AAIB

Air Accidents Investigation Branch

AAIB Bulletin 6/2022

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All times are UTC

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AAIB CORRESPONDENCE INVESTIGATIONS Cont

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-232, 9H-LOZ
No & Type of Engines:	2 IAE V2500 turbofan engines
Year of Manufacture:	2006 (Serial no: 2838)
Date & Time (UTC):	28 May 2021 at 0825 hrs
Location:	London Stansted Airport, Essex
Type of Flight:	Commercial Air Transport (Non-revenue)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	30 years
Commander's Flying Experience:	5,290 hours (of which 5,100 were on type) Last 90 days – 25 hours Last 28 days – 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On a routine short flight, during final approach to land, the No 2 engine reduced to idle and would not respond to any control inputs. The flight crew performed a missed approach and, following the relevant checklist procedure, elected to shut down the engine. They then performed an uneventful single-engine approach and landed safely. The engineering investigation determined that the cause of the engine problem was most likely an inadvertent activation of the overspeed protection valve in the fuel control system. The problem has occurred previously on other V2500 engines and is being addressed through safety actions by the engine and aircraft manufacturers.

History of the flight

The aircraft was scheduled to conduct a preservation flight[1] on 28 May 2021, departing from and returning to Stansted Airport and lasting approximately 45 minutes. The operating crew positioned from Vienna to Stansted as passengers on a commercial flight, arriving in the crew room at Stansted at 0630 hrs. They waited for the morning engineering shift to come on duty at 0700 hrs and the aircraft was handed over to them shortly afterwards. The crew conducted the standard walkaround and pre-departure checks with no abnormal findings. The aircraft departed from Stand 33L at 0803 hrs after a normal engine start and pushback and taxied to line up and hold on Runway 22.

Footnote

[1] These were routine flights conducted every 28 days to maintain serviceability of the aircraft during the pandemic reduced flight schedules.

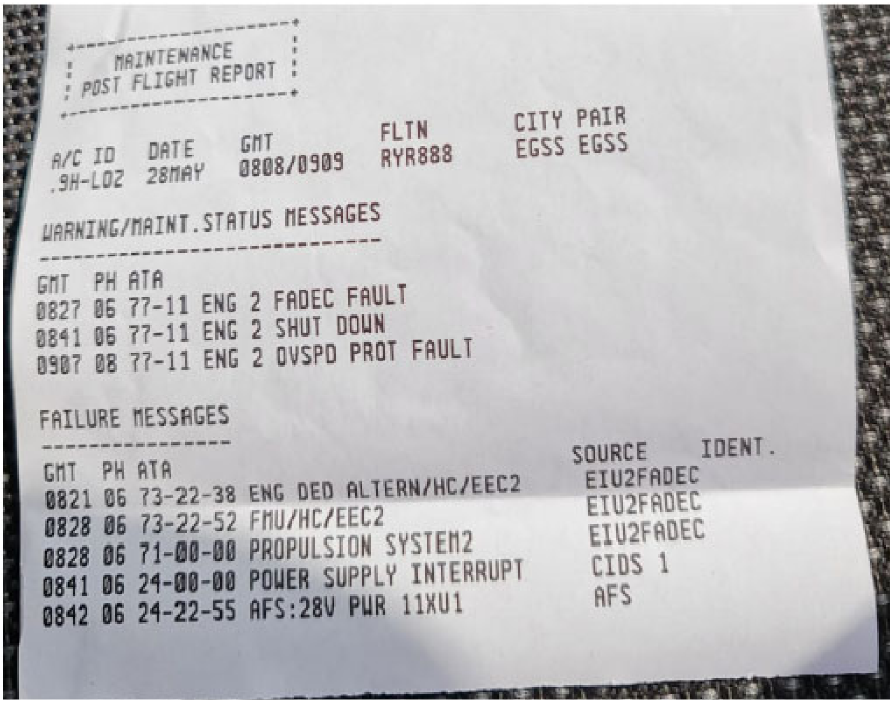
Whilst holding on the runway, the crew were requested by Air Traffic Control (ATC) to consider a new Standard Instrument Departure (SID) route, but they declined this request to avoid the need to re-brief the departure whilst positioned on an active runway. They were given clearance to take off and climb to FL080 following the CLN1E SID, which they completed without issue. They were subsequently given radar vectors to line up for an ILS approach to land back on Runway 22.

During the final approach, at 950 ft radio altitude and with autothrust engaged, an 'ENG 2 FADEC FAULT' appeared on the Electronic Centralised Aircraft Monitor (ECAM). The crew elected to go around and manually flew the standard missed approach profile, before entering a hold to perform troubleshooting of the fault. During this period the No 2 engine remained at idle despite manual throttle increases and the reselection of autothrust. The crew also reported seeing apparently erroneous engine parameter readings relative to the selected throttle position. After entering the hold, the immediate ECAM checklist actions were performed. The crew reported that the engine indications were not showing amber XX, but appeared to be frozen and were still not responding to any throttle inputs. The ECAM checklist directed that in the case of abnormal engine parameters the engine should be shut down. The crew consulted the Flight Crew Operating Manual (FCOM) for further guidance, before starting the Auxiliary Power Unit (APU) and shutting down the No 2 engine.

The crew declared a MAYDAY and selected squawk 7700. They then briefed for a return to Runway 22 at Stansted. After completing all the necessary single-engine operation checklists and landing performance calculations, they requested radar vectors for a normal ILS approach to Runway 22. Following an uneventful approach and landing, the aircraft vacated the runway and the crew confirmed with the Airport Fire and Rescue Service Commander that the failed engine appeared normal. During the landing rollout as the aircraft airspeed dropped below 70 kts an 'ENG 2 OVSPD PROT FAULT' warning was triggered but this was not displayed on the ECAM. The aircraft was then taxied to Maintenance Hangar 10 at Stansted and shut down in accordance with the relevant checklists.

Initial engineering investigation

The post-flight report was downloaded from the aircraft (Figure 1). The Digital Flight Data Recorder (DFDR) was removed and downloaded, and the data provided to the aircraft manufacturer for further investigation. The post-flight report indicated that additional failure messages had occurred during the flight which did not have an associated ECAM warning. The first was 'ENG DED ALTERN/HC/EEC2', which indicated a failure of the Engine 2 Dedicated Alternator (EDA) or the electrical harness between the alternator and the Electronic Engine Control (EEC) unit. Additionally, 'FMU/HC/EEC2' and 'PROPULSION SYSTEM 2' faults were also recorded. The operator carried out Task 73-22-00-810-834-B *'Failure of the engine dedicated alternator stator on engine 2'* from the aircraft Troubleshooting Manual (TSM) and the EEC, EDA and the Fuel Metering Unit (FMU) from the No 2 engine were removed and sent for further investigation.



