BPWG was at 3,100 ft amsl and now just ahead and to the right of G-CSFC at a distance of 1 nm, and G-BFLU was at 2,900 ft amsl and further ahead, at a distance of 1.3 nm.

At 1229 hrs, G-CSFC passed to the east of Husbands Bosworth Airfield; G-CLJK was 2nm ahead at 2,850 ft amsl. G-BPWG was maintaining its relative position to the right of G-CSFC and G-BFLU was now 2 nm ahead of G-CSFC.

At 1230 hrs, G-CLJK made a right turn onto a heading of about 220° (M); its altitude was 2,650 ft amsl and its groundspeed was about 44 kt. When G-CLJK had started to turn, G-ORBK was 0.8 nm away and maintaining a south-westerly course. G-CSFC was now 1 nm to the south of G-CLJK, and maintaining a northerly course at an altitude of about 2,600 ft amsl at a groundspeed of about 88 kt. Based on an estimated wind of 070° at 15 kt[5], G-CLJK would have appeared to have been approximately straight ahead when viewed from the cockpit of G-CSFC; similarly G-CSFC would have appeared to be about 15° to the left when viewed from the cockpit of G-CLJK.

Both aircraft maintained their relative tracks for a further 28 seconds, with G-CLJK gradually descending as the two aircraft converged; the calculated closing speed was 120 kt (61 m/s). The aircraft are estimated to have collided at 1230:47 hrs at an altitude of about 2,600 ft amsl (2,250 ft agl). The radar data indicates that G-CSFC started to turn to the left and descend at about this time. Table 1 contains the angular size[6] of each aircraft as they approached each other.

Footnote

5 Based on the weather reports recorded at Leicester Airport around the time of the accident.

6 This is based on the average of the span and height of the aircraft.

TIME TO COLLISION (s)	DISTANCE (nm) / (m)[7]	ANGULAR SIZE of G-CSFC when observed from G-CLJK (º)	ANGULAR SIZE of G-CLJK when observed from G-CSFC (º)
4	0.14 / 250	1.44	1.84
8	0.27 / 510	0.72	0.94
12	0.41 / 760	0.48	0.62
16	0.54 / 1,000	0.36	0.47
20	0.68 / 1,270	0.29	0.37
24	0.82 / 1,520	0.24	0.31
28	0.96 / 1,780	0.20	0.27
32	1.09 / 2,030	0.18	0.23

Table 1

Angular size of both aircraft from 32 seconds before the collision

The last data point from G-CLJK's flight logger was recorded at 1230:51 hrs, with the glider descending to 2,530 ft amsl at an average descent rate of 1,000 ft/min. G-CLJK subsequently struck the ground 290 m laterally from the position of the last data point. Following the collision, G-CSFC descended to about 1,500 ft amsl, where it then levelled for several minutes before positioning to land at Leicester Airport, which was 7.5 nm north of where the aircraft collided.

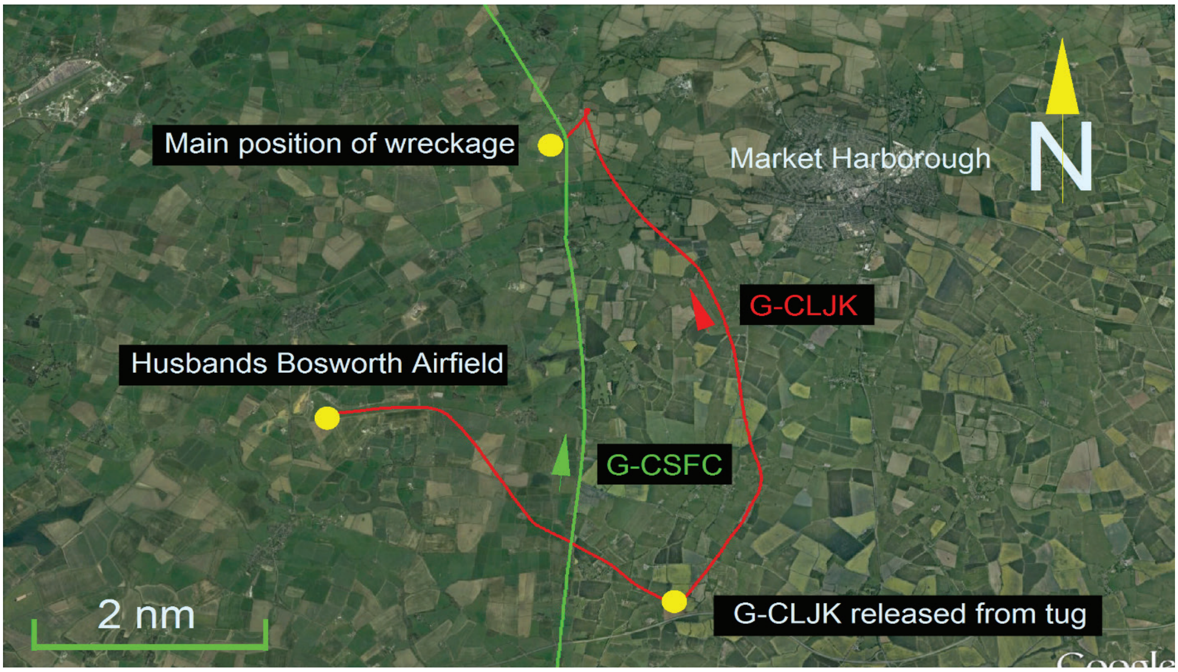


Figure 1

Radar and flight logger tracks of G-CSFC and G-CLJK

Footnote

[7] Distances have been rounded.

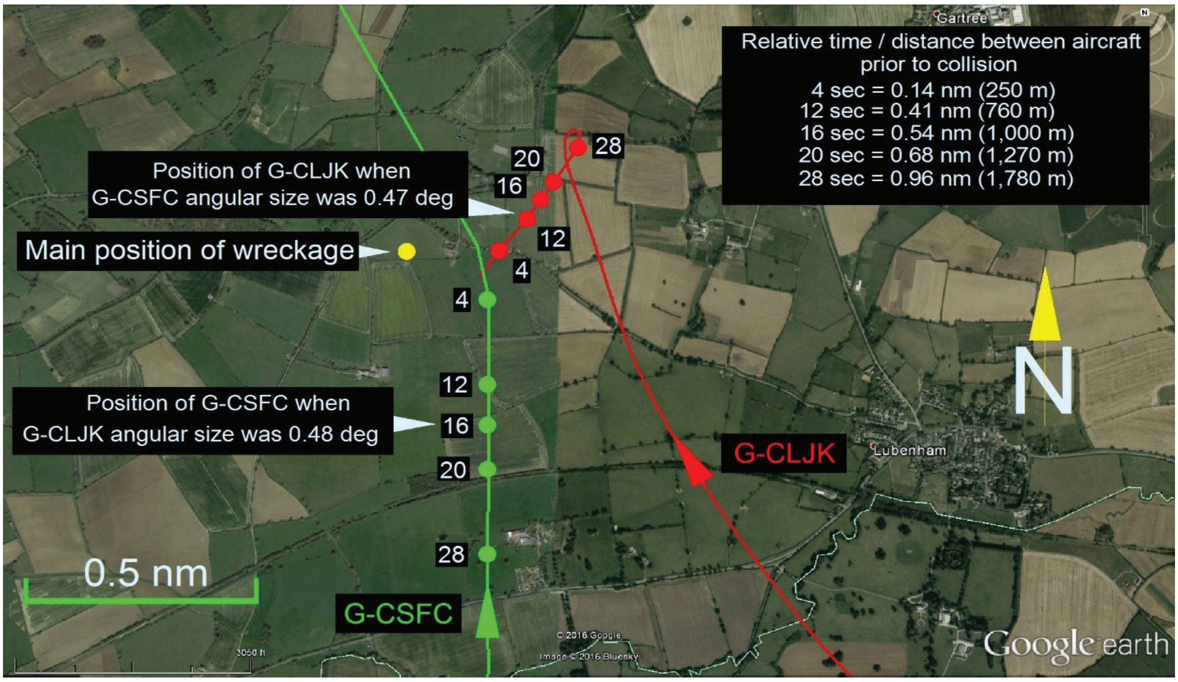


Figure 2

Relative positions of G-CSFC and G-CLJK prior to collision

Proximity of other aircraft at the time of the collision

- G-BFLU was ahead and to the left of G-CSFC at 2,500 ft amsl and a distance of 2 nm.
- G-BPWG was to the right of G-CSFC at 3,300 ft amsl, at a relative bearing of about 40° and a distance of 0.6 nm.
- G-ORBK was ahead and to the left of G-CSFC at about 2,600 ft amsl and a distance of 0.6 nm.
- G-BOPA was almost directly behind G-CSFC at about 1,400 ft amsl and at a distance of 0.4 nm.
- G-BDIE was 1.2 nm to the south of the accident position at 3,150 ft amsl.

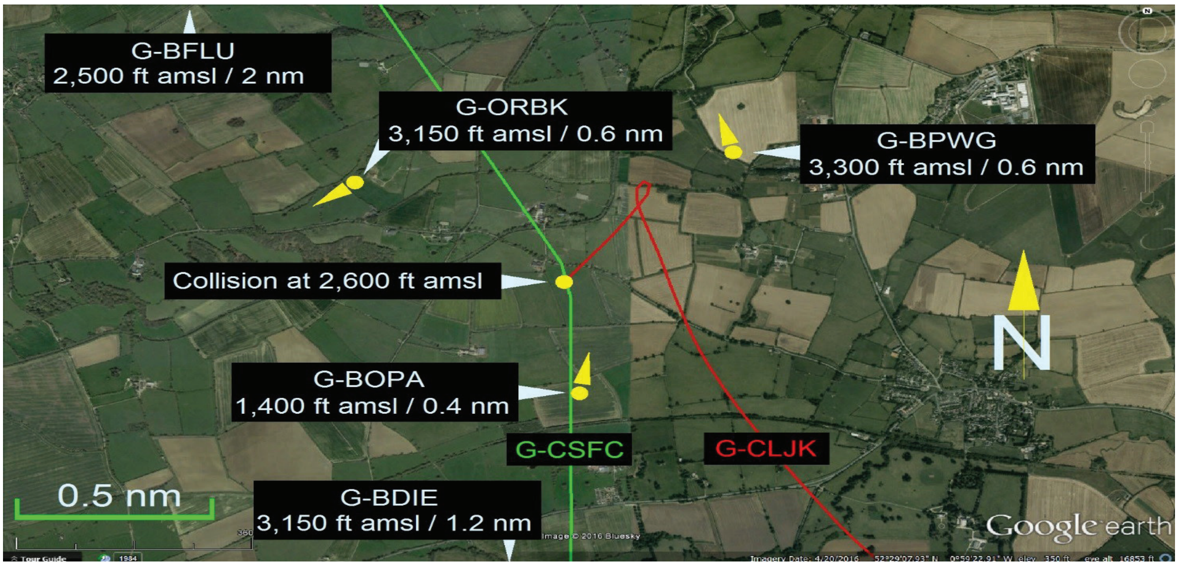


Figure 3

Relative positions of other aircraft at the time of collision

Meteorological information

There was an area of high pressure over the Continent, with a ridge of high pressure reaching out across the British Isles. This gave rise to settled and stable conditions, as reported by those flying on the day. Surface wind at the gliding club was reported as light, while at Coventry Airport (20 nm to the west) the surface wind at the time of the accident was from 070° at 12 kt, with good visibility and no low cloud. Analysis of the synoptic charts for the day indicated a wind at 2,000 ft from east-south-east at about 15 kt.

In-flight assessments were obtained from pilots who were flying powered aircraft and gliders in the area at, or near, the time. All reported good, stable flying conditions. Assessment of visibility was generally good, with reports ranging from "*a little hazy*" to "*fantastic*". However, all pilots commented on the low sun, and that visibility in the direction of the sun was reduced. One instructor of an aircraft (not involved in the events) remarked to his student that conditions were such that the risk of mid-air collision was increased.

Ephemeris sun data showed that, at the time of the accident, the sun was at an azimuth of 190° and an elevation angle of 15°. In this position, as seen from G-CLJK, the sun was in line with G-CSFC as the two aircraft approached each other during the 28 seconds prior to the collision.

Pilot information

G-CLJK

The pilot was an experienced glider pilot, who began gliding in 2005 and later qualified as a glider instructor. He regularly attended the gliding club at Husbands Bosworth, both to fly and to conduct ground instructional sessions. He owned an LS7 glider which he kept at Husbands Bosworth Airfield and had flown this since 2009. In the two months preceding the accident, he had started training to fly self-launching motor gliders (SLMG).

The pilot maintained good flying currency and generally flew on several days each month. He had last flown 5 days before the accident, when he flew two instructional flights and two SLMG flights. The pilot first flew the SZD-51-1 'Junior' glider in 2006 and had flown it occasionally since, with two flights recorded in 2016, with the most recent on 10 October 2016.

The pilot was believed to have been in good health and not suffering from any conditions which may have affected his ability to pilot his glider safely. He held a Light Aircraft Pilot Licence medical certificate which was issued by an Aeromedical Examiner[8] on 10 May 2016 and valid for two years. The certificate carried the limitation that the pilot was to wear corrective spectacles, which he was seen to be doing on the day of the accident. The

Footnote

[8] The examination for an LAPL medical certificate can be carried out by a NHS General Practitioner or by an Aeromedical Examiner (AME). An AME is a doctor specialising in aviation medicine who is certificated to issue EU medical certificates.

spectacles contained clear photochromic lenses, which darkened in response to exposure to UV radiation. The pilot with whom the accident pilot had flown that morning reported that the latter's vision in flight appeared normal and that he had detected other aircraft at reasonable ranges.

A post-mortem examination of the pilot of G-CLJK was carried out by a Home Office Registered Forensic Pathologist. He concluded that the pilot died as a result of multiple injuries consistent with having been caused when his aircraft struck the ground. There were no medical or toxicology factors that may have contributed to the accident.

G-CSFC

The instructor in command of G-CSFC began flying in 2008 and gained a Commercial Pilot's Licence in 2012. In April 2015 he trained at Leicester Airport as a flying instructor and subsequently started work as an instructor at the flying club based at Hinton-in-the-Hedges which operated G-CSFC. He flew regularly at the club and, on the day of the accident, flew an instructional flight before the accident flight.

The instructor held a Class One EASA medical certificate, valid until 4 May 2017 (4 May 2021 for Class Two privileges) and which carried the limitation that he wear corrective lenses. He reported that his normal glasses and his prescription sunglasses (which he was wearing on the accident flight) conformed to his current prescription. He appeared to have been in good health and did not declare any conditions which may have affected his ability to pilot the aircraft safely.

G-CLJK Aircraft information

The SZD-51-1 'Junior' is a single-seat glider with a wingspan of 15 m with a maximum all up mass of 380 kg. It was designed in Poland and is constructed predominantly of fibre glass. G-CLJK was white, except for the wing tips and part of the nose which were painted red.

G-CSFC Aircraft information

The Cessna 150 is a two-seat aircraft of conventional alloy construction and has a wing span of 10.2 m, and a gross weight of 726 kg. G-CSFC was painted white, with red and blue chordwise stripes just inboard of the wing tips, as well as along the fuselage sides.

The main G-CLJK wreckage site was located in a grass field approximately 8 m from a hedge and drainage ditch. This wreckage consisted of the fuselage, the empennage, the right wing and the inboard part of the left wing. There was a large ground mark in which several pieces of forward fuselage, canopy frame and Perspex from the canopy were located. There were straight ground marks either side of the hole which were consistent with having been made by at least part of both the left and right wings. Part of the canopy frame was located approximately 30 m from the main G-CLJK wreckage.

There were many pieces of wreckage located a significant distance from the main G-CLJK wreckage. These included:

- A 4.5m long outboard part of the left wing of G-CLJK, located 100 m from the main wreckage. There was a red scuff mark around the leading edge close to where it had broken away from the rest of the left wing of G-CLJK.
- The white plastic tip fairing (measuring approximately 20 cm in a spanwise direction) from G-CSFC found in several pieces.
- The outboard 40 cm of the right aileron from G-CSFC located in a tree 300 m from the main wreckage of G-CLJK.
- Two crumpled pieces of alloy wing with distinctive red and blue chordwise stripes; one piece was from the leading edge, the other was the mid-chord section aft of the leading edge and forward of the aileron. The deformation was most pronounced on the leading edge piece, particularly where the red chordwise stripe was located.