MAINTENANCE
POST FLIGHT REPORT

A/C ID	DATE	GMT	FLTN	CITY PAIR
.9H-LOZ	28MAY	0808/0909	RYR888	EGSS EGSS

WARNING/MAINT.STATUS MESSAGES

GMT	PH	ATA	
0827	06	77-11	ENG 2 FADEC FAULT
0841	06	77-11	ENG 2 SHUT DOWN
0907	08	77-11	ENG 2 OVSPD PROT FAULT

FAILURE MESSAGES

GMT	PH	ATA		SOURCE	IDENT.
0821	06	73-22-38	ENG DED ALTERN/HC/EEC2	EIU2FADEC	
0828	06	73-22-52	FMU/HC/EEC2	EIU2FADEC	
0828	06	71-00-00	PROPULSION SYSTEM2	EIU2FADEC	
0841	06	24-00-00	POWER SUPPLY INTERRUPT	CIDS 1	
0842	06	24-22-55	AFS:28V PWR 11XU1	AFS	

Figure 1

Post-flight Report

Related maintenance events prior to the incident flight

On 23 May 2021 a water wash of both engines on the aircraft had been carried out in accordance with the Aircraft Maintenance Manual task 72-00-00-100-010-A. During the required engine runs following this activity an 'ENG 2 OVSPD PROT FAULT' had been triggered. In response the operator conducted two tasks from the aircraft troubleshooting manual, which were *'loss of the N2 signal on engine 2'* and *'loss of the N2 overspeed protection on engine 2'.* The EEC, FMU and EDA electrical harnesses were inspected on the No 2 engine and the engine 2 EEC A and B channels were tested. No faults were identified by these checks and the aircraft was released back into service.

Recorded information

The aircraft manufacturer analysed the recorded flight data for the incident flight and produced a flight track which is shown in Figure 2. To assist in understanding the different phases of the flight the diagram has been annotated as follows:

- Arrow 1 – shows the initial takeoff from Stansted.
- Arrow 2 – shows the departure and climb following the SID.
- Arrow 3 – shows the first approach to land on Runway 22, with the start of the engine fault shown by the yellow pin.
- Arrow 4 – shows the go-around and missed approach route to the hold, with the engine shutdown point indicated by the yellow pin during the second circuit of the holding pattern.

- Arrow 5 – shows the re-join of the circuit at Stansted with the No 2 engine shut down.
- Arrow 6 – shows the single engine final approach and landing on Runway 22.

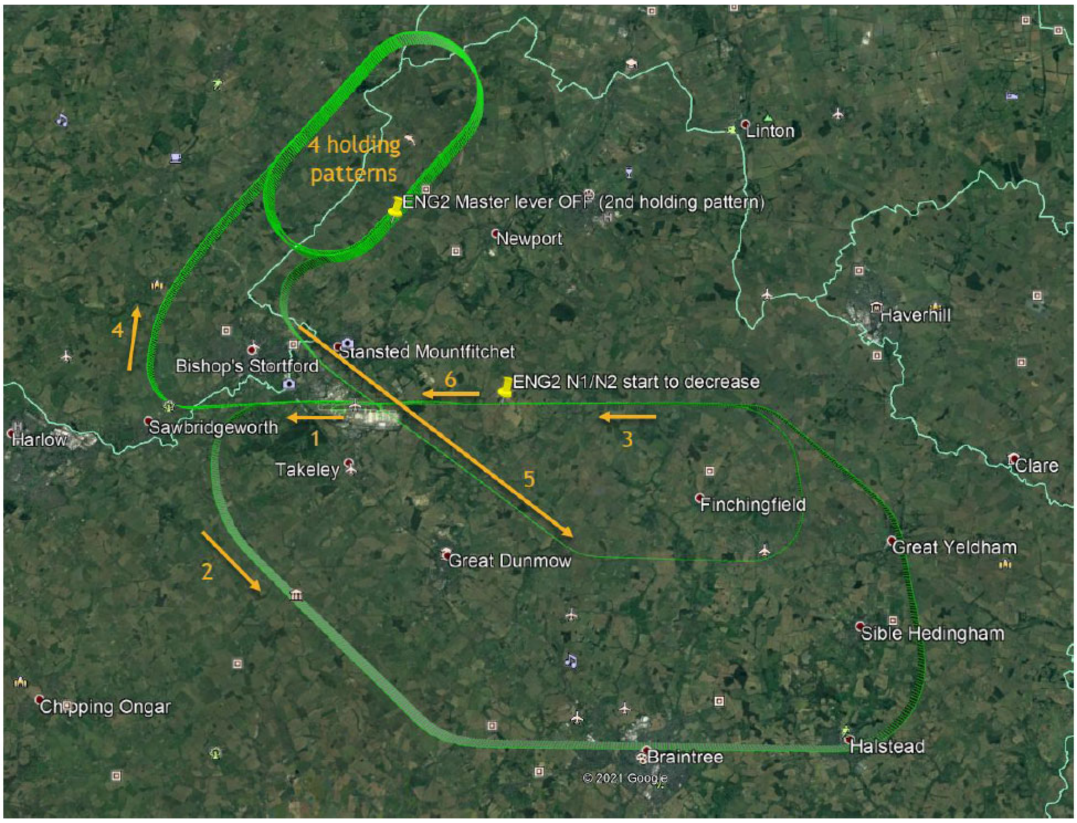


Figure 2

Recorded data showing the incident flight track

An overview of the relevant recorded data parameters for the incident flight, produced by the aircraft manufacturer, is shown in Figure 3. This highlights the section where the No 2 engine problem occurred. From 08:27:46 hrs the EEC commanded EPR target rapidly increased on both engines to maintain the selected aircraft autopilot airspeed. Whilst the EPR increased to match the EEC demand on engine No 1, the No 2 engine EPR began to decrease instead. The ECAM FADEC fault warning was triggered at 08:27:53 hrs and the crew reported that the engine parameters remained as figures rather than switching to amber XX. The actual engine No 2 EPR then remained at a constant value until the engine was shut down.