G-CSFC and G-CLJK inspection

G-CSFC was inspected at Leicester Airport (Figure 4). The outboard 60 cm of the right wingtip was missing and there was significant local damage to the outboard right wing.

Figure 4

Image of G-CSFC at Leicester Airport

Several pieces of wreckage that were recovered from the field near the glider, including the alloy section of wing leading edge and the piece of aileron, were taken to Leicester Airport and it was confirmed that they were from the outboard 60 cm of the right wing from G-CSFC.

Pieces from the right wingtip from G-CSFC were inspected in conjunction with the left outboard wing of G-CLJK at the AAIB. Both red and blue paint had been transferred onto a piece of the leading edge wing skin of G-CLJK, and the deformation to the alloy leading edge of a piece of G-CSFC right wingtip matched the profile of the left outboard wing leading edge of G-CSFC. It was tentatively concluded that that these were the locations where the two aircraft collided in a broadly head-on direction, with a relative bank angle of approximately 60°.

Glider abandonment

The glider was fitted with a four-point safety harness, comprising two lap straps and two shoulder straps and a safety strap. There was no negative 'g' (crotch) strap. The harness straps were secured centrally and held in place by a spring loaded locking bar which slid into place and was secured by a light spring arrangement. A short piece of webbing was attached to the bar which, when pulled, overcame the spring force and pulled the bar out, freeing the four straps almost simultaneously.

Only one other club glider was equipped with this locking arrangement, all others (and the pilot's own glider) used a rotary locking mechanism. Although the pilot had flown with G-CLJK's arrangement in the past, it was not one he was used to and prompted comment as he strapped in for the flight.

G-CLJK was fitted with a one piece canopy, which was side opening with two hinges on the right hand side. Its operation was controlled by two control levers and its range of movement on the ground was restricted by a wire lanyard. Both control levers were mounted on the canopy side rails and were similar in appearance. The left lever was for normal locking and unlocking of the canopy when closed; pushing the lever fully forward would unlock the canopy. The right lever, for emergency use only, operated a release mechanism for the two hinges. Moving the right lever fully forward released the two hinges from the fuselage, allowing the canopy to be jettisoned. There was a diagram placard next to the jettison handle which indicated its function.

The Pilot's Operating Handbook for G-CLJK contains the "Procedures for emergency exit" and "Procedures (for emergency exit) in special cases", Figure 6. The canopy is jettisoned by pushing forward on both the left and right red knobs and then pushing the canopy upwards.

5.3.1. Procedures for emergency exit

/1/ Let the stick free.

/2/ Push forward up to stop the handles of canopy jettisoning and push the canopy upwards.

/3/ Release the safety belts.

/4/ Leave the cockpit towards axis of eventual rotation of glider.

/5/ If the altitude allows delay the opening of parachute. On altitude below 200 m open the parachute immediately.

5.3.2. Procedures in special cases

/1/ When the canopy cannot be jettisoned try to destroy the perspex begining near the window, eventually help with legs.

/2/ In case the exit must be done on high altitude take into account:

a/ possibility of climbing on opened parachute /e.g.in cloud/ and the danger of lack of oxygen or iceing of parachute,

b/ possibility of employ the oxygen equipment installed on glider,

c/ air temperature.

Taking the above into account it may be recommended to stay inside the cockpit /if glider condition allows for/ to altitude of 4500 - 4000 m or even lower.

Figure 5

Extract from Pilot's Operating Handbook

The canopy of the pilot's own glider, an LS7, differed from the accident glider in that it was hinged at its forward end. It was also operated by two handles, one on each side rail, but they had slightly different functions and operated in the reverse sense to the accident glider. Both handles were used to lock and unlock the canopy, except they were moved rearward to unlock and forward to lock. If the right hand handle was pulled further rearwards than the normal unlocked position, the canopy hinge was released from its attachment to the fuselage, and the canopy could be jettisoned. Thus, to abandon the aircraft, both handles would need to be pulled fully back (the opposite of the accident glider), with the right handle travelling over a further distance than the left.

Canopy examination

The canopy frame was found at the accident site in six pieces, located within 30 m of the main wreckage along with a large number of pieces of Perspex. No Perspex pieces were found more than a few metres away from the main wreckage, and two of the pieces of canopy frame were embedded in the ground in close proximity to several pieces of the nose fuselage. It was concluded that the canopy struck the ground in close proximity to the fuselage.

The length of the canopy frame with the canopy release knob attached (left hand side) was assessed; the knob was found in the open position and could only be moved with some additional force being applied; this suggested that this knob was in the open position when the aircraft struck the ground.

The piece of the canopy frame which had the right hand jettison knob and the jettison mechanism (found 30 m from the fuselage) was assessed along with one of the canopy hinges. The canopy hinges are attached to the fuselage by two small vertical spigots; in each spigot there is a horizontal hole which houses the emergency jettison pin. Only one complete hinge was recovered from the wreckage site; the hole in the spigot was intact with no evidence of any impact marks from the jettison pin. The jettison mechanism on the canopy frame was intact, operated satisfactorily and was free from any impact marks that might have been caused by the spigot. There was therefore evidence that the canopy jettison mechanism had been successfully activated before the aircraft struck the ground.

Parachute and harness examination

The pilot was wearing a club parachute on the accident flight. He was familiar with the type of parachute, which was compatible with the cockpit and seat design. The parachute harness had two shoulder straps which were secured by a strap across the chest, and two crotch straps which passed forward between the legs and which were secured at each hip. The three fasteners were of a spring loaded 'snap hook' design.

The doctor and paramedics who attended in the air ambulance described their actions on arriving at the scene. The doctor recalled unclipping one or two metal fastenings but did not recall undoing anything which appeared to be an aircraft harness.
The aircraft harness was found undone. The harness was later inspected at the AAIB and found to operate satisfactorily.

Airspace operating information

Airspace classification

Airspace over the UK is divided into several classes, which are described in the UK Aeronautical Information Publication (UK AIP).[9]

The airspace in the accident area was designated as Class G airspace and was classified as uncontrolled. Aircraft operating in Class G airspace are free to operate without an ATC service or clearance, and pilots are not required to maintain contact with ATC or each other or operate with a transponder. Class G airspace includes all UK airspace which is not either controlled or advisory airspace.

Footnote

[9] The UK AIP is published by authority of the UK Civil Aviation Authority.

ATC instructions to pilots in Class G airspace are not mandatory. Although pilots may seek a Traffic service[10] from ATC, controllers cannot guarantee to achieve separation minima due to the nature of the unknown Class G air traffic environment.

The UK AIP states:

> *'Within Class G airspace, regardless of the service being provided, pilots are ultimately responsible for collision avoidance and terrain clearance, and they should consider service provision to be constrained by the unpredictable nature of this environment.'*

Rules of the Air

Both flights were subject to the Standardised European Rules of the Air (SERA)[11] regulations.

SERA.3210 Right-of-way stated:

> *When two aircraft are approaching head-on or approximately so and there is danger of collision, each shall alter its heading to the right.'*

SERA.2010 Responsibilities stated:

> *"The pilot-in-command of an aircraft shall, whether manipulating the controls or not, be responsible for the operation of the aircraft in accordance with this Regulation, except that the pilot-in-command may depart from these rules in circumstances that render such departure absolutely necessary in the interests of safety."*

SERA.3201 General stated:

> *'Nothing in this Regulation shall relieve the pilot-in-command of an aircraft from the responsibility of taking such action, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment, as will best avert collision.'*

Footnote

[10] A Traffic Service is a surveillance based ATS in Class G airspace in which pilots are provided with a BasicService plus specific surveillance-derived traffic information to assist them to avoid other traffic. Terrain clearance and the avoidance of other traffic is solely the pilot's responsibility. The service is available to flights operating under VFR or IFR outside Controlled Airspace in any meteorological conditions.

[11] Commission Implementing Regulation (EU) No. 923/2012 of the European Parliament and of the Council of 26 September 2012 laying down the common rules of the air and operational provisions regarding services and procedures in air navigation

Collision avoidance

In uncontrolled airspace, pilots operate on the principle of 'see-and-avoid'. Maintaining an effective lookout for aircraft and other hazards is therefore a prime task for a pilot to avoid collisions, particularly when flying in uncontrolled airspace. However, there are limitations in the human visual system that serve to make collision avoidance difficult by visual means alone.

The capacity of the human eye to resolve detail is not distributed evenly across the retina. The most central part of the retina is termed the fovea, and is composed only of cones - the light sensitive cells used for day vision. Cones provide high visual acuity, colour vision and contrast discrimination. Although there is good resolving power at the fovea, this ability drops rapidly only a few degrees away from it. Normal visual reflexes adjust the direction of gaze to ensure that the image of an observed object falls on the fovea for optimum resolution. Such vision, sometimes termed 'focal' vision, requires a stable image and the viewer's attention.

Away from the fovea, the density of cones reduces, and that of cells called rods increases. Rods are more sensitive to light than cones, and are used for day, night and low intensity vision. Rod vision is monochromatic and of low acuity, giving only outlines or shapes. It is, however, responsive to movement. It does not require the same degree of attention as focal vision and is important for spatial orientation and 'flow vision', which gives a sense of speed. Rod vision is sometimes referred to as 'peripheral' vision.

A distant aircraft will be perceptible to a pilot so long as it is acquired at or near the fovea. As an area of sky is scanned by the pilot, the eye naturally makes a series of jumps, or saccades, with intervening rests. The scene is only interrogated by the brain during the rest periods. A very small object may therefore be 'jumped over' or fall on an area away from the fovea – in either case it will not be detected. Each saccade-rest cycle takes a finite time and a full scan of an area of sky will take some seconds. An object missed early in the scan may have sufficient time to approach hazardously close or even collide before that area is scanned again by the pilot.

Two aircraft on a collision course maintain a constant relative bearing to each other and the aircraft will appear in the same place on the other aircraft's canopy unless the pilot makes a head movement. As the colliding aircraft is not moving relatively, it does not necessarily attract the attention of the peripheral vision system. The rate of increase in retinal size of the approaching aircraft is not linear and the image stays relatively small until very shortly before impact. Additionally, small targets may be hidden behind canopy arches or struts until very late. For these reasons pilots are taught not just to look around them, but to positively move their head as they do so.

Collision avoidance systems

The 'see-and-avoid' principle can be enhanced by the use of electronic conspicuity (EC) aids that enable the proximity of other airspace users to be known, with studies having shown that this can be eight times more effective[12].

There are several types of EC aid currently available, which include transponders and radios, but each has its own limitations and the use of different technologies has meant that not all systems are compatible.

G-CLJK was equipped with a type of EC aid called FLARM[13]. Many gliders in the UK are also equipped with this system, although the fitment of FLARM to powered aircraft across the UK general aviation[14] community is not as widespread. A limitation of the system is that only FLARM-equipped aircraft can detect each other. Further, it is not designed[15] to detect other aircraft equipped with a Mode A, C or S transponder or provide conspicuity to ground-based radar.

G-CSFC was fitted with a Mode C transponder that was transmitting data throughout the flight and its position and altitude was available on radar. It was not equipped with FLARM or other EC aid that would have alerted the pilots of G-CSFC to the position of G-CLJK.

The detection of G-CLJK's position was reliant on primary radar only, as it was not required, nor fitted, with a transponder. No identifiable radar track for G-CLJK was available[16].

In summary, although G-CSFC and G-CLJK were each equipped with a type of EC aid, the differing technologies meant that the pilots of both aircraft were reliant on visually acquiring each other's aircraft in order to take avoiding action.

Future development of EC aids.

Several Safety Recommendations have been made by the AAIB to improve the conspicuity of aircraft operating in uncontrolled airspace. Following mid-air collisions involving two gliders in April 2004, and a helicopter and microlight aircraft in July 2004, the AAIB issued Safety Recommendation 2005-006 to the CAA to initiate further studies into improving conspicuity of gliders and light aircraft. In 2005, the UK Airprox Board also recommended

Footnote

[12] Unalerted Air-to-Air visual Acquisition Andrews MIT 1991 Project Report ATC-152

[13] FLARM was invented in Switzerland in 2004 in response to a high number of fatal mid-air collisions between gliders, which despite the principle of 'see and avoid', were still occurring in good visibility. FLARM is a flight alarm system that transmits the position and altitude of an aircraft over a low-powered, short-range radio to other FLARM-equipped aircraft once every second. The system is capable of displaying the proximity of other FLARM-equipped aircraft to pilots and providing an audible and visual warning if there is a risk of collision.

[14] Civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire.

[15] Power FLARM is a recent development of the original FLARM technology. This includes the ability to detect Mode C, Mode S and ADS-B transmissions.

[16] Gliders have a relatively low radar cross-section and are typically constructed from composite materials, which reduces the likelihood of them being detected by primary radar.

that the CAA should promote the production, and subsequently mandate the use of a 'lightweight' transponder for gliders. In response, the CAA considered Mode S transponders to be the most appropriate equipment, but following consultation with the general aviation community, decided that it was not appropriate to mandate their use for operations in uncontrolled airspace.

The principal arguments against the mandatory fitment of a Mode S transponder was their relatively high power consumption, weight and cost. Moreover, if neither conflicting aircraft was in receipt of an ATC radar service, then no alert could be given to the pilots.

In 2010, following the collision between a glider and light aircraft[17], the AAIB recommended that the CAA, in light of technological changes, review again the EC of gliders and light aircraft operating in uncontrolled airspace. In 2014, an Electronic Conspicuity Working Group (ECWG) was established by the CAA, working collaboratively with NATS[18] and associations from across the general aviation community. Several manufacturers also participated, with project funding provided by the Department for Transport.

The main aim of the ECWG was to provide a technical specification for EC devices suitable for aircraft, gliders and balloons operating in uncontrolled airspace, and assurance that such devices will not compromise the performance of current air-to-air or air-to-ground safety systems already in operation, such as TCAS and ground-based radars. As part of this work, NATS conducted a trial, known as project 'EVA[19]' which ran between August 2014 and October 2016, working with AOPA[20], Trig Avionics and f.u.n.k.e Avionics. This looked at establishing the suitability of a non-certified GPS device performance when used with Automatic Dependent Surveillance-Broadcast (ADS-B)-based collision avoidance systems.

In December 2016, the CAA published the results of the project in CAP 1391, with the specified device incorporating similar functionality to FLARM, but based on ADS-B technology.

In July 2015, the ECWG merged with the Visual and Electronic Conspicuity Working Group to form the Conspicuity Working Group (CWG). The CWG forms part of the CAA's Mid-Air Collision (MAC) Programme, with the task of promoting the development of EC's and their voluntary[21] carriage on aircraft, gliders and balloons operating in uncontrolled airspace. The CAA website[22] includes details of EC devices that meet the specification in CAP 1391.

Footnote

[17] AAIB report 5/2010, aircraft G-BYXR and glider G-CKHT
[18] NATS is the UK national ATS provider.
[19] http://www.nats.aero/projecteva/
[20] AOPA - Aircraft Owners and Pilots Association, http://www.aopa.co.uk/
[21] CAP 1391 states "it is not mandatory for GA aircraft in Class G airspace to have an EC device and there is no appetite, either within the ECWG or among stakeholders, to change that. Instead, the goal is to create an environment which encourages more pilots to voluntarily equip their aircraft with an EC device."
[22] http://www.caa.co.uk/General-aviation/Aircraft-ownership-and-maintenance/Electronic-Conspicuity-devices/

Performance of FLARM fitted to G-CLJK

Analysis of FLARM data gathered from ground stations[23], G-CLJK and other aircraft in the vicinity indicated that the FLARM system fitted to G-CLJK had a reduced operating range of about 1 km, compared to an expected range of 3 km to 5 km. The evidence indicates that the lower than expected range of the FLARM fitted to G-CLJK was most likely due to a non-optimised antenna installation, rather than a fault within the system.

FLARM uses two antenna, one for GPS reception and one radio frequency (RF) antenna that transmits and receives information from other FLARM-equipped aircraft. FLARM states in its installation guide for the RF antenna, "*the correct installation has a considerable effect upon range for transmitter/receiver range, so the installation must be carefully considered*".

The manufacturer of the FLARM unit fitted to G-CLJK provided a 'user' manual, which included guidance on how to install and use the system. The manufacturer did not provide guidance on how to test the performance of the system following its fitment. The FLARM system incorporates its own built-in-test function that can alert the pilot of internal faults within the unit, but it cannot determine nor display its operating range.

FLARM also provides information for units that it manufactures. This includes a 'range analyser' software tool that is provided on its website[24]. Using this software tool, the range of the system, and corresponding 'quality' of the antenna installation, may be measured by analysing recorded data.

The reduced performance of the FLARM fitted to G-CLJK was not a factor in preventing this accident, but it is important that efforts are made to ensure that EC systems operate as expected, such that the maximum safety benefit may be obtained where possible.

The AAIB discussed with FLARM, and the manufacturer of the system fitted to G-CLJK, that improved guidance of antenna installations and awareness of how to test the performance of FLARM would be beneficial.

Safety action taken

- FLARM has published guidance information on post-installation testing of its systems, which has also included guidance on the installation of antenna. This can be found on the manufacturer's website[25].

- The manufacturer of the FLARM system fitted to G-CLJK has published guidance information on post-installation testing of its system. This can be found on the manufacturer's websites[26].

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[23] The Open Glider Network (OGN) - http://wiki.glidernet.org/ - which provides an online service for tracking FLARM equipped aircraft.
[24] http://flarm.com/support/tools-software/flarm-range-analyzer/
[25] http://flarm.com/support/manuals-documents/
[26] http://www.lxnavigation.com/support/manuals/

- The British Gliding Association (BGA) published information in its January 2017 Newsletter to raise awareness of the ability to check the range of FLARM systems.
- The BGA also referred to information already available on its website relating to conspicuity devices.

BFU airprox and collision study

The German Federal Bureau of Aircraft Accident Investigation (BFU) published in January 2017 a "Study Concerning Airproxes and Collisions of Aircraft in German Air Space 2010 – 2015. In section 2.3 the report notes the difficulty in detecting gliders early. It also notes the US Navy studies in which the estimated reaction time from the moment of recognition to the avoidance manoeuvre is around 12½ seconds.

Previous mid-air collisions

The CAA database was interrogated for records of mid-air collisions that had occurred within the UK in the 10 year period prior to, and not including, this accident. Military aircraft and balloons were excluded. Over this period, there were 22 mid-air collisions, resulting in 17 fatalities. There were 11 mid-air collisions that involved at least one glider, but only one of these resulted in a fatality to the glider pilot

Analysis

General & pre-collision

Both the commander of G-CSFC and the pilot of G-CLJK were appropriately qualified and experienced to conduct their respective flights. Both were wearing their required glasses.

The accident occurred in uncontrolled Class G airspace in which both aircraft were entitled to fly. The pilots of G-CSFC had been in receipt of a basic service until shortly before the accident. As G-CLJK was not fitted with a transponder there would not have been an identifiable radar track displayed to the controller and ATC would not have been able to provide a warning to G-CSFC. The radio fitted to G-CLJK was not receiving, and therefore the pilot would not have been able to listen out for traffic movements. Further, although both aircraft were fitted with a type of EC aid, FLARM in G-CLJK and a transponder in G-CSFC, the differing technologies meant that they did not communicate with each other. Therefore the pilots of G-CSFC and pilot of G-CLJK were reliant on visually acquiring each other's aircraft in order to avoid a collision.

There were several other aircraft in the area and these were a source of distraction for the pilots of G-CSFC, and these were also likely to have been a distraction for the pilot of G-CLJK. The right hand turn made by G-CLJK may well have been in response to seeing the helicopter G-ORBK approaching from the right, in which case it is possible that the pilot's attention may have been focused on the helicopter after having completed the turn. Following the turn, the view of the pilot of G-CLJK in the direction of G-CSFC would have been impaired by the glare from the sun, which was directly in line with G-CSFC for approximately 20 seconds prior to the collision. The lack of any apparent avoiding action by the pilot of G-CLJK suggests that he saw G-CSFC very late, if at all. The sun was not a factor for G-CSFC crew.

The avoidance of collision manoeuvres presupposes that pilots have established visual contact in time to take avoiding action. In this situation, the avoiding manoeuvre of G-CSFC was consistent with the provisions of SERA which allow a pilot to depart from the rules in the interests of safety.

Post-collision

The spinning and/or tumbling motion of G-CLJK described by the witnesses was consistent with a loss of control resulting from the extensive damage to the left wing.

It was not possible to determine accurately the time available for the pilot of G-CLJK to abandon the glider. The time between the collision at 2,250 ft agl and G-CLJK striking the ground was likely to have been between 10 and 30 seconds (assuming an estimated vertical speed of between 150 and 50 mph respectively). This gave limited time for the pilot to first assess the situation, jettison the canopy, release the harness and make a successful abandonment.

There was evidence that the pilot of G-CLJK made the correct actions to enable the canopy to be jettisoned, although at what stage in the descent could not be determined. The wreckage of the canopy was in close proximity to the fuselage wreckage and therefore it is not clear if the pilot was having difficulties jettisoning the canopy. Post-collision the environment within the glider is likely to have been disorientating and physically limiting due to the forces, which would have reduced the chance of a successful abandonment in the limited time and height available.

Conclusions

The accident occurred because the pilots did not see each other's aircraft in sufficient time to take effective avoiding action. Collision avoidance was by lookout and visual detection, which has limitations, and the low sun would have reduced the likelihood of the pilot of G-CLJK seeing G-CSFC in time.

G-CLJK was fitted with FLARM but G-CSFC was not fitted with such a system. Therefore, there was no electronic means to increase the ability to detect other aircraft in the vicinity to allow for effective collision avoidance. The CAA have since issued CAP 1391 and are part of CWG which promotes the installation of EC devices in aircraft.

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.

INCIDENT

Aircraft Type and Registration:	Agusta A109S Grand, G-PBWR
No & Type of Engines:	2 Pratt & Whitney Canada PW207C turboshaft engines
Year of Manufacture:	2007 (Serial no: 22050)
Date & Time (UTC):	5 May 2017 at 1030 hrs
Location:	London Stansted Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Failure of left side horizontal stabiliser
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	3,983 hours (of which 1,152 were on type) Last 90 days - 50 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After a normal landing, ground staff made the pilot aware of a problem with the left side horizontal stabiliser which had failed. The pilot reported that no unusual handling characteristics were experienced. The area where the horizontal stabiliser had failed was the subject of an EASA Airworthiness Directive which required repeat inspections.

History of the flight

The helicopter was being positioned from Dunsfold Aerodrome to London Stansted Airport to collect a commercial passenger for an onward flight. The 'A' Check and pre-flight inspections had been carried out prior to flight and nothing untoward was observed. The pilot reported that there was quite a lot of low-level atmospheric turbulence during the flight, but no more than expected and no unusual handling characteristics were experienced.

On arrival the ground staff indicated there was a problem with the aircraft. On inspection, the pilot observed that the left side horizontal stabiliser had failed at approximately mid-span. The failed portion had remained attached by sections of its skin and electrical cabling, (Figure 1).

Figure 1
View of failed horizontal stabiliser, looking aft

Other information

The horizontal stabiliser fitted to this helicopter was included in EASA Airworthiness Directive (AD) 2011-0150, which requires repetitive inspection in the area of the failure and, depending on findings, corrective action. The repetitive inspection was required every 50 flying hours and it had last been completed on this aircraft approximately 45 hours previously, with no adverse findings. The failure was reported to the regulator via the mandatory occurrence reporting scheme (MOR) and the failed part was returned to the manufacturer for detailed examination.

Safety action

Prompted by this event, the manufacturer issued a Service Bulletin providing new instructions for a one-time inspection and new repetitive inspections at a reduced inspection threshold and interval. As a result of this and its own safety assessment, EASA issued Emergency Airworthiness Directive AD 2017-0085-E, on 12 May 2017, to mandate these instructions.

INCIDENT

Aircraft Type and Registration:	Agusta AW139, PH-EUJ
No & Type of Engines:	2 Pratt & Whitney Canada PT6C-67C turboshaft engine
Year of Manufacture:	2013 (Serial no: 31511)
Date & Time (UTC):	19 February 2017 at 0839 hrs
Location:	Leman 27B Platform, North Sea
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 9
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	8,000 hours (of which 2,975 were on type) Last 90 days - 105 hours Last 28 days - 43 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

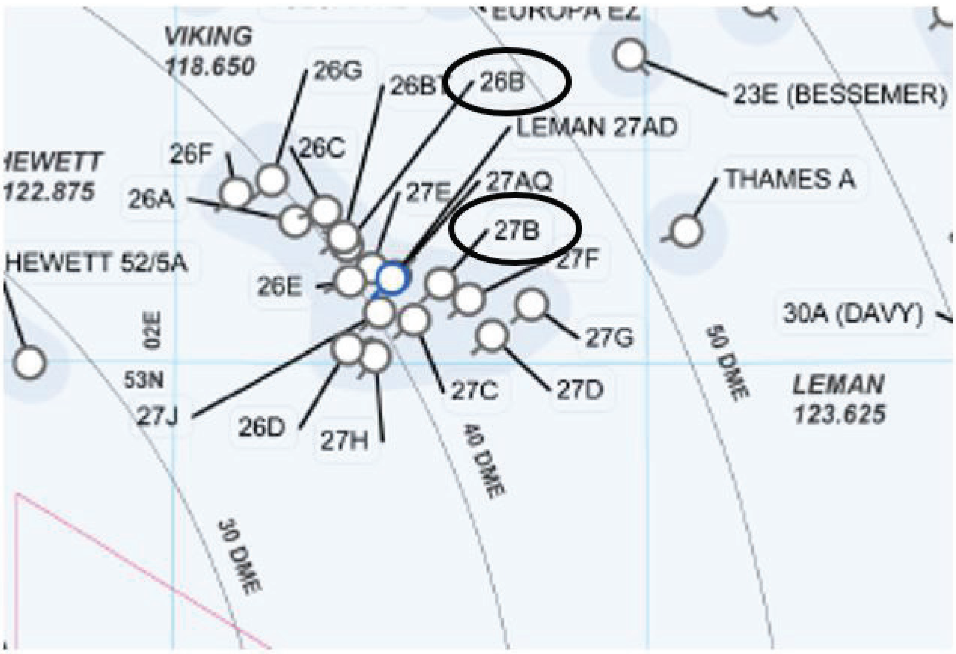
Synopsis

Whilst planning for a seven-sector shuttle in support of a UK customer, the operations department mistakenly inserted the wrong helideck into the flight plan. The error was not noticed and the helicopter proceeded to land at the Leman 27B helideck instead of the Shell Leman 26B.

History of the flight

As part of ongoing collaboration between the Dutch and UK parts of the operator, the Dutch arm of the operator was tasked to provide support for a UK customer.

The flight was planned as a seven-sector shuttle. The flight plan was produced by the operations department at the crew base using information from the customer's planning system, which detailed the route and payload for each sector. This information was then used to generate an operational flight plan. During this manual planning process, the fourth planned destination was incorrectly selected as the Leman 27B, rather than Shell Leman 26B helideck.



©RigMap

Figure 1

Rig map of Leman Field (Leman 27B is denoted as 27B, Shell Leman 26B as 26B)

The aircraft departed Den Helder Airport and the first three sectors were completed without incident. On the fourth sector the crew took off from the Seafox 4 platform to proceed to Leman 27B.

The crew landed on the Leman 27B helideck, which was unmanned because no helicopter arrivals were expected. The helicopter's passengers informed the crew that they had landed on the wrong rig and this was also confirmed by a radio call from Leman 27B. The crew correctly followed the company standard operating procedures for a landing on the wrong helideck. After consulting with the Leman area radio operator about the identity of the correct platform, the crew took off and proceeded to Shell Leman 26B where the helicopter landed without further incident.

Procedures

North Sea helicopter operators and their customers use a variety of different computer systems for flight planning, in aircraft flight management systems and monitoring the location of offshore workers. These systems use different sets of codes to denote helidecks. This means there is often a need to decode and recode installations in order to transfer information between different systems.

The planned route generated by the customer was as follows:

DHR-K14C-L13D-SF4-LEB-LEG-LED-DHR

Operations staff at the crew base produced a flight plan on the basis of this route request which involved the selection of helidecks from a drop down menu. In this case, for the fourth sector, the operations staff entered the drop down menu using the name Leman when selecting for the code LEB, which brought up a list of Leman platforms from which Leman 27B was chosen. Leman 27B was the only installation in the list selected which ended in a B. In order for the flight plan to have shown the correct destination, they actually needed to enter the list with Shell, because LEB is the code for Shell Leman 26B. Entering the drop down list with Shell would have brought up the list which included Shell Leman 26B. The route was unfamiliar to operations staff in Den Helder because it was usually completed by the UK-based arm of the operator.

Once operations staff completed the flight plan, the information was available together with weather and payload information for the crew when they reported for their flight. The crew retrieved the route but were not required to check it against the customer's route request sheet. The plan was then digitally signed and downloaded onto tablets to be used for the flights. There was no clear information source for coding available to the crew at the time of the occurrence.

On arrival at Seafox 4 at the end of the 3rd flight, the crew were handed a manifest for their next flight. This manifest listed the passenger load as well as the destination which was written as 'Leman Bravo'.

Radio communications in the North Sea are advisory services to helicopters rather than air traffic control services. Each helicopter contacts the radio operator responsible for the area of the North Sea in which they are operating. This radio operator keeps a listening watch for the helicopter whilst it is in flight, and provides information on helideck states for installations where there are no helideck crews. In this case the Leman area radio operator was on the Seafox 4, and therefore was unable to see either the helicopter or the helidecks in the sector. The radio operator did advise the crew that the deck was clear but neither the crew nor the radio operator used the full callsign of the intended helideck.

Analysis

The job of entering the destinations into the flight planning software was made significantly more challenging due to the coding differences between the customer and the operator. The customer sheet detailing the passengers and helidecks listed the fourth destination as LEB, which operations staff mistakenly entered as Leman 27B.

This incident shows very close similarities to a serious incident involving AW139, G-VINB (Bulletin 07/2017). The incorrect instillation was selected from a drop down menu and the mistake went unnoticed due to the complexities of coding differences. There was little chance for the crew to check the plan due to lack of information regarding the codes.

The use of 'Leman Bravo' on the manifest only served to reinforce the flight planning error in the minds of the crew. Neither the crew nor the radio operator used the full callsign of the intended destination when ascertaining helideck availability. This might have provided an opportunity for the error to be picked up before the helicopter landed on the wrong helideck. The manifest check and the radio call were the last chances for the crew to prevent the mistake occurring.

Conclusion

An error at the flight planning stage led the crew to land on the wrong helideck. There were a number of occasions when the error could have been picked up: briefing before departure from Den Helder; crosschecking the flight plan and payload information before departing to the installation; and during the radio calls with the radio operator in the Leman area. Once the mistake was realised, the crew correctly followed the operator's procedures for landing on the wrong helideck before proceeding to the correct destination.

Safety actions

The operator carried out an internal investigation into the incident and identified a number of safety actions. These included a secondary check of flight plans to ensure that customer requirements and flight plans match, a review of flight planning for robustness and ease of use as well as a review of installation coding. The crew now have access to the coding information and are required to check their flight plans against the original customer request.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A340-642, G-VGAS
No & Type of Engines:	4 Rolls-Royce RB211 Trent 556-61 turbofan engines
Year of Manufacture:	2005 (Serial no: 639)
Date & Time (UTC):	23 February 2017 at 2254 hrs
Location:	En route from London Heathrow to New York, USA
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 198
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	11,450 hours (of which 7,360 were on type) Last 90 days - 129 hours Last 28 days - 29 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the cruise at FL 400, the crew received a warning of excessive cabin altitude. They descended and continued to destination. At the same time as the warning of excessive cabin altitude, a fault was recorded in a Cabin Pressure Controller and it was suspected that this caused the cabin outflow valves to open allowing the cabin altitude to increase.

History of the flight

G-VGAS departed London Heathrow Airport at 1600 hrs for a commercial air transport flight to John F. Kennedy International Airport, New York City, USA, with 198 passengers and 14 crew on board. At 2254 hrs, the aircraft was at FL 400, approximately 200 nm northeast of Boston, Massachusetts, when the CAB PR EXCESS CAB ALT warning was displayed on the ECAM[1], indicating an excessive cabin altitude. Although the pressurisation system display indicated no abnormalities, the ECAM warning remained, and two crew members and both pilots believed they had symptoms of hypoxia[2].