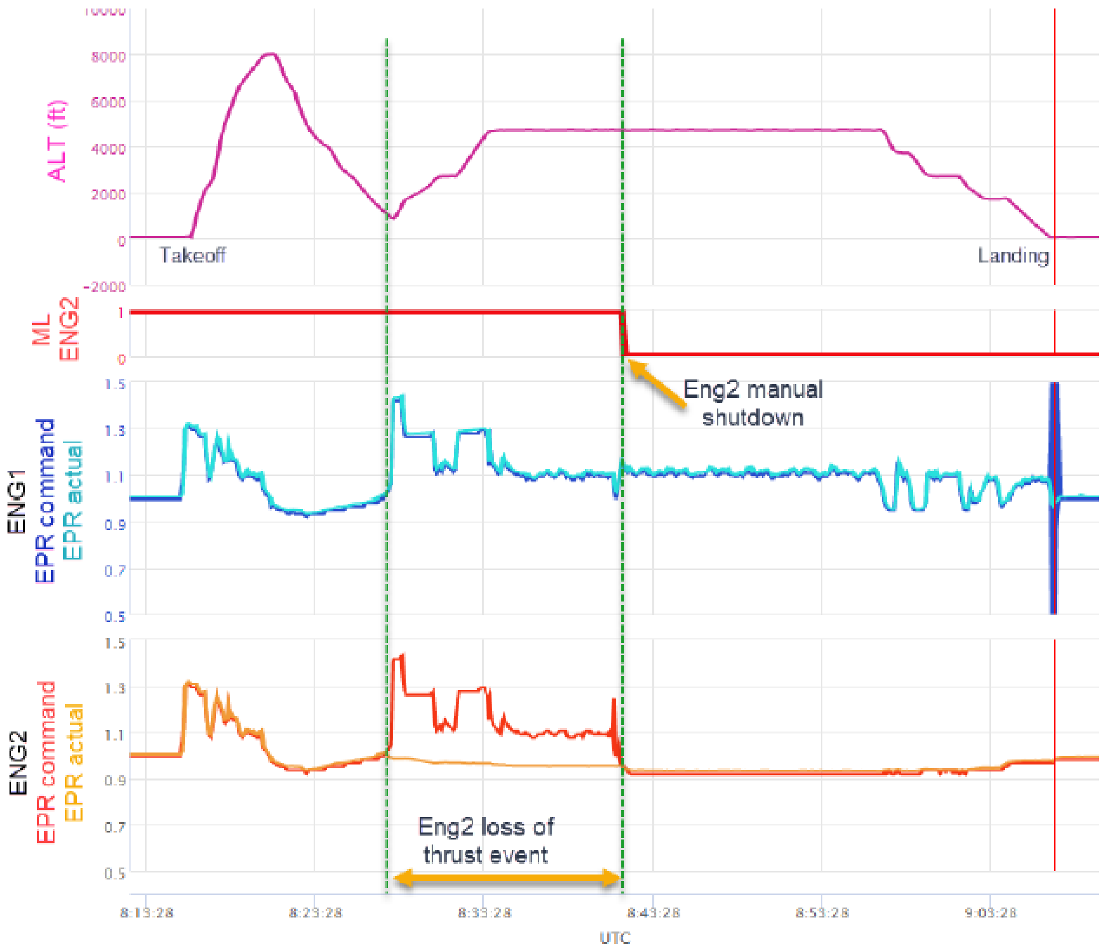


Figure 3

Relevant recorded data parameters for the incident flight

Aircraft information

The aircraft was fitted with two IAE V2527-A5 engines, which are Full Authority Digital Electronic Control (FADEC) equipped. The FADEC system consists of a dual-channel EEC and the associated components and sensors to adjust and monitor the engine thrust and rotational speed. The main engine parameters are the Engine Pressure Ratio[2] (EPR) which indicates the thrust produced by the engine, N1 which is the speed of rotation of the low-pressure spool[3] and the Exhaust Gas Temperature (EGT), which is one of the normal limiting parameters for the engine. In normal mode the EEC computes the EPR figure required based on the throttle position or Flight Management Guidance Computer (FMGC) input, if autothrust is engaged. It then controls the fuel flow to the combustion chamber spray nozzles using the FMU, to achieve the target EPR. If a fault results in the EPR figure not being available, the control system reverts to reversionary mode and uses N1 to control the engine. N2 is the speed of rotation of the high-pressure spool.

Footnote

[2] This is a ratio of the intake air pressure and the exhaust gas pressure, measured by sensors in the engine intake and low-pressure turbine exhaust.

[3] The term spool refers to the entire compressor stages and turbine stages connected by a shaft.

The FMU has three mechanical control features, these are:

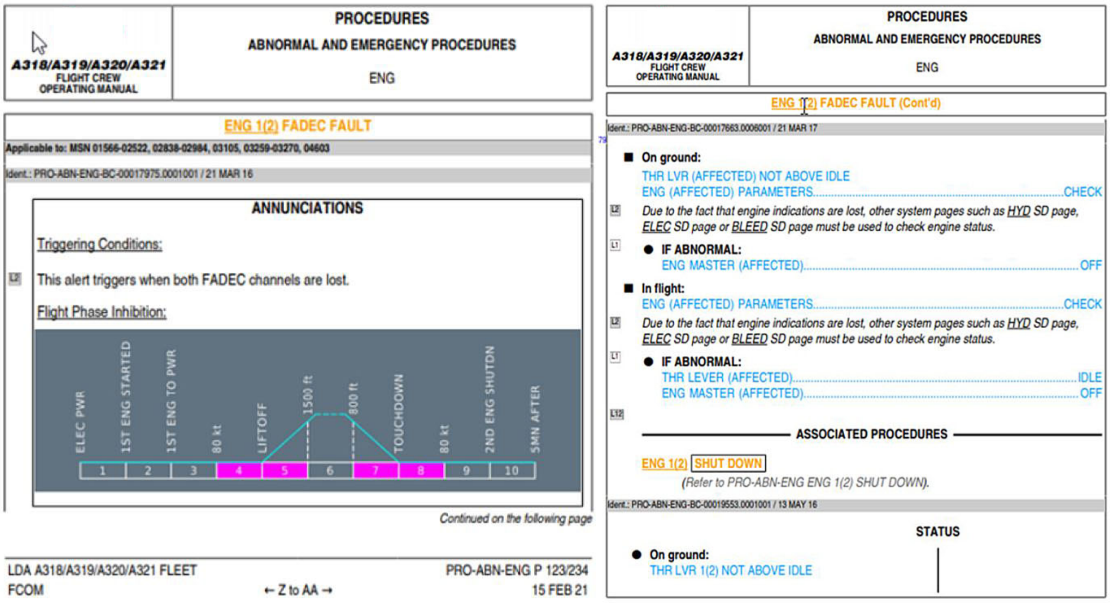
- The Fuel Metering Valve (FMV) which under normal operation modulates to deliver a metered fuel flow to the fuel nozzles based on the EEC command.
- An engine overspeed protection valve which works in series with the FMV to reduce the fuel flow to the spray nozzles if an overspeed of either the low-pressure or high-pressure spool is sensed by the EEC.
- A Pressure Rising and Shut-off Valve (PRSOV) which is the main open/shut valve that controls fuel to the engine to facilitate starting and stopping of the engine.