Footnote

[1] ECAM: Electronic Centralised Aircraft Monitoring system
[2] Hypoxia is a condition where body tissues are deprived of oxygen

The pilots began a descent but, when passing FL 260, the ECAM warning extinguished. The pilots elected to level off at FL 250 and continue towards their destination but, after approximately 30 minutes, the ECAM warning returned. Indications on the pressurisation system display were still normal but the pilots descended the aircraft to an altitude of 11,000 ft and, again, decided to continue to the destination where the aircraft landed without further incident.

Assessment of cause

Data from the aircraft showed that there was a Cabin Pressure Controller 1 (CPC1) fault at the same time as the first CAB PR EXCESS CAB ALT warning. Engineers suspected that the CPC1 had failed in such a way as to drive the outflow valves open, thus allowing the cabin altitude to increase (the warning is triggered when the cabin altitude exceeds 9,550 ft).

On inspection, five components within the CPC were found to be defective due to wear but the failure mode suspected by the engineers was not identified conclusively.

SERIOUS INCIDENT

Aircraft Type and Registration:	Dornier 328-120, D-CTRJ
No & Type of Engines:	2 Pratt & Whitney Canada PW119C turboprop engines
Year of Manufacture:	1994 (serial no: 3015)
Date & Time (UTC):	26 January 2017 at 1513 hrs
Location:	Sumburgh Airport, Shetland
Type of Flight:	Certification test flight
Persons on Board:	Crew - 2 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	10,379 hours (of which 4,035 were on type) Last 90 days - 75 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further information from EASA following post-flight data analysis

Synopsis

D-CTRJ touched down in a strong crosswind. The pilot applied full left rudder but the aircraft yawed right. During the rollout, power was increased momentarily and aileron deflection was reversed from a 'roll right' to a 'roll left' sense. The aircraft rolled left, the right main landing gear lifted off the runway and the aircraft yawed into wind. The pilots could not regain control before the aircraft left the right side of the runway and ran onto the grass.

History of the flight

The flight was an EASA certification test flight aiming to extend the maximum demonstrated crosswind of the Dornier 328 from 21 kt to 30 kt. The commander of the aircraft occupied the right seat and was pilot monitoring (PM). The pilot flying (PF), sitting in the left seat, was an EASA test pilot who had flown 30 minutes on type.

Three full-stop landings on Runway 09 were accomplished successfully using 20° of flap before the final approach to land was flown with 32° of flap. The weather at Sumburgh Airport was: wind from 160° at 24 kt gusting 36 kt, 8,000 m visibility, and scattered cloud at 1,100 ft agl. The two-minute average wind, passed to the crew by ATC while the aircraft was on final approach, was from 160° at 26 kt.

The PF reported that, on the final landing, the aircraft touched down slightly to the left (downwind) of the runway centreline after which he selected GROUND IDLE power. The aircraft moved right, towards the centreline, but, when the PF applied left rudder to maintain runway heading, it had no effect and the aircraft began to drift to the right side of the runway. In an attempt to regain directional control and prevent runway excursion, the pilot applied left brake. At the same time, he inadvertently relaxed his aileron input, and the aileron deflection reversed from a 'roll right' to a 'roll left' sense. This caused the right wing to lift and the right main landing gear to lift off the runway (Figure 1). Thinking that this was due to his brake application, the pilot ceased differential braking and re-applied right aileron. The bank angle reduced and the right mainwheel touched down again. Thinking that he had "applied reverse thrust and that this might have reduced rudder effectiveness", the PF moved the power levers forward to what he thought would be GROUND IDLE. In fact, he had moved the power levers to FLIGHT IDLE, thereby increasing power, and the PM immediately returned them to GROUND IDLE and applied maximum reverse thrust.

Figure 1
Right main landing gear lifting off the runway

The aircraft yawed to the left but, despite the application of full left rudder and the intervention of the aircraft commander, the aircraft continued to diverge from the runway centreline. Control could not be regained and the aircraft passed from the runway surface onto the grass at approximately 25 kt. The ground was soft and the aircraft came to a halt abruptly.

Flight data

Flight data showed that, during the first 1.5 seconds after touchdown, aileron deflection increased to approximately 14° in a 'roll right' sense. Over the following 5.5 seconds, the aileron deflection reversed to reach approximately 11° in a 'roll left' sense as the right main landing gear lifted from the runway.

Left rudder was applied progressively, reaching its maximum travel three seconds after the main landing gear touched down, 1.5 seconds after the nose landing gear touched down. Maximum left rudder input was maintained until after the aircraft left the runway.

Recorded flight data did not include information directly from the nosewheel steering system. However, data from the nose landing gear weight-on-wheels switch – which disengages the nosewheel steering when the weight is off the wheels – suggested that the nosewheel steering did not engage after touchdown except for brief periods.

Assessment of cause

The PF stated that he had attempted to regain control on the runway through the application of asymmetric braking and cancellation of reverse thrust. While doing so, he inadvertently relaxed the left aileron input causing the right wing and main landing gear to lift off the ground.

The aircraft commander considered that, when the right main landing gear lifted from the runway, the aircraft began to "weather-cock" into wind. Subsequently, there was insufficient directional control in the strong crosswind conditions to prevent the aircraft from leaving the runway.

It is likely that the nosewheel steering was only engaged intermittently during the landing roll, which would have contributed to the handling difficulties.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SWLL	
No & Type of Engines:	1 Rotax 912-S2 piston engine	
Year of Manufacture:	2005 (Serial no: AT3-012)	
Date & Time (UTC):	10 May 2017 at 1148 hrs	
Location:	Sywell Aerodrome, Northamptonshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller, left wheel, nosewheel, fuselage above left wing	
Commander's Licence:	Light Aircraft Pilot's Licence	
Commander's Age:	71 years	
Commander's Flying Experience:	524 hours (of which 2 were on type) Last 90 days - 4 hours Last 28 days - 0 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot report that, during takeoff from Runway 21R at Sywell Aerodrome in a light and variable easterly wind, the aircraft yawed slightly to the left upon application of engine power, as is usual for the AT-3. He corrected this using rudder. However, after lifting off, the aircraft continued to yaw to the left and he was unable to correct this. The left wing dropped, and the left main wheel and propeller subsequently struck the ground. The pilot managed to lift the left wing, briefly keeping the aircraft airborne, however it continued turning left until it contacted the ground again and came to rest. The pilot switched off the electrics and closed the fuel control valve, vacating the aircraft without assistance. The aircraft suffered damage to the propeller, left main wheel, nosewheel and fuselage.

The pilot considered that the aircraft left the ground in a low-speed, unstable condition and he had not assessed or rectified this condition in a timely manner.

ACCIDENT

Aircraft Type and Registration:	Aero AT-3 R100, G-SYEL
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2006 (Serial no: AT3-019)
Date & Time (UTC):	27 June 2017 at 1100 hrs
Location:	Sywell Aerodrome, Northamptonshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosegear collapsed and two propeller tips damaged
Commander's Licence:	Student
Commander's Age:	46 years
Commander's Flying Experience:	16 hours (of which 16 were on type) Last 90 days - 12 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot had been briefed to fly a first solo circuit. The weather was: wind 090º/6kt, visibility 10km, cloud overcast at 1,500 ft. Runway 05 was in use which was 602 m long and 30 m wide and had a grass surface. The aircraft departed normally and established on the downwind leg at 900 ft aal, where the pilot lowered the first stage of flap. Light rain had moved into the circuit which reduced the visibility but the circuit was completed and, when established on finals, full flap was lowered at about 65kt. The instructor, who was monitoring the circuit, and the pilot both thought the approach was normal but the touchdown, although smooth, was flat and, following several bounces, the nose landing gear collapsed and the aircraft came to a stop. The pilot switched off the fuel and electrics and vacated the aircraft.

The pilot thought that the approach was slightly fast and the touchdown may have resulted in a Pilot Induced Oscillation (PIO) leading to the nose landing gear collapsing. Also, the deterioration in the weather made the pilot reluctant to go around.

ACCIDENT

Aircraft Type and Registration:	Beech 76 Duchess, G-TWNN
No & Type of Engines:	2 Lycoming (L)O-360-A1G6D piston engines
Year of Manufacture:	1980 (Serial no: ME-329)
Date & Time (UTC):	3 May 2017 at 1449 hrs
Location:	Wellsbourne Mountford Airfield, Warwickshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to propellers, engines and fuselage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	74 years
Commander's Flying Experience:	15,000 hours (of which 20 were on type) Last 90 days - 47 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a training flight the handling pilot did not lower the landing gear prior to landing and the aircraft landed with the wheels up. The commander assessed the cause of the accident to be *"over-concentration on the flying and training aspects of the exercise, to the detriment of aircraft basic procedures"*.

History of the flight

The commander was conducting a training flight in preparation for the handling pilot's MEP class rating and single-pilot instrument rating renewal. The handling pilot occupied the left seat and the commander was in the right seat.

Following completion of upper air exercises, the handling pilot flew two circuits to Runway 36; both were normal two-engine approaches for touch-and-go landings and were completed in moderately turbulent conditions, with a 10 kt crosswind component. The commander noted that the only training issue from these circuits was a tendency for the pilot to over-control power to achieve the required speeds on final approach.

The accident approach, also to Runway 36, was a flapless approach for a touch-and-go landing. The commander commented that the handling pilot's speed control was again a problem and consequently his attention was focussed on monitoring the airspeed. The aircraft was equipped with a single ASI, mounted on the left side of the left instrument panel. The commander stated that as the ASI indications are not clearly visible from the right seat, additional concentration was required in his monitoring of the airspeed. There were some relatively small airspeed control issues on the approach, which required verbal input from the commander.

The flare was a little high, and whilst talking the trainee through the correct touchdown technique the commander did not notice that the landing gear was still selected UP.

The aircraft landed in the normal landing attitude and skidded down the runway for some 150 m, drifting to the left of the centreline before coming to rest. The aircraft was made safe and vacated through the normal cockpit entry doors.

The commander assessed the cause of the accident to be “over-concentration on the flying and training aspects of the exercise, to the detriment of aircraft basic procedures”.

ACCIDENT

Aircraft Type and Registration:	Beechcraft 35, F-BASF
No & Type of Engines:	1 x Continental IO-470-N
Year of Manufacture:	1962
Date & Time (UTC):	13 May 2017 at 1516 hrs
Location:	Jersey Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller, flaps, cowl flaps, radio antennas
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	1,300 hours (of which 800 were on type) Last 90 days - 35 hours Last 28 days - 17 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After leaving Brest, the pilot contacted Jersey Approach Control. The controller requested that he remain below 1,000 ft in the vicinity of Fremont TV mast. On reaching the mast, the controller asked the pilot to report when visual with a Cherokee aircraft. He then requested the pilot to follow the Cherokee which was being radar vectored towards Runway 26.

Realising he was closing on the Cherokee, the pilot contemplated extending the landing gear, but decided to delay this as the speed was above the 140 kt landing gear limiting speed. Once on final approach he realised that both aircraft were very close and maintained some height to avoid the Cherokee's prop wash. The pilot was focussed intently on the Cherokee ahead and listening to the tower controller in case he was directed to go around. He was aware of the stall warner sounding, then the Cherokee finally cleared the runway and the pilot received clearance to land. The landing gear was not lowered and the aircraft landed gear-up.

ACCIDENT

Aircraft Type and Registration:	Cessna 195, N3458V	
No & Type of Engines:	1 Jacobs L4 /R755-7 piston engine	
Year of Manufacture:	1948 (Serial no: 7159)	
Date & Time (UTC):	23 April 2017 at 1300 hrs	
Location:	Dunkeswell Aerodrome, Devon	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Significant airframe damage	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	67 years	
Commander's Flying Experience:	2,643 hours (of which 8 were on type) Last 90 days - 18 hours Last 28 days - 11 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot had flown three circuits in the aircraft when, during the third landing, the aircraft bounced on touchdown which caused the pilot's feet to "lift up" the rudder pedals and operate the brakes. The pilot was prevented from arresting the descent or removing his feet from the brakes because, as the aircraft was only fitted with lap strap restraints, his upper body had been thrown forward during the bounce. Immediately after touchdown the aircraft pitched forward onto its nose and became inverted before coming to a stop. The pilot was able to leave the aircraft without assistance.

ACCIDENT

Aircraft Type and Registration:	Cessna A152 Aerobat, G-BOSO
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1981 (Serial no: A152-0975)
Date & Time (UTC):	19 April 2017 at 1447 hrs
Location:	Redhill Aerodrome, Surrey
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Firewall, propeller and right wing damaged, nosewheel collapsed
Commander's Licence:	Student
Commander's Age:	57 years
Commander's Flying Experience:	20 hours (of which 20 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following several successful landings with an instructor, the student pilot flew solo circuits to grass Runway 08L. He reported the weather to be fine with nil wind, good visibility and a temperature of 12°C.

During the final landing, G-BOSO bounced and then landed in a level or nose-down attitude. The nosewheel leg collapsed, and the aircraft came to a stop on its nose and starboard wingtip.

The pilot believed that it may have been preferable to initiate a go-around after the initial bounce.

ACCIDENT

Aircraft Type and Registration:	Cessna 525A, N525DT
No & Type of Engines:	2 Williams FJ44 turbofan engines
Year of Manufacture:	2000
Date & Time (UTC):	17 May 2017 at 0929 hrs
Location:	Gloucestershire Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to the right main landing gear door and right flap
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	3,800 hours (of which 1,020 were on type) Last 90 days - 57 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft completed an ILS/DME approach to Runway 27 at Gloucestershire Airfield. The pilot reported the weather to be raining with broken clouds at 500 ft, a temperature of 13°C, 5,000 m visibility, and negligible wind. A runway inspection conducted approximately 5 minutes prior to the incident indicated that the runway surface state was wet with water patches.

After landing the pilot reported that the aircraft brakes were inoperative. He steered the aircraft off the runway to a clear grassy area on the right hand side, where it came to rest. The aircraft sustained minor dents on the right main landing gear door and on the right flap.

Subsequent engineering work could not replicate the reported brake fault. However, as a precaution, the brake cable rigging was checked, and the brake metering valve and the anti-skid computer were replaced.

ACCIDENT

Aircraft Type and Registration:	DH87B Hornet Moth, G-AESE
No & Type of Engines:	1 De Havilland Gipsy Major 1C piston engine
Year of Manufacture:	1937 (Serial no: 8108)
Date & Time (UTC):	30 July 2016 at 1147 hrs
Location:	Coventry Airport
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left landing gear, left wingtip and spar
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	845 hours (of which 550 were on type) Last 90 days - 22 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a local flight to Shotteswell Airport, where the pilot completed two landings, the aircraft returned to Coventry Airport. He performed a successful full stop landing on Runway 23 followed by a further circuit and successful touchdown. However, after all three wheels settled on the paved surface, the pilot reported encountering a gusting crosswind from the left from between 300° and 320°. Actual wind conditions could not be established but the pilot reported that the Coventry Airport forecast was wind from 300° at 8 kt.

This crosswind caused the aircraft to veer to the left, which was corrected, but then the aircraft veered to the right. The pilot reported applying full opposite rudder and braking but the turn developed into a ground loop, after which the aircraft came to a halt with the left landing gear collapsed. Both occupants were wearing full harnesses and escaped uninjured.

ACCIDENT

Aircraft Type and Registration:	Extra EA 300/LC, G-GOFF
No & Type of Engines:	1 Lycoming AEIO-580-B1A piston engine
Year of Manufacture:	2011 (Serial no: LC008)
Date & Time (UTC):	17 June 2017 at 1830 hrs
Location:	Foxborough Farm Airstrip, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Impact damage to propeller, spinner, wheel spats and outboard end of right wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	902 hours (of which 103 were on type) Last 90 days - 38 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was being operated from Foxborough Farm Airstrip, which has a 580 m grass runway, oriented on a heading 290°M/110°M. The pilot took off for a local flight on Runway 29, estimating the wind as westerly at 7 kt. Prior to landing back at Foxborough Farm airstrip he requested the surface wind at Norwich Airport, which was 13 nm ESE of the airstrip. Norwich ATC informed the pilot that the wind at Norwich Airport was 140° at 7 kt.