The FADEC system prevents an exceedance of the N1 or N2 spool by control logic which acts directly on the fuel flow commanded by the EEC. When triggered, the fuel flow is reduced but not completely shut off, with the residual fuel flow maintaining the engine at a power setting slightly below flight idle. This fuel flow is fixed and does not respond to throttle position inputs. The overspeed protection valve which achieves this is operated by a dual channel servo valve, commanded by either channel of the EEC. The valve is hydraulically latched once engaged and can only be reset by shutting down the engine.

The EDA is a dedicated alternator fitted to and driven by the engine main gearbox to provide a dedicated Direct Current (DC) electrical power supply to the EEC, independent of the aircraft electrical systems. The EDA also supplies an N2 speed signal to the EEC and cockpit indication. During engine start the EEC receives a 28V DC supply from the aircraft until the EDA takes over at approximately 10% N2. In the event of an EDA failure the EEC will switch back to the aircraft DC supply.

Operating procedures

An 'ENG 2 FADEC FAULT' warning on the ECAM indicates that both A and B channels of the indicated engine EEC have been lost. In many cases this results in the complete loss of the indicated engine parameters, and the figures are replaced by an amber XX indication. When this occurs the engine status can still be checked by referring to the engine's associated indicated parameters such as hydraulic, electric, and pneumatic bleed systems. If abnormal engine behaviour is identified the engine must be shut down using the master engine control lever. The relevant FCOM checklist is shown in Figure 4.



A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL

PROCEDURES
ABNORMAL AND EMERGENCY PROCEDURES
ENG

ENG 1(2) FADEC FAULT

Applicable to: MSN 01566-02522, 02838-02984, 03105, 03259-03270, 04603

Ident.: PRO-ABN-ENG-BC-00017975.0001001 / 21 MAR 16

ANNUNCIATIONS

Triggering Conditions:

L2 This alert triggers when both FADEC channels are lost.

Flight Phase Inhibition:

ELEC PWR, 1ST ENG STARTED, 1ST ENG TO PWR, 80 kt, LIFTOFF, 1500 ft, 800 ft, TOUCHDOWN, 80 kt, 2ND ENG SHUTDN, 5MN AFTER

1 2 3 4 5 6 7 8 9 10

Continued on the following page

LDA A318/A319/A320/A321 FLEET FCOM ← Z to AA → PRO-ABN-ENG P 123/234 15 FEB 21

A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL

PROCEDURES
ABNORMAL AND EMERGENCY PROCEDURES
ENG

ENG 1(2) FADEC FAULT (Cont'd)

Ident.: PRO-ABN-ENG-BC-00017663.0006001 / 21 MAR 17

- On ground:
  - THR LVR (AFFECTED) NOT ABOVE IDLE
  - ENG (AFFECTED) PARAMETERS.....CHECK
  - L2 *Due to the fact that engine indications are lost, other system pages such as HYD SD page, ELEC SD page or BLEED SD page must be used to check engine status.*
  - L1 ● IF ABNORMAL:
    - ENG MASTER (AFFECTED).....OFF
- In flight:
  - ENG (AFFECTED) PARAMETERS.....CHECK
  - L2 *Due to the fact that engine indications are lost, other system pages such as HYD SD page, ELEC SD page or BLEED SD page must be used to check engine status.*
  - L1 ● IF ABNORMAL:
    - THR LEVER (AFFECTED).....IDLE
    - ENG MASTER (AFFECTED).....OFF

L12

ASSOCIATED PROCEDURES

ENG 1(2) SHUT DOWN
(Refer to PRO-ABN-ENG ENG 1(2) SHUT DOWN).

Ident.: PRO-ABN-ENG-BC-00019553.0001001 / 13 MAY 16

STATUS

- On ground:
  THR LVR 1(2) NOT ABOVE IDLE

Figure 4

FCOM procedure for ENG 1(2) FADEC FAULT warning

Component investigation findings

EEC

The overhaul report for the removed EEC identified that some contamination was found on the pressure ports but stated that this was not linked to the issue reported on the incident flight.

EDA

The overhaul report confirmed that the component failed on test due to an insulation failure. It stated that this could cause an intermittent EEC electrical failure leading to temporary erroneous computations by the EEC. It is possible that the loss of or erroneous behaviour of the N2 signal can cause a false activation of the overspeed protection within the EEC, but this would have been recorded as a separate fault on the post-flight report and reflected in the N2 parameter values in the flight data. As these indicators were not present, it was ruled out as a possible cause for this incident.

FMU

The overhaul report identified the presence of internal fuel leaks around all three of the mechanical control valves within the FMU, with fuel also present in the electrical wiring cavity. These are known issues on the engine and are subject to ongoing product improvement processes by the engine manufacturer.

Previous similar events

Uncommanded (by the EEC) closure of the overspeed protection valve within the FMU has been experienced in previous similar events on other V2500 engines in service. These events have resulted in either a FADEC, engine stall[4], or engine overspeed protection fault warning being triggered. In all cases the engine ran down to idle and neither physical movement of the throttle nor autothrust commands from the FMGC had any effect on the engine.

Analysis

The manufacturer's assessment of the failure messages seen on the post-flight report and the ECAM warning was that they were consistent with the reduction in EPR caused by an uncommanded activation of the overspeed protection valve in the FMU. This reduced the fuel flow to the engine to a fixed level which was just below flight idle. The flight data values recorded for N1 and N2 immediately prior to this were normal and confirmed that no actual overspeed had occurred, which would have resulted in the valve correctly operating. Once activated, the fixed flow rate through the overspeed protection valve cannot be varied by any input from the throttle or the FMGC. As such, the apparently frozen parameters reported by the flight crew were an accurate indication of the engine status.

The other ancillary engine indications and associated systems' operating parameters recorded by the DFDR were all consistent with this. The valve remained hydraulically latched while the engine was operating but would have reset after the engine was shut down. The final overspeed protection fault warning seen on the post-flight report is intentionally inhibited by the system until after touchdown and the aircraft airspeed has reduced below 80 kt, which is why it appeared to occur after the engine had been shut down. The previous in-service events where the overspeed protection valve had operated without being commanded by the EEC, were very similar to this incident involving 9H-LOZ. It was not possible to confirm a definitive root cause for the activation of the overspeed protection valve from the evidence recovered by the investigation. However, these events are all the subject of ongoing continued airworthiness activities by the engine and aircraft manufacturers.

Safety actions

It has been reported that the engine manufacturer has conducted investigations at component and system level to understand the cause of the inadvertent overspeed protection valve activations. Definitive identification of the root cause has not been possible, but several factors have been identified as possible contributors. These will be addressed as product improvement changes to the FMU and are targeted to be available in Q3 2022. The aircraft manufacturer reported that progress on these issues is regularly communicated to operators of the engine during customer meetings, in which both the aircraft and engine manufacturers participate.