The pilot did not observe the airstrip's windsock and made an approach to Runway 11, but on landing he felt the aircraft floated longer than normal. He applied the brakes and the aircraft skipped approximately 15 ft. The pilot stated that once the aircraft had skipped, he did not consider going around to be a safe option and, approaching the end of the runway, pitched the aircraft onto its nose to further slow the aircraft. The aircraft came to rest in a low boundary hedge at the end of Runway 11.

The pilot attributed the cause of the accident as landing downwind, having not identified the local wind direction at the airstrip, different from that reported at Norwich Airport.

ACCIDENT

Aircraft Type and Registration:	Falco F8L Falco, G-CYLL
No & Type of Engines:	1 Lycoming IO-330-B1A (Modified) piston engine
Year of Manufacture:	2011 (Serial no: PFA 100-14572)
Date & Time (UTC):	17 June 2017 at 1215 hrs
Location:	Breighton Airfield, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller destroyed and suspected shock-loading of engine. Some damage to nose landing gear assembly and to underside panels.
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,076 hours (of which 17 were on type) Last 90 days - 28 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The retractable nose landing gear collapsed despite an indication that it was down and locked. It is possible the nose landing gear assembly had been damaged during an earlier flight, with two normal landings being completed before the problem occurred.

History of the flight

During a local flight with the aircraft inbound to Breighton Airfield, the landing gear was selected down: and indicators then showed the gear was locked down; mechanical pop-up indicators for the main gear and a steady green light for the nose gear. Following a normal approach, the aircraft touched down, into wind, on the main landing gear and then, as speed reduced, the nose landing wheel made ground contact. After a short delay, the nose continued to drop, the propeller struck the grass surface and shattered, and the aircraft slowed to a halt, with the nose landing gear collapsed inside its wheel well.

Preceding flights

Six days before the accident another pilot had flown the aircraft from Le Touquet Airfield to Breighton. While taxiing for takeoff, this pilot felt a jolt and heard a loud noise from the vicinity of the nose landing gear, so he slowed the aircraft and checked the steering. As there were no other untoward indications, he assumed he had taxied over an unseen rut in the taxiway and that the aircraft was undamaged. He continued the flight and landed at Breighton uneventfully.

Two days after the aircraft returned from Le Touquet, the pilot for the accident flight made a local flight, culminating in a single, uneventful landing. No damage was apparent during his pre-flight inspection and no problems were encountered with the landing gear during the flight.

Possible cause

When the nose landing gear screwjack assembly was dismantled, its adjustment screw was found to be bent. This may have caused the green light to illuminate and the screw jack to be de-powered before it reached the locked-down position. It is possible the adjustment screw was damaged in the incident at Le Touquet but still enabled the landing gear to operate normally until the accident flight, but the precise cause could not be accurately determined

ACCIDENT

Aircraft Type and Registration:	Flight Design CTSW, G-CFDO
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2008 (Serial no: 8366)
Date & Time (UTC):	13 June 2017 at 1830 hrs
Location:	Causey Park Airfield, Northumberland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, windscreen and wheel spats damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	400 hours (of which 130 were on type) Last 90 days - 11 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was flying to Causey Park Airfield where the aircraft was based. The weather was fine with wind from the south-west at 10 to 15 kt, and he decided to land on the south-westerly grass runway.

The aircraft touched down firmly and bounced to the left, landing in a field of corn that bordered the runway. The landing gear became entangled in the corn and the nose wheel dug into the soft ground and collapsed. The aircraft then rolled forward, coming to rest inverted. Having secured the aircraft the pilot vacated uninjured and without assistance. The aircraft was subsequently righted and recovered with assistance.

The pilot attributed the accident to landing heavily whilst attempting a short field landing, combined with the long crops and soft ground.

ACCIDENT

Aircraft Type and Registration:	Gulfstream AA-5B Tiger, G-BOZZ
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1979 (Serial no: AA5B-1155)
Date & Time (UTC):	18 May 2017 at 1400 hrs
Location:	Weston-on-the-Green, Bicester, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Bent nose leg tube, engine shock-loaded, damaged propeller blades
Commander's Licence:	Private Pilot's Licence
Commander's Age:	19 years
Commander's Flying Experience:	113 hours (of which 8 were on type) Last 90 days - 14 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he had made a normal approach and selected full flap prior to landing on Runway 19 at Weston-on-the-Green. The speed was normal, but during the flare the wheels touched the grass runway and hit a bump, causing the aircraft to bounce back into the air. The pilot stated that he continued to hold the aircraft in the flare and allowed it to settle back onto the runway; however, approximately 10 m into the ground roll the nose dropped and the propeller struck the ground. The nose landing gear was subsequently found to be bent rearwards.

The pilot believes that the uneven surface of the grass runway contributed to the aircraft bouncing and damaging the nose landing gear leg.

ACCIDENT

Aircraft Type and Registration:	Jodel D120A Paris-Nice, G-BYBE
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1964 (Serial no: 269)
Date & Time (UTC):	13 May 2017 at 1000 hrs
Location:	MOD St Athan, South Wales
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right wheel strut, right wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	300 hours (of which 103 were on type) Last 90 days - 8 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft landed on Runway 25 and, approximately 100 m after touchdown, began to veer to the left. The pilot applied a "dab" of right brake and then rudder but to no effect. The aircraft then ground looped, causing the right landing gear to collapse. The reported wind was 240° at 9 kt.

Both occupants, who were wearing lap and diagonal harnesses, escaped uninjured.

ACCIDENT

Aircraft Type and Registration:	Jodel D120 Paris-Nice, G-DIZO
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1965 (Serial no: 326)
Date & Time (UTC):	15 April 2017 at 1002 hrs
Location:	Lee-on-Solent Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to both main landing gear legs and minor damage to underside of left wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	471 hours (of which 369 were on type) Last 90 days - 13 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft bounced during landing on asphalt Runway 23 at Lee-on-Solent, with a crosswind from 310º that gusted to a recorded maximum of 13 kt. The second touchdown was a three-point touchdown but the pilot reported that a sudden gust of wind then caused the aircraft to ground loop to the right.

As the aircraft turned through 180º, the left main landing gear leg collapsed and the right main landing gear bent, before the aircraft came to rest on the left wing and the right main landing gear.

The pilot assessed that the bounced landing and the ground loop were caused by gusts of wind that were stronger than those he had anticipated. He noted that this type of aircraft can be prone to landing gear collapse when large side forces are encountered.

ACCIDENT

Aircraft Type and Registration:	Luscombe 8E Silvaire Deluxe, G-BRGF
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1947 (Serial no: 5475)
Date & Time (UTC):	11 June 2017 at 1144 hrs
Location:	Old Buckenham Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller bent, windscreen cracked, canopy damaged, dent in the aft firewall and the tailfin bent
Commander's Licence:	Private Pilot's Licence
Commander's Age:	75 years
Commander's Flying Experience:	1,212 hours (of which 888 were on type) Last 90 days - 5 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was on final approach to land and descended over a rapeseed crop close to the end of the runway. The pilot states that he was attempting to land the aircraft "as short as possible on the short runway" but "misjudged" the approach and the landing gear made contact with the crop, causing the aircraft to nose over. The aircraft came to a stop on its back sustaining damage to the engine bay, propeller, windscreen, canopy and tailfin. The pilot was uninjured.

ACCIDENT

Aircraft Type and Registration:	Luscombe 8E Silvaire Deluxe, G-BSHH
No & Type of Engines:	1 Continental Motors Corp C85-12F piston engine
Year of Manufacture:	1946 (Serial no: 3981)
Date & Time (UTC):	8 July 2017 at 1330 hrs
Location:	Porthtowan Airstrip, Cornwall
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1(Minor) Passengers - 1(Minor)
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	333 hours (of which 280 were on type) Last 90 days - 12 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

After completing his normal pre-takeoff checks, including the power checks, for this high-wing, tailwheel-fitted aircraft, the pilot commenced takeoff from a 500 m grass runway. No difficulty was encountered until immediately after the aircraft had become airborne, when a partial loss of engine power was experienced. The pilot landed the aircraft on the remaining runway and braked hard to ensure the aircraft stopped before the perimeter of the airstrip, where there was a stone wall.

The harsh braking tipped the aircraft forward, the propeller struck the ground causing the engine to stop, and the aircraft overturned. The pilot and his passenger undid their straps and managed to make their own escape through the side doors. The cause of the partial power loss has so far not be determined.

ACCIDENT

Aircraft Type and Registration:	Maule MXT-7-160 Star Rocket, G-BUXD
No & Type of Engines:	1 Lycoming O-320-B2D piston engine
Year of Manufacture:	1993 (Serial no: 17001C)
Date & Time (UTC):	28 April 2017 at 1110 hrs
Location:	Eaglescott Airfield, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Aircraft extensively damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	183 hours (of which 20 were on type) Last 90 days - 7 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft stalled after the pilot flew a go-around after losing sight of the runway.

History of the flight

The pilot reported that he had flown from Goodwood to Eaglescott Airfield, where he flew a right-hand circuit to land on Runway 07. On turning on to finals the pilot lost sight of the runway and so orbited twice while he attempted to regain sight of the runway. During this manoeuvre the aircraft descended and the pilot, on realising that he was now too low, commenced a go-around. The pilot reported that he did not adequately monitor his airspeed during the go-around and the aircraft stalled; with insufficient height to fully recover from the stall, the aircraft crashed in a field short of the runway. The pilot and passenger were uninjured but the aircraft was extensively damaged.

Airfield information

Eaglescott Airfield has two grass runways and the western end of the airfield is surrounded by fields with a similar alignment to Runway 07 (Figure 1). The airfield instructions for visiting pilots is that Prior Permission is Required (PPR) by telephone and the arrival procedure is to make a radio call 10 miles out and then fly a standard overhead join at 2,000 ft QFE and a left-hand circuit at 800 ft.

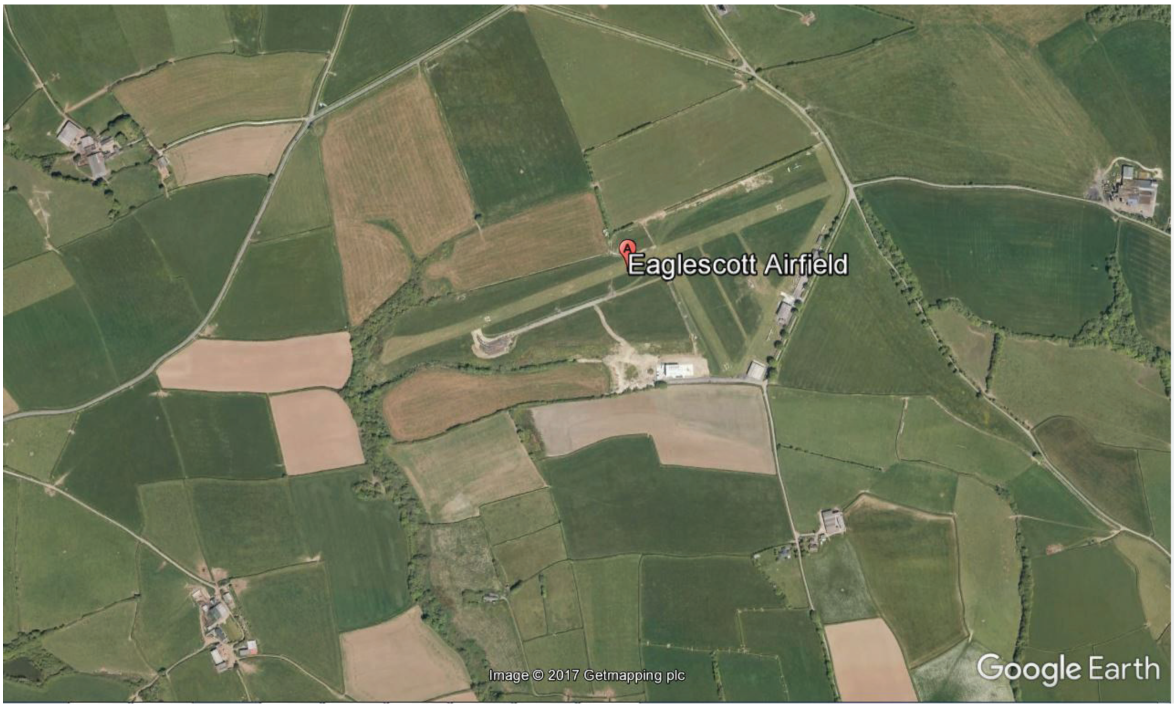


Figure 1
Eaglescott Airfield

Witness reports

The Airfield Manager (AM), who is also the Chief Flying Instructor, reported that he took the telephone call from the pilot when he requested PPR. He gave the pilot the QFE setting and advised him to arrive in the overhead at 2,000 ft QFE for a standard overhead join for a left-hand circuit for Runway 07. The pilot made the required radio call when 10 miles out and as he approached the overhead reported that he was letting down on the dead-side for a right-hand circuit on Runway 07. The AM stated that as the radio calls were confident, and there was no other traffic in the circuit, he did not correct the pilot. The pilot reported "Downwind Runway 07" at a position that the AM considered to be closer to the airfield than normal. The AM continued to watch G-BUXD and noticed that after it had made a slight descent on the base leg the aircraft then flew a right orbit. The AM made a radio call to the pilot when the aircraft was pointing towards the airfield and suggested that he should roll out, perform a go-around and complete a standard left-hand circuit.

The pilot did not respond to the radio call and continued orbiting. The AM made a second call when the aircraft was pointing towards the airfield stating "go-around, go-around, climb straight ahead, and perform a standard left-hand circuit." The aircraft then seemed to make a 45° join onto final from the base leg and when on the final approach appeared to commence a go-around. However, the nose of the aircraft was seen to rise, the left wing dropped and the aircraft disappeared from view. The AM called the emergency services (999) and the Eaglescott based Devon Air Ambulance helicopter who arrived on the scene within three to four minutes of the accident.

AAIB Comment

The pilot informed the AAIB that he had, correctly, written in his flight plan that he should fly a left-hand circuit at Eaglescott Airfield. He used a tablet device to navigate, and on-route checked the airfield information recorded on the device, which stated that pilots should fly a right-hand circuit. On rechecking the airfield information on the device after the accident, the pilot realised that this referred to gliders and that fixed-wing powered aircraft should fly a left-hand circuit.

With a passenger sitting in the front right seat, it would have been difficult for the pilot in the left seat to remain in sight of the runway when flying a right-hand circuit close to the airfield. As shown in Figure 1, the number of nearby fields with similar 'east-west' alignment to that of Runway 07 may have made identification of the runway more difficult.

ACCIDENT

Aircraft Type and Registration:	Piper PA-24-250 Comanche, G-BYTI
No & Type of Engines:	1 Lycoming O-540-A1D5 piston engine
Year of Manufacture:	1963 (Serial no: 24-3489)
Date & Time (UTC):	21 May 2017 at 1012 hrs
Location:	Retford Gamston Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged propeller, lower fuselage and left flap
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	485 hours (of which 400 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries made by the AAIB

This was the first flight after the main landing gear had been refitted following repairs. A new squat (safety) switch was installed prior to the flight and landing gear functional tests were completed in accordance with the published procedures.

The pilot's intention was to fly one circuit with the landing gear down, before landing and coming to a full stop. He reported that everything was normal with the landing gear indicating down and locked until he applied the brakes after touchdown, at which point the undercarriage collapsed.

The maintenance agency reported that the landing gear retraction mechanism was undamaged and the configuration of the ball screw and transmission indicated that the landing gear had been retracted by the electric motor. The circuit breaker for the electric motor was found to have tripped.

The safety switch prevents the landing gear from retracting if the left main landing gear leg is compressed and multiple failures are required for the landing gear to retract without selection. The pilot reported that he had not operated the landing gear selector lever at any stage of the flight.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-151 Cherokee Warrior, G-LUSH
No & Type of Engines:	1 Lycoming O-320-E3D piston engine
Year of Manufacture:	1975 (Serial no: 28-7515201)
Date & Time (UTC):	17 April 2017 at 16:20 hrs
Location:	Near Blackbushe Airport, Surrey
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Both wings detached, fuselage and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	190 hours (of which 115 were on type) Last 90 days - 46 hours Last 28 days - 46 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After a 40 minute flight to the local area, the pilot returned to Blackbushe with the intention of performing two circuits; carburettor heat was used for the approach. After a touch-and-go with the carburettor heat now selected OFF as normal, he turned crosswind at 500 ft agl, during which he reported that engine power "suddenly and significantly reduced." With limited time and altitude available to assess the cause, the pilot elected to land in the nearest suitable field. This was in an area of woodland and the aircraft suffered significant damage due to contact with some trees during the landing. The pilot, who was wearing a lap and diagonal harness, escaped uninjured. No causal defects were identified during a subsequent examination of the aircraft by a maintenance organisation.

The weather at the time of the accident was reported as broken cloud at 3,600 ft, temperature of 11°C and a dew point of 4°C. CAA '*Safety Sense Leaflet 14 Piston Engine Icing*[1]' includes a chart showing the likelihood of carburettor icing in different weather conditions. The dew point and temperature conditions at the time of the accident would have been conducive to '*serious icing – any power*'.

Footnote

[1] Available on the CAA website at http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BNRG	
No & Type of Engines:	1 Lycoming O-320-D3G piston engine	
Year of Manufacture:	1981 (Serial no: 28-8116217)	
Date & Time (UTC):	7 May 2017 at 1200 hrs	
Location:	Sandown Airport, Isle of Wight	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 3
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to propeller, engine, left landing gear and left wing	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	21 years	
Commander's Flying Experience:	60 hours (of which 12 were on type) Last 90 days - 4 hours Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

After a standard overhead join and circuit, the pilot attempted to land but touched down late. He considered he had enough runway to continue, but acknowledged in hindsight he should have performed a go-around at this point. After the initial touchdown the aircraft bounced, further reducing the landing distance available. The pilot then considered the safer option was to continue the landing. Once on the ground, he applied full brake pressure but the aircraft rolled off the end of the runway at slow speed, into wasteland and some brambles. The pilot considered that the cause of the accident was pilot error due to a poor approach and not making the decision to perform a go-around.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-180 Cherokee, G-HOCK
No & Type of Engines:	1 Lycoming O-360-A4A piston engine
Year of Manufacture:	1967 (Serial no: 28-4395)
Date & Time (UTC):	30 June 2017 at 1135 hrs
Location:	Sandown Airport, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Propeller, spinner, nosewheel, fuselage and engine
Commander's Licence:	Private Pilot's Licence
Commander's Age:	73 years
Commander's Flying Experience:	666 hours (of which 584 were on type) Last 90 days - 10 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Just as the aircraft touched down, the pilot was distracted by something hitting the windshield causing him to momentarily pull back on the control wheel. The aircraft briefly became airborne before landing hard and bouncing several times. On the final bounce the nose gear collapsed and the propeller made contact with the ground. The pilot exited the aircraft unaided.

ACCIDENT

Aircraft Type and Registration:	Rans S6-116 Coyote II, G-BUOK	
No & Type of Engines:	1 Rotax 912-UL piston engine	
Year of Manufacture:	1993 (Serial no: PFA 204A-12317)	
Date & Time (UTC):	20 June 2017 at 1230 hrs	
Location:	Bagby (Thirsk) Airfield, Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Both propeller blades broken, landing gear, engine, cockpit, windscreen and right wing distortion	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	422 hours (of which 17 were on type) Last 90 days - 17 hours Last 28 days - 12 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

The aircraft had just taken off from Runway 24 at Bagby and was at a height of approximately 20 ft when the left wing dropped, the aircraft turned to the left, descended and hit the ground. The pilot was uninjured but the aircraft sustained significant damage. The pilot considered the accident was caused by insufficient airspeed coupled with a tailwind component leading to a left wing stall.

History of the flight

The aircraft accelerated normally and took off from Runway 24 at Bagby Airfield, reaching an estimated height of 20 ft when the left wing dropped. The aircraft then turned to the left, lost height and hit the ground. The pilot was uninjured but the aircraft sustained significant damage to its propeller, cockpit and canopy, right wing and landing gear.

Airfield conditions

The runway heading at Bagby was 240°, with 2.5% downslope. The local ‘recommendation’ at the airfield was to take off and get airborne on the grass section of the runway prior to a concrete paved section, which was approximately 230 m from the threshold. The pilot reported a 150°/8 kt crosswind, with gusts of 120°/12 kt, at the time of the accident. These backing wind conditions created a gusting tailwind component.

Discussion

The Rans S6, fitted with a Rotax 912 engine in this case, should have been capable of getting airborne with a takeoff run of 60 m. It has a cruising speed of 90 kt and a relatively low stall speed of 35 kt. With minimal or no headwind the airfield conditions would mean the aircraft could have easily taken off and achieved a safe airspeed well before the concrete section of the runway. However, as the pilot stated; “the probable cause for a wing stall was not enough airspeed for the wind conditions, coupled with a gusting tailwind”.

It is likely that the pilot, mindful of the recommendation regarding the concrete section, got his aircraft airborne as soon as possible but with a slightly lower than normal airspeed. This, coupled with the resultant tailwind component, calculated to be gusting at approximately 5 kt, may have brought the relative airspeed over the left wing down to a speed at which a stall would be likely. The height and low inertia of this aircraft would make a recovery action in this situation extremely difficult.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ES Coyote II, G-BZKO
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2000 (Serial no: PFA 204-13564)
Date & Time (UTC):	23 March 2017 at 1100 hrs
Location:	Newtonards Airport, Co. Down
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose and left main landing gear failed, engine and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	5,510 hours (of which 8 were on type) Last 90 days - 71 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was being used for an instructional flight in the local area. After completing the pre-takeoff checks the student completed a normal takeoff from Runway 03, climbed the aircraft to the circuit height of 700ft and turned onto the crosswind leg of the circuit. As the aircraft was about to leave the circuit the instructor observed that the engine oil pressure had dropped; there were no other abnormal engine indications. The student was instructed to turn the aircraft back towards the airfield and make a "PAN" call, after which the instructor took control of the aircraft. Shortly after turning towards the airfield, with the aircraft over Strangford Lough, the engine failed. The position and height of the aircraft meant that it was not possible to reach the airfield but the instructor was able to maintain control of the aircraft until it reached an area of scrub and soft ground close to the airfield, where a successful forced landing was completed. During the landing, the landing gear dug into the soft ground, which resulted in the collapse of the nose and left landing gear legs. The failure of the engine was attributed to the rapid loss of engine oil due to a severe leak.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ESD (Modified) Coyote II, G-MYIS	
No & Type of Engines:	1 Rotax 503 piston engine	
Year of Manufacture:	1993 (Serial no: PFA 204-12382)	
Date & Time (UTC):	27 May 2017 at 1210 hrs	
Location:	Northrepps Airfield, Norfolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Right rear wing strut broken	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	67 years	
Commander's Flying Experience:	578 hours (of which 290 were on type) Last 90 days - 3 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The aircraft was making an approach to land on Runway 22 at Northrepps Airfield, Norfolk. The final approach to runway has two obstacles, overhead electricity cables and a railway line on an embankment. To provide a visual alert to the presence of the obstacles two poles had been placed at the base of the embankment, with red and white spinning markers strung on a wire between the tops of the poles. In addition, the threshold of Runway 22 has been displaced by 125 m.

During the later stages of the final approach, the aircraft suffered an uncommanded height loss as it passed over the railway embankment. The pilot applied engine power to arrest the descent but was unable to do so before the right wing support struts struck the top of the pole to the right of the runway, which resulted in the failure of the right rear wing strut. The pilot was able to land the aircraft normally.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna FR172F Rocket, G-DRAM
No & Type of Engines:	1 Continental Motors Corp IO-360-D piston engine
Year of Manufacture:	1969 (Serial no: 102)
Date & Time (UTC):	31 May 2017 at 1204 hrs
Location:	Prestwick Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left float damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	1,760 hours (of which 1,200 were on type) Last 90 days - 15 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

The aircraft, which was equipped with floats and retractable landing gear units, was on its second flight after major maintenance. During the flight the engine suffered rough running, prompting the pilot to declare a PAN and expedite a landing. After selecting the gear down, he and his passenger checked the mechanical gear indicator 'flags' to confirm that the gear was down. The pilot could not recall if all the green gear down and locked indicator lights were illuminated.

After a smooth touchdown the aircraft rolled normally for 40 to 50 m, before veering to the left, coming to a stop on the shoulder of Runway 12. It transpired that the left landing gear had collapsed, causing the left float to contact the runway. On lifting the aircraft, the left main gear extended and locked down.

Subsequent retraction tests did not reveal any problems with the landing gear. Examination of the engine revealed significant fouling of one spark plug. 8 hours flying have since been completed without any landing gear problems.

The pilot considered that the PAN condition may have been contributory as there was no opportunity to go around or double-check the gear, the priority being to land.

ACCIDENT

Aircraft Type and Registration:	Slingsby T67M MkII Firefly, G-BNSP
No & Type of Engines:	1 Lycoming AEIO-320-D1B piston engine
Year of Manufacture:	1987 (Serial no: 2044)
Date & Time (UTC):	17 April 2017 at 1225 hrs
Location:	Turweston Aerodrome, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Axle, nosewheel and fittings fell apart, nose landing gear fork bent
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	9,745 hours (of which 186 were on type) Last 90 days - 126 hours Last 28 days - 47 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB

Synopsis

The aircraft had landed at Turweston Aerodrome and had slowed to a walking pace on the runway. The pilot was given permission to backtrack and commenced a 180° turn. Halfway through the turn the pilot suddenly felt the nose drop and the aircraft came to an abrupt stop. He made the aircraft safe, vacated the cockpit and found that the nosewheel axle had migrated out, allowing the wheel to be released from the nose landing gear fork. The retaining nut, meant to hold the axle in place, could not be found. It is not known exactly when or why the nut had detached.

History of the flight

The pilot planned to carry out a local flight with aerobatics and circuits to test, and capture footage on a head-mounted action video camera. He carried out a pre-flight check and noticed nothing unusual with the aircraft or its landing gear. The taxi and takeoff were normal and the pilot carried out his flight as planned. He returned to the airfield, joined the circuit and landed. Just after touchdown he gently applied the brakes and noted a small amount of left and right movement. This he considered normal and put it down to uneven pedal foot pressure during initial application. Otherwise the rollout was unremarkable. The pilot had slowed the aircraft to a walking pace, was given permission to backtrack and started a slow 180° turn. Halfway through the turn, without warning, the nose dropped and the aircraft came to an abrupt halt. He made the aircraft safe and vacated the cockpit. He then examined the aircraft and found the nosewheel had detached from its fork and was lying close by on the runway.

Engineering investigation

Examination of the nosewheel and fork assembly found that the axle had migrated out and allowed the wheel to be released from its fork. The 'K-nut[1]' meant to secure the axle was not found. The aircraft had recently undergone its annual service which was when the nosewheel was last disturbed. The aircraft had accrued 16 flying hours since that check.

Analysis

The AMM (Aircraft Maintenance Manual) is not specific regarding the fitting of the nosewheel. It merely states the wheel should be offered up to the nosewheel fork, aligned with the bolt holes, the greased bolt and spacers inserted and then secured with a washer and lock nut.

It is possible that the orientation of the axle and the condition of the K-nut may have been contributory factors. In this case the evidence suggests the axle was fitted from the left side of the fork resulting in a tendency, with nosewheel rotation, to apply a slight undoing torque. In addition, if the K-nut is worn, with a reduced run-down torque, its locking ability will be compromised. The presence of grease on the axle bolt may also have been a factor. In combination these factors can lead to an unsafe condition.

Anecdotal evidence suggests that there have been a problems in the past on other T67 aircraft, whereby, for no apparent reason, the K-nut has loosened and detached. However, there is no mandatory occurrence report (MOR) data to support this. In addition, there are no reports to the Type Certificate holder that would indicate any tendency for the nut to detach. However, during this investigation it became apparent that other operators and maintenance organisations had taken action to address this problem and had introduced a safety split pin outboard of the K-nut. An example is shown in Figure 1.

Footnote

[1] K-nut is a hexagonal threaded nut made using the minimum material. It has a flange on its lower face and is purposely distorted on its upper face to create a tightness in the thread in order to self-lock the nut when fitted to a threaded fastener. The locking ability of the nut is assessed by its run-down torque, however this can be affected by thread condition or the presence of a contaminant.

Figure 1
Safety split pin outboard of the K-nut

Research carried out by the Type Certificate holder has found that T67 Firefly aircraft were originally fitted with SAB nose landing gear but later, during production, this was changed to a Fairey Hydraulics landing gear assembly under Slingsby modification (mod) 468. The Fairey landing gear axle was later improved by the introduction of a tab washer to lock the axle nut under an additional modification (mod 646).

Conclusion

Although it is not known exactly why the nut loosened and fell off, the recency of the maintenance activity on the nosewheel and fork assembly, along with the presence of grease or possibly a worn K-nut, are possible causal factors of this incident.

Safety action

The Type Certificate holder has carried out its own assessment of this incident and is considering an additional modification to introduce improved positive locking of the axle assembly. Their intention is to issue a Service Bulletin (SB) and will discuss with the CAA whether it should be mandated by an Airworthiness Directive (AD).

ACCIDENT

Aircraft Type and Registration:	Smith DSA-1 Miniplane, G-BTGJ
No & Type of Engines:	1 Continental Motors Corp C90-8FJ piston engine
Year of Manufacture:	1962 (Serial no: NMII)
Date & Time (UTC):	23 April 2017 at 1040 hrs
Location:	Henstridge Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Main landing gear legs collapsed, propeller destroyed and damage to underside of fuselage and lower wings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	613 hours (of which 304 were on type) Last 90 days - 12 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

During the landing flare on the asphalt Runway 25 at Henstridge the pilot lost sight of an aircraft landing ahead. He pushed forward on the control column to check the runway in front was clear, and then pulled the column back to continue the flare. He believes that because he did not apply any power during this manoeuvre, the airspeed reduced too much and the aircraft stalled and descended quickly towards the runway. Both main landing gear legs collapsed on impact and the wooden propeller shattered. The aircraft then slid a short distance along the runway until the tip of the lower right wing contacted the surface and the aircraft span right through 180º. It came to rest on grass area beside the runway (Figure 1) and the uninjured pilot climbed out without assistance.

Figure 1

G-BTGJ after it came to a halt with collapsed main landing gear legs and shattered propeller.
Photo reproduced courtesy of Mr Martin Rendall

ACCIDENT

Aircraft Type and Registration:	Spitfire MK.T IX, G-CICK
No & Type of Engines:	1 Rolls-Royce Merlin 266 piston engine
Year of Manufacture:	1944 (Serial no: CBAF 8912)
Date & Time (UTC):	16 June 2017 at 1348 hrs
Location:	Sywell Aerodrome, Northamptonshire
Type of Flight:	SSA&C (Safety Standards Acknowledgement & Consent)
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Propeller destroyed and minor damage to the lower fuselage and wing-mounted radiators
Commander's Licence:	Private Pilot's Licence
Commander's Age:	71 years
Commander's Flying Experience:	6,560 hours (of which 574 were on type) Last 90 days - 19 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After turning the aircraft onto the downwind leg of the circuit at Sywell, the pilot moved the landing gear selector to DOWN to lower the landing gear in preparation for landing. The landing gear appeared to extend normally and the pilot stated that he thought that he felt the landing gear locks engage. During the completion of the pre-landing checks the pilot observed that the green landing gear DOWN indication appeared to be lit, indicating that the landing gear was extended and locked. Immediately after touchdown the landing gear retracted and the propeller struck the ground, breaking all four blades. The aircraft slid for a short distance before coming to rest on the runway. After recovery of the aircraft, the landing gear extension and retraction system was tested and found to operate normally. The pilot attributed the incident to the effect of sunlight shining on the landing gear position indication panel, which gave the false impression that the DOWN panel was illuminated and that the landing gear was locked in the extended position.

ACCIDENT

Aircraft Type and Registration:	Starduster Too SA300, G-BNNA
No & Type of Engines:	1 Lycoming O-360-A1F piston engine
Year of Manufacture:	1973 (Serial no: 1462)
Date & Time (UTC):	20 June 2017 at 1720 hrs
Location:	Keyston Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive damage to front and rear of fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	340 hours (of which 53 were on type) Last 90 days - 10 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The flight to and the approach into Keyston Airfield were normal. The grass runway of the farm strip is unmarked and is bordered by a hedge to the east and barley field to the west.