Footnote

4 No evidence of the engine experiencing an actual stall or surge was reported.

At the request of the operator of 9H-LOZ, the aircraft manufacturer also agreed to review the wording of the FCOM procedure for an 'ENG 1/2 FADEC FAULT' warning, to advise crews that the parameters will not always revert to 'XX' in the event of a problem occurring and may appear as frozen or abnormal values.

ACCIDENT

Aircraft Type and Registration:	Beech 58, G-BTFT
No & Type of Engines:	2 Continental Motors Corp IO-520-CB piston engines
Year of Manufacture:	1979 (Serial no: TH-979)
Date & Time (UTC):	14 October 2021 at 0800 hrs
Location:	Rochester Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	All propeller blades bent, flap trailing edges distorted and underside of the aircraft fuselage buckled
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,136 hours (of which 540 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and enquiries made by the AAIB

Synopsis

The aircraft had flown from Thruxton to Rochester where it landed with its landing gear retracted. All the blades on both propellers were bent and the underside of the fuselage and trailing edges of the flaps were distorted. The pilot and passenger were uninjured. It is not known why the landing gear had not extended.

History of the flight

The aircraft had been flown from Thruxton to Rochester Airport. The pilot called ahead and requested joining instructions with approximately 10 miles to run. Approximately seven minutes later the pilot advised that he was unable to see the airfield but then, four minutes after that, he reported downwind. Soon after, the aircraft was observed turning onto finals. A message was passed to the pilot with wind information and authorising landing, at his discretion, on Runway 20. The aircraft landed and an airport staff witness, who was watching the landing, described it as "smooth", but they "suddenly" noticed the aircraft had landed 'wheels up' and was now sliding to a stop on the runway. An emergency response was initiated, the aircraft was made safe, and the pilot and passenger vacated without injury. All of the blades on both propellers were found bent, the underside of the fuselage was distorted and buckled and both flap trailing edges were damaged.

Discussion

The pilot reported that he could not state exactly why the gear did not extend as he believed it was selected with the flaps downwind. All the landing gear doors were found closed and flush with their surrounding structure prior to the aircraft recovery from the runway. During recovery, the landing gear had to be extended manually as it did not respond to normal selection when power was applied. Later examination by a maintenance organisation found that structural distortion sustained during the landing may have initially prevented the landing gear from lowering correctly after the recovery from the runway. However, after further examination and a 'release' of the distortion, the landing gear was found to operate and indicate correctly.

AAIB Observations

The radio calls and the pilot's initial difficulty in spotting the runway suggest that the pilot may have been concentrating on orientating himself and finding the airfield, distracting him from establishing the aircraft in the circuit. The pilot stated that he believed he did select the landing gear down, supported by the landing gear selector being found in the DOWN position. However, he did not state that he confirmed three green down and locked indicator lights and the movement of the landing gear selector is not dependent on mechanical movement of the landing gear. It is possible that his checks were done in haste, as suggested by the late downwind call and turn on to finals very shortly after, and this may have precluded a complete confirmation of the landing gear status.

Conclusions

It appears that several contributory factors may have combined to cause the aircraft to land with its landing gear retracted. A transient landing gear technical fault, which prevented extension if DOWN was selected, cannot be ruled out.

SERIOUS INCIDENT

Aircraft Type and Registration:	Grob G 120TP-A, G-ETPC
No & Type of Engines:	1 Rolls-Royce M250-B17F turboprop engine
Year of Manufacture:	2017 (Serial no: 11125)
Date & Time (UTC):	15 September 2021 at 1215 hrs
Location:	In flight, RNAS Yeovilton, Somerset
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Oil contamination of windscreen.
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	7,241 hours (of which 65 were on type) Last 90 days - 36 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During a training flight, forward visibility was obscured when engine oil leaked from the propeller onto the windscreen. The pilot made a successful precautionary landing using full sideslip to enable him to use the only part of the windscreen that was clear.

An examination of the propeller revealed a damaged piston seal. The aircraft manufacturer had previously issued a Service Letter regarding oil leaking from the piston seal and following this event the propeller manufacturer issued a Service Bulletin to inform operators of an improved O-ring seal with increased durability.

History of the flight

The pilot in the left seat, was undertaking a training flight under the supervision of an instructor in the right seat who was the PIC. The weather was good, and the flight was uneventful until the PIC noticed the visibility through the windscreen was deteriorating. He thought it was ice forming and elected to take control of the aircraft. The pilot flying was surprised as he was unaware of a reason for the PIC to take control; shortly afterwards his forward visibility was also obscured with what both pilots identified as engine oil (Figure 1 centre).

All the engine parameters stayed within normal limits and the pilot climbed to increase the gliding range should an engine failure occur. A PAN was declared, and the pilot decided to make a precautionary landing at RNAS Yeovilton. A MAYDAY was declared as the pilot flew a steep final approach with right side slip. This enabled the pilot to use the lower right corner of the windscreen which was the only part that remained clear (Figure 1 right). The left seat pilot monitored and read out the height and airspeed, so the pilot did not have to remove his focus from the area of clear windscreen. The pilot touched down a third of the way along Runway 26, removing the sideslip at the last moment and braked hard to reduce the risk of a runway excursion.

Figure 1
Oil contamination post flight

Aircraft information

The Grob G 120TP-A is an advanced turboprop training aircraft powered by a Rolls-Royce M250-B17F gas turbine engine driving a five bladed MTV-5 propeller. The propeller uses pressurised engine oil to move a piston in the hub assembly to change the pitch of the propeller blades to maintain the selected engine rpm (Figure 2). Sealing between the pitch change piston and the hub assembly is by an O-ring: 120.2 mm in diameter, with a 7 mm diameter cross section. The O-ring is manufactured from a nitrile rubber compound.

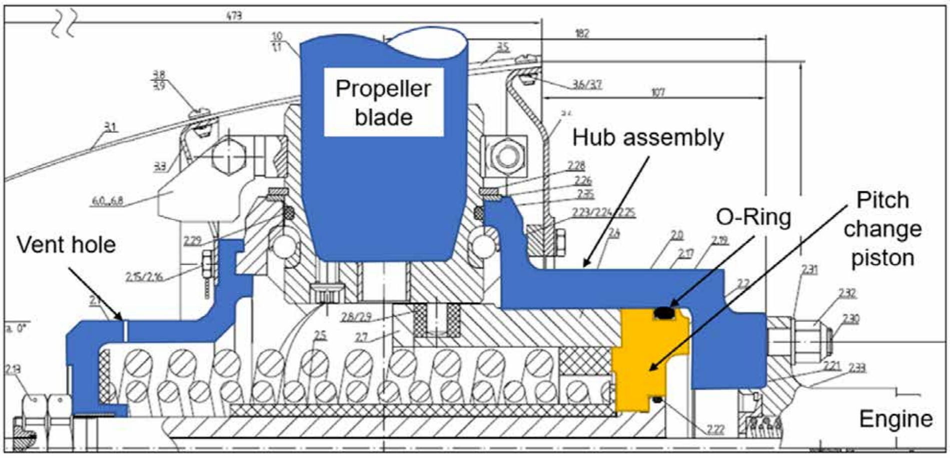


Figure 2
Cross-section through the propeller showing the piston O-ring

The aircraft manufacturer stated that they were aware of two incidents where the pitch change piston O-ring failed resulting in oil leaking from the vent hole in the forward part of the hub. The propeller manufacturer attributed these failures to a compatibility issue between the O-ring material and the engine oil. Consequently, in July 2019 the aircraft manufacturer issued Service Letter SL 565-009 which highlighted the signs to be aware of during pre-flight and engine run-up checks which would indicate a failed O-ring. It also included reference to the propeller manufacturer's Service Bulletin SB No 36 which detailed compatible engine oils. No anomalies were found during the pre-flight inspection or engine run-up on G-ETPC before the flight.

The propeller manufacturer also made three changes to the O-ring material to increase its durability (Table 1). The shore hardness[1] of the nitrile rubber compound was increased from 70 to 72 and the latest standard has a proprietary surface finish applied which increases the surface hardness and reduces friction All three O-rings are compatible with the engine oils listed in SB No 36.

Part number	Material	Compound	Finish	Comments
C-047-135	NBR 70	NB7000	None	Original material from 2013
C-047-135-1	NBR 72	707	None	Product improvement in 2020
C-047-135-2	NBR 72	707	OVE70 DF	Introduced by Service Bulletin No 37

Table 1

O-ring material and finish evolution

Propeller examination

The propeller was removed and examined at an authorised overhaul facility. The piston O-ring was found to have multiple cuts and widespread surface damage (Figure 3) allowing oil to pass into the hub, causing a breakdown of the hub bearing grease. The O-ring had part number C-047-135. The propeller manufacturer stated that the damage was a result of the O-ring swelling due to high engine oil temperature and contact with a non-compatible engine oil. The size increase of the O-ring due to swelling, caused it to stick and roll as the piston moved, rather than slide. The surface was then damaged with cuts and tears.

Engine oil

G-ETPC was supplied from new with the engine filled with Mobil Jet Oil 254 and after 21 flying hours it was replaced, in April 2018, with AeroShell 560. The oil was changed again after 151 flying hours, in December 2020, with AeroShell 560 and the aircraft flew a further 106 hours before the leak occurred. Both oils conform to specification MIL-PRF-23699-HTS and are listed in SB No 36.

Footnote

[1] Shore hardness is a mechanical macro indentation test typically used to determine the hardness of polymers.

Figure 3
O-ring damage (left), hub interior (right)

Other incidents

In February 2019 an RAF Grob G 120TP-A[2] also suffered a pitch change piston seal failure, resulting in oil contamination of the windscreen. The pilot successfully landed the aircraft, and the cause was determined to be a combination of damage incurred during assembly and the engine oil compatibility with the O-ring material. As a result of this incident, the propeller assembly procedures were amended to prevent damage to the seal, and the engine oil was changed to Mobil Jet Oil 254. The original O-ring, part number C-047-035, was replaced with a C-047-135-1 O-ring. The remainder of the RAF fleet was fitted with C-047-135-1 O-rings within 100 flying hours.

Manufacturer's findings

An investigation by the propeller manufacturer determined that there was a compatibility issue between the propeller piston O-ring and the engine oil resulting in softening and damage to the O-ring, which allowed oil to pass the seal. Furthermore, there was evidence that the O-ring was possibly damaged during installation which might also have resulted in an oil leak.

Footnote

2 The RAF designation for the Grob G 120TP-A is a 'Prefect'.

Comment

The propeller manufacturer identified a compatibility issue with the pitch change piston O-ring of the MTV-5 propeller and the oils used in the Rolls-Royce M250 engine. They had already issued SB No 36 which detailed compatible engine oils and following this incident, they issued SB No 37 to inform operators of the latest O-ring available with improved durability.

In both the G-ETPC incident and the similar previous incidents, forward visibility was lost due to a film of oil across the windscreen, but the quantity of oil lost was not sufficient to affect the performance of the aircraft. Using effective Crew Resource Management skills, the PIC on G-ETPC was able to delegate essential tasks, such as airspeed and height monitoring, thereby allowing him to maintain full concentration on the limited view afforded through the only clear part of the windscreen.

ACCIDENT

Aircraft Type and Registration:	Tecnam P2008-JC, G-TSFC	
No & Type of Engines:	1 Rotax 912-S2 piston engine	
Year of Manufacture:	2015 (Serial no: 1047)	
Date & Time (UTC):	22 March 2021 at 1505 hrs	
Location:	Stapleford Aerodrome, Essex	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Right main landing gear collapsed	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	45 years	
Commander's Flying Experience:	481 hours (of which 6 were on type) Last 90 days - 6 hours Last 28 days - 6 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

Whilst taxiing after a normal landing, the right main landing gear collapsed due to a failed attachment bolt. Examination of the bolt determined that the failure was due to a fatigue crack, most likely initiated by wear and damage to the bolt's surface protection.

The operator's maintenance organisation had recently transitioned the aircraft from a generic maintenance schedule to the maintenance schedule specified by the manufacturer. The new schedule includes a specific check on the condition of these attachment bolts annually or every 100 hours. In addition, the maintenance organisation has stated that it intends to replace these bolts every 200 to 300 hours.

Aircraft information

The Tecnam P2008 is a single engine, two-seat, high wing aircraft of conventional layout with tricycle landing gear. The main landing gear legs are of a flat spring type. They are attached to the fuselage by a saddle clamp and two bolts at the outboard edge of the fuselage and a single bolt towards the centre of the fuselage, (Figure 1).

Investigation

After a normal landing the right main landing gear collapsed as the aircraft taxied clear of the runway. Examination identified that the bolt securing the inboard end of the landing gear leg had failed in fatigue, (Figures 1 and 2). Wear and damage to the surface protection was likely to be the initiation of the fatigue crack. The wear indicated that the bolt had been moving in its bushings.