In the three-point landing attitude of the Starduster there is no forward visibility of the runway, so visual cues are taken from either side of the aircraft. Prior to touchdown the pilot had been prioritising his cues to the east side (where the hedge and parked aircraft were located) and had neglected to monitor the west side sufficiently. He was therefore unaware that the aircraft had drifted half over the crop margin. It touched down in the barley crop and the resultant rapid deceleration caused it to nose over. The momentum continued the rotation vertically over the tail and back onto the landing gear and the aircraft came to rest, upright, at the runway/crop boundary. The pilot disembarked the aircraft normally.

The pilot assessed that contributory factors to the accident were: this being his first landing at the airfield in a tailwheel aircraft and rushing his decisions due to being late for a planned meeting with friends.

ACCIDENT

Aircraft Type and Registration:	Stolp Starduster Too SA300, G-JIII
No & Type of Engines:	1 Lycoming IO-360-C1C piston engine
Year of Manufacture:	1975 (Serial no: 02/03/2012)
Date & Time (UTC):	14 May 2017 at 1000 hrs
Location:	Raydale, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	14,652 hours (of which 450 were on type) Last 90 days - 19 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Following engine shutdown due to a failed fuel pump, the pilot made a forced landing during which the landing gear collapsed.

ACCIDENT

Aircraft Type and Registration:	YAK-52, G-SPUT
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P piston engine
Year of Manufacture:	1991 (Serial no: 9111608)
Date & Time (UTC):	13 April 2017 at 1550 hrs
Location:	Brown Shutters Airfield, Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller, engine and wing damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	267 hours (of which 49 were on type) Last 90 days - 5 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After landing, and whilst taxiing past the end of the designated grass runway surface, the pilot attempted to turn left at an estimated ground speed of between 20-25 mph. The aircraft slid sideways down a grass slope to the right, hit a mound and tipped onto its nose and a wingtip. The pilot was uninjured.

History of the flight

After an uneventful landing on Runway 33 the pilot taxied the aircraft off the end of the designated area of the grass runway. The pilot then started to turn the aircraft to the left but, with a reported estimated speed of approximately 20-25 mph the aircraft slid to the right down a grass slope and into a mound where it tipped onto its nose, damaging the propeller, engine and wing. The reported conditions at the time were dry with a light and variable wind and 10 km visibility.

The airfield's web page states that it is a challenging airfield due to the landing distance available (CAA Safety Sense Leaflet 07, *'Aeroplane Performance'*, provides relevant guidance). The web page also highlights the need for prior permission to be sought and provides pilot briefing material and cautions together with contact details. Although not close enough to affect the runway, there were infrastructure works taking place at that end of the airfield that day and, whilst they may have provided a distraction, the pilot did not refer to them in his statement.

The nosewheel of the Yak 52 is not steerable; the rudder mechanism is linked to a valve that distributes pneumatic brake pressure to the left and right brakes. The control for the total amount of braking is on the control stick. At taxiing speeds, differential braking is used for directional control and any contribution from the aerodynamic effect of the rudder will be largely dependent on the airflow over it from the propeller. No technical problems with the braking system were reported, but the pilot stated that braking was totally ineffective due to the slippery nature of the grass. He also advised that he did not take the slope or the lateral forces on the grass sufficiently into account.

ACCIDENT

Aircraft Type and Registration:	Zenair CH701UL, G-CBMW
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2005
Date & Time (UTC):	6 May 2017 at 1120 hrs
Location:	Rossall Field Airfield, Lancashire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear, propeller, engine cowlings and left wing damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	28 years
Commander's Flying Experience:	220 hours (of which 7 were on type) Last 90 days - 7 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that shortly after takeoff, at approximately 200 ft agl, the engine began to lose power. The pilot immediately turned the aircraft through 90° with the intent of completing a forced landing into the wind, but the ground ahead of the aircraft was obstructed. The pilot continued the turn in an attempt to land on the reciprocal runway but at 100ft agl the engine stopped. The aircraft was unable to reach the runway and landed in an unprepared area beside the runway. Shortly after touchdown the nose landing gear collapsed, which resulted in damage to the propeller, engine cowlings and left wing. The pilot attributed the loss of engine power to the formation of an air lock in the fuel lines from newly-installed wing mounted fuel tanks, which restricted the fuel supply to the engine. The potential for the formation of air locks in the system had not been recognised when the tanks had been installed and inspected.

ACCIDENT

Aircraft Type and Registration:	Letov LK-2M Sluka, G-MZNZ
No & Type of Engines:	1 Rotax 447 1-V piston engine
Year of Manufacture:	2000 (Serial no: PFA 263-13274)
Date & Time (UTC):	31 May 2017 at 1435 hrs
Location:	College Farm Airstrip, Oakley, Bedfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	704 hours (of which 9 were on type) Last 90 days - 9 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was on a local flight from College Farm Airstrip, where the aircraft was based. At the time the weather was good and the wind calm.

Soon after becoming airborne the aircraft's engine failed, and the pilot lowered the aircraft's nose with the intention of landing straight ahead. The aircraft flew over one set of power lines before colliding with a second, higher set. At the point of contact the aircraft's engine caught fire. The power line broke and the aircraft fell to the ground coming to rest inverted. The pilot released his harness and rolled out of the aircraft. He then ran to the other end of the strip to get a fire extinguisher but on his return the aircraft had been consumed by the fire. The local RFFS and ambulance service then arrived on scene. The pilot suffered a minor head injury.

Subsequent examination of the aircraft's engine indicated to the pilot that its failure was probably due to the front cylinder head gasket failing at full power.

ACCIDENT

Aircraft Type and Registration:	Magni M16C, G-CIZK
No & Type of Engines:	1 Rotax 914ULS piston engine
Year of Manufacture:	2016 (Serial no: 16-16-9534)
Date & Time (UTC):	17 June 2017 at 1449 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Significant damage to rotor blades, rotor head and mast. Airframe distorted and propeller blades destroyed.
Commander's Licence:	Student
Commander's Age:	54 years
Commander's Flying Experience:	22 hours (of which 22 were on type) Last 90 days - 11 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the student pilot and input from his instructor

History of the flight

This was the student pilot's fourth solo flight and he was using Popham's grass Runway 26 in good visibility and with a light wind from 240º. His first two solo flights had been made 15 days previously, following a flight with his instructor.

On the day of the accident, the student completed one solo flight, had a break, and had then begun flying a further series of circuits, watched from the ground by his instructor. The aircraft's attitude in the third landing was flat and, as the gyroplane slowed, the student moved the control stick fully back. The nose of the gyroplane pitched up and it rolled right until the rotor blades struck the ground before hitting the propeller. The gyroplane turned through 90º and came to rest upright, with the engine stopped, before the student turned off the fuel pumps and the magnetos and climbed out.

After watching the accident, the instructor commented that a normal landing involves touching down on the mainwheels and then moving the control stick back gradually, to initially keep the nosewheel off the ground as the gyroplane slows. On this occasion the student rapidly moved the control stick fully back and he then lost control.

Figure 1

Magni M16C Tandem Trainer, G-CIZK after the accident with distortion of the rotor system and control rods evident

ACCIDENT

Aircraft Type and Registration:	MTOsport gyroplane, G-HOTC	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2010 (Serial no: RSUK/MTOS/058)	
Date & Time (UTC):	8 May 2017 at 1401 hrs	
Location:	Shobdon Aerodrome, Herefordshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Rotor blade tips and rear stabiliser abraded	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	57 years	
Commander's Flying Experience:	397 hours (of which 124 were on type) Last 90 days - 18 hours Last 28 days - 5 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Prior to takeoff on Runway 09, the pilot stated that the pre-rotator had rotated the gyroplane's main rotor to approximately 150-160 rpm, less than the normal speed of 200 rpm. Despite this, the pilot elected to take off and, as the aircraft accelerated, increasing control forces were required to maintain the runway centreline. The aircraft pitched nose-up and rolled to the left, causing the main rotor blade tips and rear stabiliser to strike the runway surface. The pilot aborted the takeoff.

The pilot attributed the accident to continuing the takeoff attempt with less than 200 rotor rpm, combined with him applying the power too quickly, which created a *'blade flap'* situation.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15-912, G-CBSP
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2002 (Serial no: 7903)
Date & Time (UTC):	18 June 2017 at 1155 hrs
Location:	Eshott Airfield, Northumberland
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Substantial damage
Commander's Licence:	Student
Commander's Age:	43 years
Commander's Flying Experience:	47 hours (of which 47 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student, on his second solo flight, was returning to land on Runway 19 having completed a cross-country exercise. The reported wind was from the south-west, which resulted in a slight crosswind from the right. The approach appeared normal but, just after touching down, the aircraft became airborne again. The student stated that, before he could assess the situation, the right wing dropped slightly, causing the aircraft to drift to the right of the edge of the runway. Ahead of the aircraft's flight path, at the airfield boundary, was a fence and adjacent line of trees. The student considered that there was insufficient distance remaining to climb over the trees and, before he could land, the aircraft struck the fence and came to a stop.

The student considered that his lack of experience accompanied with a crosswind were causal factors.

ACCIDENT

Aircraft Type and Registration:	Pegasus XL-Q, G-MGCB
No & Type of Engines:	1 Rotax 462 piston engine
Year of Manufacture:	1996 (Serial no: 7267)
Date & Time (UTC):	25 March 2017 at 1600 hrs
Location:	Headon Airfield, Nottinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	3,184 hours (of which 3 were on type) Last 90 days - 14 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

A student pilot with 59 hours total flying time[1] (all on type), was flying with an instructor, but without dual controls fitted to the aircraft. The student had not flown for four months but they had flown together before, and the instructor anticipated they would fly one circuit using the grass Runway 05 at Headon before he authorised the student to continue flying solo.

Weather conditions were good, with an estimated wind from 030º at 6 kt. Just prior to landing the student tried to make a correction to the approach path and in doing so the airspeed decayed. As a result the aircraft landed heavily, the nosewheel collapsed and steering control was lost, so the pilots were unable to prevent the aircraft from leaving the runway at low speed and overturning. They then experienced some difficulty vacating the aircraft because of airframe distortion.

The instructor stated afterwards that dual control bars should have been fitted because, when he saw the student encounter difficulty on the final approach, he attempted to intervene by manipulating the rigging wires but this was not successful. The student suggested he should have gone around rather than trying to make a late correction to the line of approach.

Footnote

1 Including 24 hours solo flying time.

ACCIDENT

Aircraft Type and Registration:	Quik GT450, G-CECA
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2006 (Serial no: 8185)
Date & Time (UTC):	7 May 2017 at 1748 hrs
Location:	St Michaels Airfield, Lancashire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Damage to trike, fuselage and significant damage to wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	708 hours (of which 342 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot and passenger had completed a local flight and were returning to land on grass Runway 15; at the end of this runway are two earth bunds bordering a stream that runs across the end of the runway. The wind conditions were calm and the approach appeared normal. As the aircraft touched down, an undulation in the runway caused the aircraft to bounce, and it became airborne. When the aircraft touched down again, the pilot determined that there would be insufficient runway distance remaining to stop and applied engine power to go around. The aircraft gradually climbed, but failed to gain sufficient height and struck the bund at the end of the runway, causing the pilot to lose control. The aircraft then impacted the bund on the other side of the stream before coming to a stop. The pilot and passenger were both seriously injured.

ACCIDENT

Aircraft Type and Registration:	Quik GT450, G-CFEX
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2008 (Serial no: 8362)
Date & Time (UTC):	19 June 2017 at 1026 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Front forks bent and base tube slightly indented
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	2,544 hours (of which 359 were on type) Last 90 days - 60 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After touching down during a training flight the student attempted to go around but mistakenly applied brakes as well as throttle. The instructor took control but the brakes were still being applied. The aircraft slowed, departed the runway at an estimated 10 mph and was damaged when it came to an abrupt stop on encountering a rut to the side of the runway.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK Calidus, G-GRYN	
No & Type of Engines:	1 Rotax 912 ULS piston engine	
Year of Manufacture:	2010 (Serial no: RSUK/CALS/003)	
Date & Time (UTC):	3 July 2017 at 1300 hrs	
Location:	Turweston Aerodrome, Northamptonshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Rotors, tail, empennage and propeller	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	59 years	
Commander's Flying Experience:	306 hours (of which 6 were on type) Last 90 days - 1 hour Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot had not flown for several months and had a total of six hours on type. Having flown for about one hour he returned to land on Runway 27 at Turweston. The wind was from the west-south-west. As the pilot flared the aircraft for touchdown, he realised that he had initiated the manoeuvre too early and that the aircraft was still several feet above the runway and at a low airspeed. He lowered the aircraft's nose, during which the aircraft yawed and drifted to the right. He applied corrective rudder and control stick inputs, but the aircraft touched down on the right main wheel before rolling onto its right side where it came to a stop.

The pilot stated that it had felt as if the aircraft "had been caught by a gust of wind from the left", and considered that his lack of recency and experience on type were causal factors in the accident.

ACCIDENT

Aircraft Type and Registration:	Tecnam P2008-JC, G-OLIC
No & Type of Engines:	1 Rotax 912-S2 piston engine
Year of Manufacture:	2016 (Serial no: 1059)
Date & Time (UTC):	9 July 2017 at 1130 hrs
Location:	Lydd Airport, Kent
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg collapsed, propeller destroyed, engine shock-loaded and damage to firewall and underside panels
Commander's Licence:	Student
Commander's Age:	40 years
Commander's Flying Experience:	56 hours (of which 6 were on type) Last 90 days - 10 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

History of the flight

The student pilot was undertaking a solo cross-country flight to Lydd Airport where, accompanied by his instructor, he had landed a few days previously. Runway 21 was in use and the reported wind was from 110º at 8 kts so there was a crosswind from the left and a slight tailwind. The pilot believed he approached at the correct airspeed but, when he flared, the aircraft ballooned and then sank. Although he tried to reduce the descent rate by adding power, the aircraft bounced and when it contacted the runway a second time, the nose leg collapsed rearwards, the propeller blade tips shattered and the engine stopped before the aircraft came to a halt on the runway (Figures 1 and 2).

The pilot later stated that it was a hot day (24ºC) and that convective lift over the runway may have been a factor when the aircraft ballooned. In retrospect he assessed that he should have initiated a go-around, rather than adding power to try to reduce the high descent rate that preceded the first touchdown. His instructor reported that the pilot had demonstrated two "good" landings during a training flight from Stapleford Airport before departing on the cross-country flight.

Figure 1

G-OLIC pictured before the accident

Figure 2

G-OLIC pictured after the accident

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).

ACCIDENT REPORT ADDENDUM

Aircraft Type and Registration:	Hawker Sea Fury T Mk 20, G-RNHF
No and Type of Engines:	1 Bristol Centaurus XVIII piston engine
Year of Manufacture:	1949 (Serial no: ES3615)
Date and Time:	31 July 2014 at 1601 hrs
Location:	RNAS Culdrose, Cornwall

Synopsis

The aircraft was performing in a public air display at Culdrose when the pilot became aware of a significant engine vibration and then a corresponding loss of thrust. Despite the loss of engine power the pilot was able to land the aircraft on the runway but the landing gear collapsed on touchdown, causing it to veer off the runway. The aircraft came to a stop on the grass approximately 1,500 ft from the initial touchdown point. The pilot vacated the aircraft unaided and without injury. The accident was a result of the loss of engine power caused by severe mechanical disruption within the 'front row' crankcase of the engine.

Introduction

The accident report, EW/G2014/07/32, was published in AAIB Bulletin 7/2015 and at the time evidence suggested the breakup was as a result of an overheated articulated connecting rod (con-rod) wrist pin bearing. After this report was published, forensic work continued to try to establish the exact cause of the engine failure and the AAIB undertook to publish the relevant findings when available.

Despite the extensive destruction of most of the components within the front section of the engine, forensic analysis has been able to determine that severe overheating had occurred in the crankpin sleeve bearing in the front bank of cylinders. This led to a chain of events within the engine which became increasingly destructive to the wrist pin bearings, connecting rods, pistons and sleeve valve gear. This destruction was exacerbated by the rear bank of cylinders continuing to run until the accumulated damage within the front bank of the engine stopped the engine producing useable power, although it continued rotating as the aircraft landed until its landing gear collapsed. The extreme damage to the components of the front bank of cylinders left insufficient evidence to determine conclusively the initial cause of the engine failure.