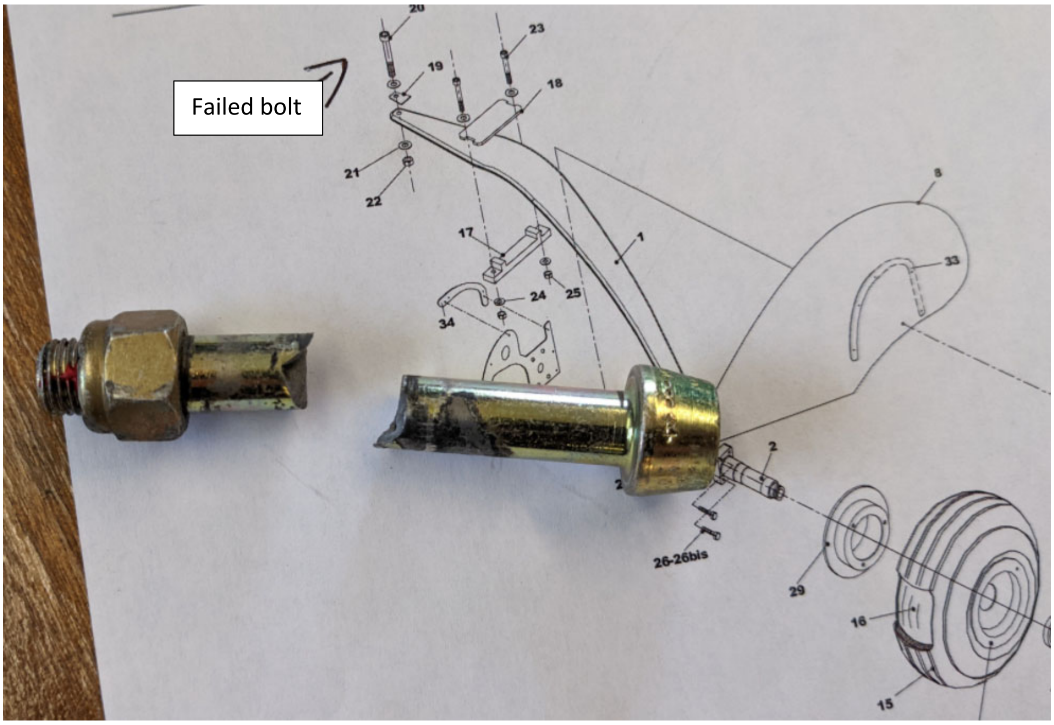


Figure 1

Failed bolt and diagram showing its location

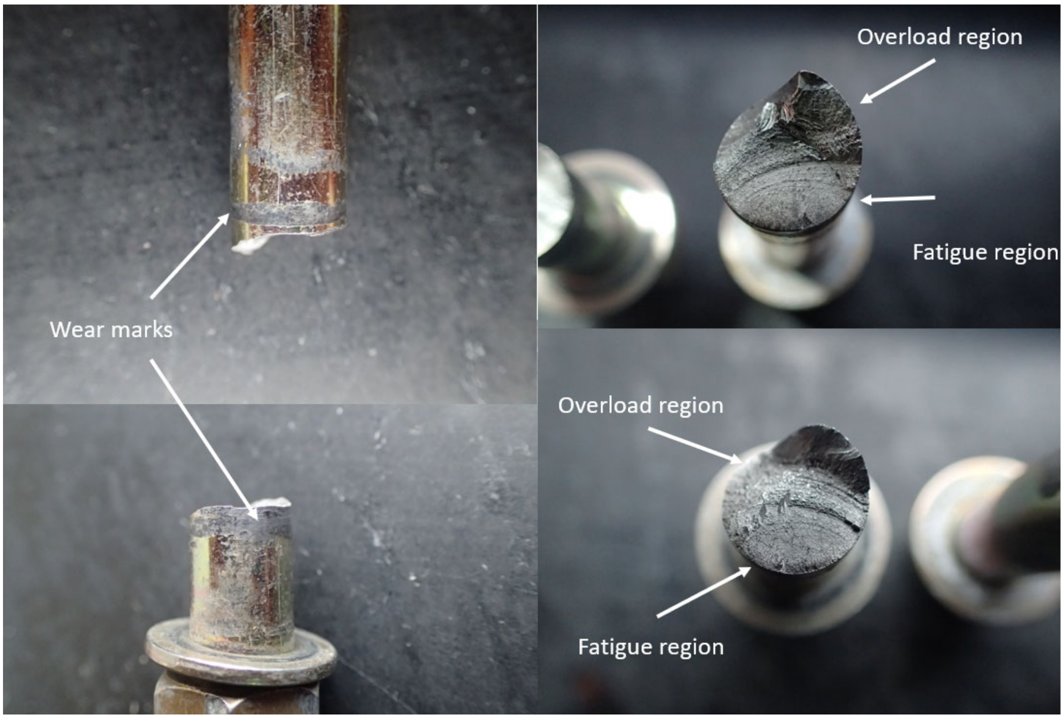


Figure 2

Detail showing wear marks and fracture surfaces of the failed bolt

The aircraft had been maintained using the LAMP (Light Aircraft Maintenance Programme). LAMP was a generic programme applicable to all light aircraft and it did not specifically require a detailed inspection of these bolts. The LAMP is being phased out in favour of Self Declared Maintenance Programmes. Shortly before the accident, the aircraft had been transitioned to the maintenance schedule specified by the aircraft manufacturer. This schedule includes the following specific inspection to determine the condition of these attachment bolts:

> *'Annually or every 100 hours;*
>
> *Inspect nose and main gear attachments, bolts and bushings for condition and security. Check especially for cracks, corrosion, and damaged surface protection. Inspect for looseness, condition and security of mounting points.'*

The operator's maintenance organisation has stated that, additionally, they will check the torque of the bolts every 50 hours and intend to replace them every 200 to 300 hours.

These changes should allow any degradation of these attachment bolts to be identified before failure and therefore prevent recurrence.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL-450, G-CBGR
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2001 (Serial no: PFA 274A-13682)
Date & Time (UTC):	1 February 2022 at 1605 hrs
Location:	Clench Common Airfield, Marlborough, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) 1 (Minor) Passengers - N/A
Nature of Damage:	Landing gear and propeller damaged, and right wing detached at trailing edge. Windscreen shattered and fuselage damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	14,200 hours (of which 286 were on type) Last 90 days - 32 hours Last 28 days - 14 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

In the final stages of the approach to landing, the flaps retracted uncommanded by the pilot, who was subsequently unable to prevent the aircraft striking the ground heavily. Both the pilot and passenger were injured, and the aircraft was severely damaged.

The flap handle pivot bolt had become detached from its gate during the approach, allowing the flap handle to move and the flaps to retract.