System description

The Bristol Centaurus engine is an eighteen-cylinder double-row sleeve valve supercharged radial, with a 53 litre capacity, capable of producing 2,500 horsepower. Figure 1 and Figure 2 show the arrangement of the master con-rod, articulated rods, crankpin and floating retainer assembly.

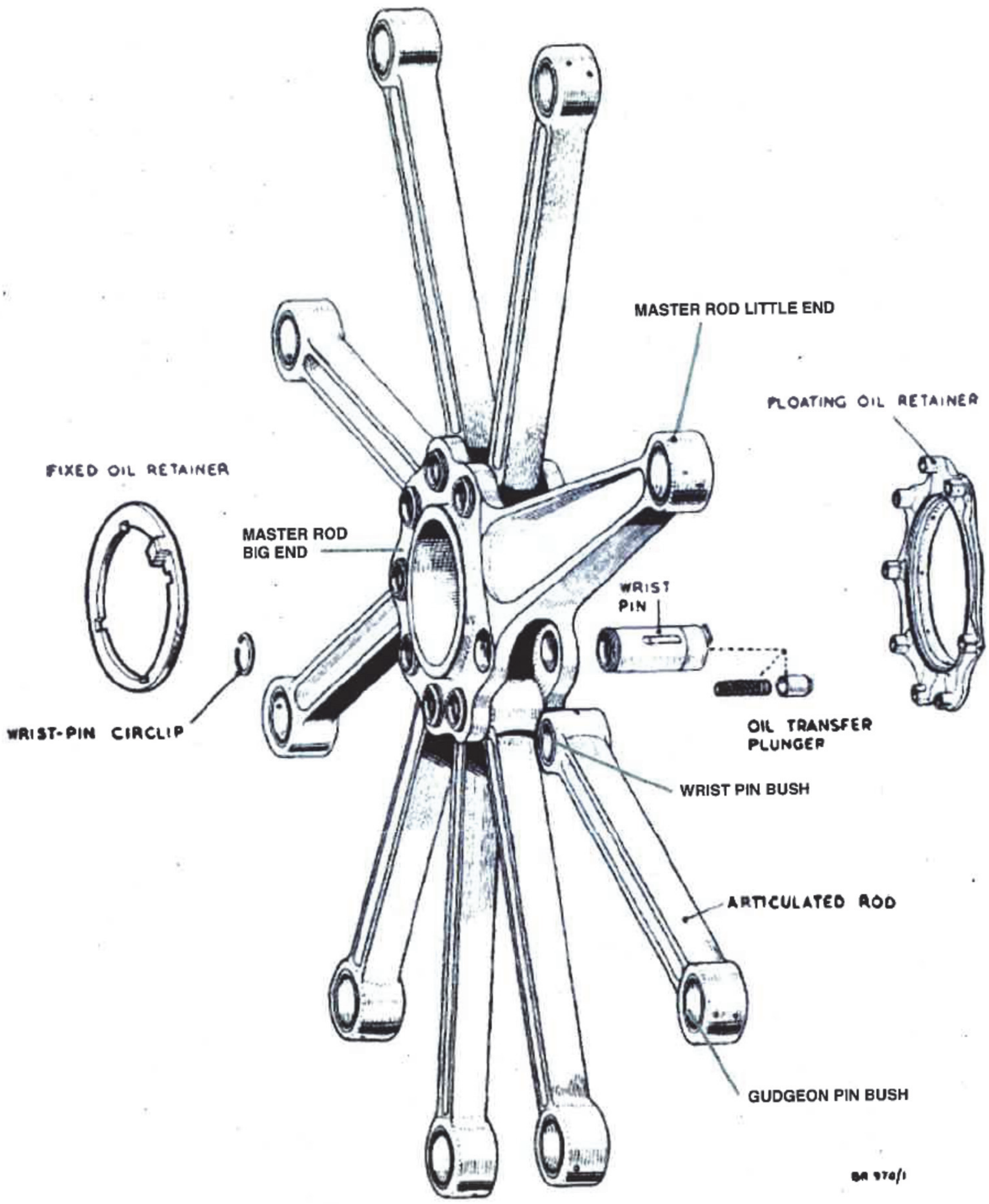


Figure 1

Master and articulated connecting rods with the floating oil retainer

Lubrication system

In this engine, oil pressure is generated by the main oil pump at a nominal 100 psi and distributed into four separate sub-sections around the engine. A main oil feed passes through a tube inside the supercharger into the rear end of the crankshaft. It then travels forward along the crankshaft, finally exiting through feedlines to lubricate the reduction gearbox. Along the way, oil is forced through various ports and jets to lubricate bearings, pistons and cylinders. High-pressure oil also feeds the 'centrifugers', which remove any sludge and aeration before it is used to operate the supercharger control valve and drive system. Another high-pressure feed is supplied to the governor before entering the propeller constant-speed unit. Oil pressure is then reduced by a reduction valve to lubricate the sleeve valve drive system and a small supply of low-pressure oil lubricates the magnetos.

Return oil from the spray jets and oil that has passed through the bearing, collects at the bottom of the engine where it is scavenged by front and rear pumps. Oil is trapped in some locations and used as splash lubrication for start-up.

The oil system in G-RNHF contained a sufficient quantity of lubricating oil and samples taken at the time showed that the oil had suffered some adulteration during the engine failure, but this is not considered causal or contributory to the engine failure.

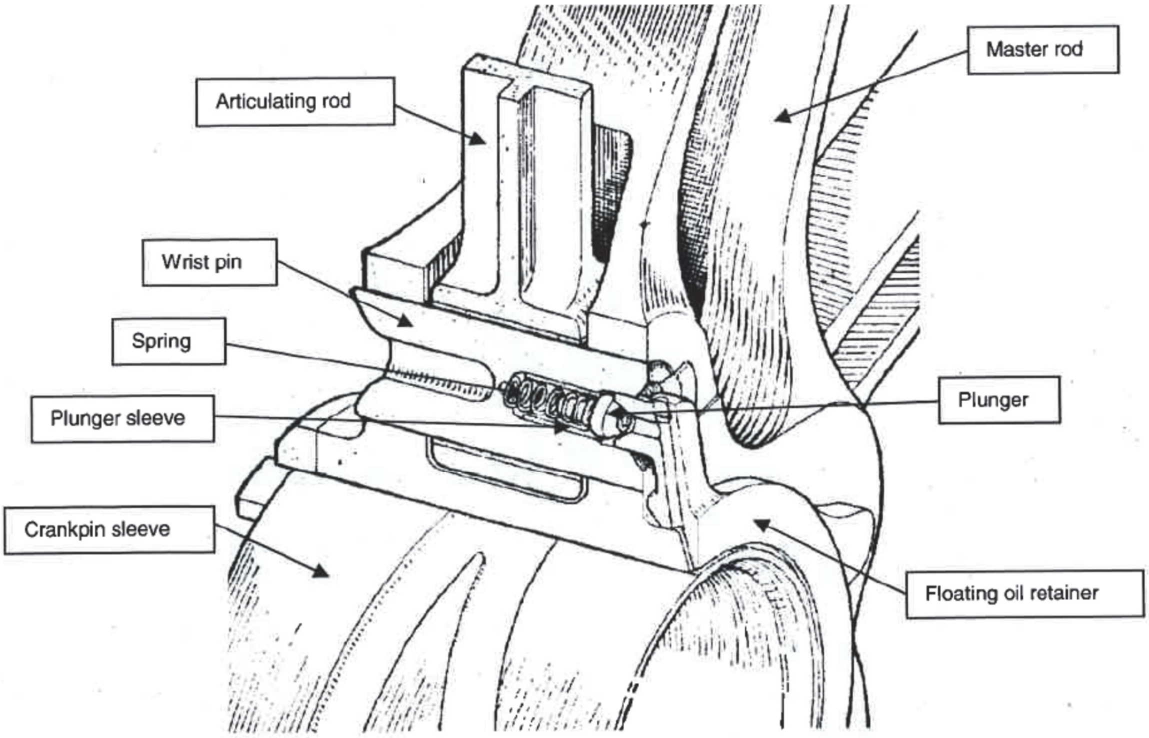


Figure 2

Crankpin sleeve and wrist pin assembly

Crankpin assembly

The crankpin carries all of the loads into the crankshaft from the master and articulated connecting rods via a white metal crankpin sleeve bearing. This bearing is pressure lubricated via ports within the crankshaft. From there oil is collected by an oil retainer, known as the floating oil retainer, which distributes oil to the centre of the wrist pins to lubricate the phosphor bronze wrist pin bearing surfaces. Oil pressure is maintained within the wrist pin by a spring loaded plunger which seals the gap between the wrist pin and floating oil retainer.

Sequence of events

Forensic analysis was carried out in the materials laboratories of 1710 Naval Air Squadron (1710 NAS) within the Royal Navy. The following sequence of events have been identified and are summarised from their report:

> *'a. For reasons unclear the forward crankpin sleeve bearing overheated, cracked up and liberated flakes of white metal.*
>
> *b. Breakup of the bearing resulted in greater overheating, melting the white metal bearing surface.*
>
> *c. Liquid tin from the bearing penetrated along the grain boundaries of the forward master rod, causing embrittlement at the grain boundaries.*
>
> *d. The embrittled grain boundaries cracked and some fragments of the master rod around the bore become separated. This process continued as the liquid tin penetrated more deeply.*
>
> *e. Loose fragments of master rod material from around the bore gouged the bore surface and the sleeve, overcoming the interference fit and causing it to spin with the master rod, finally cutting off any possible oil flow to the connecting rod assembly.*
>
> *f. Continued embrittlement, high temperature and high stress caused the master rod to burst locally at its thinnest and highest temperature points, behind the wrist pins #16 and #18.*
>
> *g. Erupted material interfered with articulating rods #16 and #18 and frictionally heated them, causing them to overheat, soften and fail.*
>
> *h. The unrestrained piston and articulating rod #16 came out of their cylinder into the engine core and were impacted by the counterweight.*
>
> *i. Continued impacts fractured and propelled the piston, gudgeon pin and articulating rod around the engine core, impacting and damaging other components.*
>
> *j. At some point the gudgeon pin became momentarily trapped and was impacted, shattering it.*
>
> *k. Debris fragments became trapped in the sleeve driving mechanism, jamming them and causing them to fail.*
>
> *l. Throughout the above, the heat generated around the forward crank pin propagated back into the rear bank crankpin, overheating the crank pin sleeve bearing causing it to start breaking up.'*

This sequence was arrested when the landing gear collapsed and the propeller struck the ground and stopped as the aircraft slid along the grass alongside the runway.

Possible contributory factors

Although the exact feature which caused the crankpin sleeve bearing to overheat is unknown, there are a number of areas of interest which may have been contributory factors. These factors have been extracted from the 1710 NAS laboratory report and are set out below:

> *‘a. Pieces of a fibrous cellulose material were found within the engine from an unknown source. One was causing a partial blockage of the rear crankweb oil jet, which could not have caused the failure, but in combination with the piece found loose in the crankcase indicates that there was debris in the system. The source could not be confirmed. The material may have come from a degraded fibre gasket somewhere in the system, or possibly from an original gasket that was replaced during earlier maintenance. Alternatively it could have come from a source outside the engine and entered at some point during its life. It is possible that some of this debris may have entered the forward crankpin bearing and disrupted the lubricating oil film, leading to overheating. Cellulose debris may have passed through that bearing and blocked the oil supply to a wrist pin, heating the pin and transmitting heat into the master rod, overheating the crankpin bearing. Whichever specific mechanism, overheating of the crankpin bearing resulting from contamination of the system with fibrous cellulose debris is considered a possibility.*
>
> *b. The crankshaft oil retainer gland was found to be severely embrittled. This may have been due to heat transmitted along the crankshaft or may have been due to its extreme[1] age. If it was embrittled prior to the accident it may have stopped working as an effective seal and caused a pressure loss inside the crankshaft. This pressure loss may have disrupted the oil film in the crankpin bearing and allowed it to overheat. The pressure distribution around the engine is not understood in enough detail to determine if a leak of this type would have been detectable to the pilot. This scenario is considered to be a possibility.*
>
> *c. It is possible that hard debris, from an external source or a part of the engine or oil system not found, was able to enter the forward crankpin bearing and either cause abrasive wear and overheat it or block local oilways, allowing a wrist pin to overheat. If this was the case then the debris was displaced during the failure sequence and not subsequently recovered. This scenario cannot be conclusively ruled out.*
>
> *d. It is possible that an out of balance loading on the forward connecting rod assembly transmitted an excessive loading to the forward crankpin bearing, causing it to overheat. No evidence was observed to indicate that the assembly was intrinsically out of balance.’*

Footnote

1 It is possible that this seal was originally fitted to the engine when it was built prior to delivery to Iraq in the late 1940s. There is no evidence to suggest this seal was replaced when the engine was brought back into service in 2010.

Discussion

The Centaurus engine is fitted with roller main bearings and conventional close tolerance white metal bearings on the crankpins. White metal, in this case known as Babbitt metal, is an alloy of copper, tin, lead and antinomy alloyed to give a low-friction but hard-wearing surface. The low friction and heat conduction properties of the material is further enhanced by the oil lubrication system whereby a hydrodynamic oil film forms under pressure on the bearing surface. Although the bearing will operate without too much difficulty during momentary reduced lubrication, sustained loss or constant reduced lubrication will result in bearing damage. The damage will initially manifest itself in scuffing and scoring in the bearing surface and is often referred to as 'running' a bearing. Heat is generated in this process and in most circumstances will degrade any oil present, reducing lubrication further. Eventually the heat generated will be so great that bearing damage occurs, as observed in this engine.

Unlike in-line engines, where the big end bearing only carries a single piston load with an impulse once per revolution, a radial engine crankpin bearing carries multiple impulse loads per revolution from the articulated con-rods via wrist pins into the master con-rod. Should a crankpin bearing become distressed, the multiple impulse effect can accelerate the situation and therefore degrade more rapidly than with an in-line engine. If the crankpin bearing is overheated and starts to fail, the wrist pins by their design and location, will also be susceptible to any excess heat from the nearby crankpin bearing.

The evidence, in this case, shows an overheated crankpin bearing and this may be as a result of a seriously degraded or complete loss of lubrication. The condition of the other major engine components, such as the rear bank and supercharger, suggests a localised problem. It is possible that unidentified debris interrupted oil to the bearing. Of interest was the embrittlement of the crankshaft oil retainer gland. Loss of the sealing capabilities of this gland could result in a sustained weakening of the hydrodynamic oil film which may lead to the 'running' of the bearing over a very short period.

In either case the temperature generated would eventually cause any remaining oil present to boil or burn off the vital surfaces in an ever-worsening cycle.

Conclusion

The evidence suggests a localised lubrication problem led to a severe overheating of the crankpin bearing. An extensive forensic examination of the engine has been carried out and it has not been possible to identify the exact initiator that led to this situation. However, it has been possible to identify the precise sequence of metallurgical effects on key components as the bearing overheated and failed, which resulted in the highly destructive chain of events within the front crankcase.

Safety action

Various marks of the Centaurus engine are still in use in a small number of aircraft but findings in this case could equally apply to other radial and in-line aero-engine types. Based on this, the CAA has undertaken to publish a

Safety Notice aimed at the historic aircraft community, to draw attention to the issues and difficulties of maintaining airworthiness of aging aircraft engines and their associated components.

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

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL
11 nm NE of Peterhead, Scotland
on 1 April 2009.

Published November 2011.

1/2014 Airbus A330-343, G-VSXY
at London Gatwick Airport
on 16 April 2012.

Published February 2014.

2/2014 Eurocopter EC225 LP Super Puma
G-REDW, 34 nm east of Aberdeen, Scotland on 10 May 2012
and
G-CHCN, 32 nm south-west of Sumburgh, Shetland Islands
on 22 October 2012.

Published June 2014.

3/2014 Agusta A109E, G-CRST
Near Vauxhall Bridge,
Central London
on 16 January 2013.

Published September 2014.

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.

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 System
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 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
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
PNF	Pilot Not Flying
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
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
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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