History of the flight

The aircraft had recently undergone an engine service and a new instrument panel had been fitted. Having completed engine ground runs, a test flight was conducted by the pilot several weeks before the accident flight. The aircraft then flew for a Permit to Fly check flight but the radio was found to be operating intermittently. A further flight was then required to complete the requirements for issue of the Permit. During this flight the aircraft and radios were tested with no faults and the aircraft returned to Clench Common Airfield having completed the requirements for the Permit renewal. During the final stages of the approach to landing the flaps retracted uncommanded at approximately 40 ft. The pilot immediately recognised what had happened and tried to raise the nose but was unable to stop the aircraft striking the ground heavily. Both the pilot and passenger were injured.

Accident site

The aircraft was severely damaged. The first impact was on the nose undercarriage leg, which sheared off, followed by the main undercarriage legs, which failed at some point. The aircraft came to rest on its fuselage the right way up, and the starboard wing was dislodged and only held on by the trailing edge bolt.

Figure 1

G-CBGR after recovery from the accident site (used with permission)

Aircraft information

The Jabiru UL-450 kit is supplied with manual flaps which are operated via a lever mounted on the side wall to the left of the pilot's head. The lever has a button which latches it in three positions to give flaps up, a mid-flap position or full flap. The flap lever is pulled laterally to release the peg from the hole which then enables the flaps to be moved to a new position. The Light Aircraft Associations type acceptance data sheet[1] comments:

> *'It is common for the attach/pivot bolt of the Flap Actuating Handle to not be tightened sufficiently, this can lead to the flap disengaging on approach with potentially serious consequences if not caught quickly by the pilot.'*

The document then goes on to say:

> *'…it is important to set and maintain the tightness of the flap lever pivot bolt in order to provide a suitable pre-load tending to hold the peg in place, otherwise there is a risk of the flap control jumping the gate.'*

Footnote

1 http://www.lightaircraftassociation.co.uk/engineering/TADs/274A%20JABIRU%20UL%20450.pdf?msclkid=facc58ebc16711ecaef410fa01748d66 [Accessed 21 April 2022].

Uncommanded flap retractions on the aircraft type are usually caused either by the flap lever not being engaged with the detent sufficiently, or if the flap limiting speed has been exceeded.

The pilot commented that he had experienced uncommanded flap retraction on this type of aircraft before and that he was mindful of this in ensuring the flap lever was located firmly into the required position. He noted that they did encounter some turbulence on the approach a few seconds before the flaps retracted and that this may have dislodged the flap lever. The aircraft was flying below the flap limiting speed.

The flaps are large, at about 70% of the span of the wing, so any uncommanded retraction will cause a significant loss of lift and a change in aircraft attitude.

Analysis

The design of the flap system relies on the pivot bolt to be correctly adjusted so that the flap lever does not come out of the selected gate. In the case of G-CBGR, turbulence on the approach may have dislodged the flap lever, which caused the uncommanded flap retraction. This occurred at a height at which the pilot could not recover the aircraft before it struck the ground.

Conclusion

The flap handle in G-CBGR became dislodged from its selected gate leading to the flaps retracting uncommanded by the pilot. Despite the pilot immediately recognising what had happened, it was not possible to recover the aircraft before it struck the ground.

The issue of the pivot bolt on the flap handle in this aircraft type not being tightened sufficiently to prevent the flap handle coming out of the selected gate is well-known and is publicised by the LAA in their type acceptance data sheet.

ACCIDENT

Aircraft Type and Registration:	Letov LK-2M Sluka, G-MZBF
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	1996 (Serial no: PFA 263-12881)
Date & Time (UTC):	6 March 2022 at 1200 hrs
Location:	1 nm South of Kernan Airfield, Tandragee, County Armagh
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nacelle and wings damaged
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	374 hours (of which 339 were on type) Last 90 days - 10 hours Last 28 days - 7 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At approximately 600 ft agl, during final approach to Kernan Airfield, the pilot felt a sudden release of pressure in the control column and a loss of roll control. He carried out a forced landing in a field immediately below, striking a hedge just before touchdown.

The cause of the accident was loss of right aileron control, due to a turnbuckle becoming disconnected from the right aileron cable due to a lack of secondary locking.

History of the flight

The pilot had conducted a two-hour 10 minute flight, and was returning to Kernan Airfield. On final approach to Runway 35, at approximately 600 ft agl, he felt a sudden release of pressure in the control column and a loss of roll control.

Due to high voltage power lines, approximately quarter of a mile ahead on the approach to Kernan Airfield, the pilot chose to conduct a forced landing. The pilot selected a field immediately below the flight path for the landing, reduced the engine power to idle, and the aircraft descended in a right turn. The aircraft struck a hedge just before landing but remained upright. Damage to both wings, nose fairing and propeller was sustained during landing. The pilot was able to exit the aircraft unaided.

Aircraft information

The Letov LK-2M Sluka is a single-seat Microlight that is de-regulated by the CAA and does not require a Permit to Fly. Airworthiness of the aircraft is the responsibility of the pilot.

Aircraft examination

Post-accident inspection by the pilot revealed that a control wire from the right wing aileron tensioning system had unscrewed from the end of a turnbuckle. Safety wire to prevent the turnbuckle from unscrewing was missing. The last maintenance checks were completed in November 2021 by the pilot but he could not recollect when the turnbuckle was last inspected.

ACCIDENT

Gyroplane Type and Registration:	Rotorsport UK Calidus, G-TGLG
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	2015 (Serial no: RSUK/CALS/028)
Date & Time (UTC):	18 March 2022 at 1251 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 1 (Serious) 1 (None) Passengers - N/A
Nature of Damage:	Damage to the left side of the fuselage pod, wheels, propeller, left vertical stabiliser and rotor blades
Commander's Licence:	Private Pilot's Licence (Gyroplane)
Commander's Age:	70 years
Commander's Flying Experience:	1,253 hours (of which 1,251 were on type) Last 90 days - 19 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During an aborted takeoff, the student pilot pulled the throttle and stick back. This caused the gyroplane to abruptly, pitch-up and roll to the left. The gyroplane fell on to its side and slid to a stop.

History of the flight

The purpose of the flight was training for a student pilot on a gyroplane private pilot's licence course. The student, who already held a fixed-wing licence, had completed 17 hours of the course and had been progressing well. The objective of the flight was to finesse the student's landing technique. The instructor, who was occupying the rear seat, and student planned to fly several circuits at Shobdon. The first few circuits were planned to end with low passes along the runway. They planned to follow these with some landing practice, each landing coming to a full stop before commencing another takeoff.

The weather at Shobdon included light winds and clear skies, and the airfield was busy with general aviation traffic.

The start-up and taxi were uneventful but, due to other traffic, there were several delays before they were able to takeoff, and they had sat in the gyroplane for 31 minutes before being able to commence the first takeoff.

The first takeoff was normal and was followed by three circuits. Each circuit concluded with a low pass flying a few feet above the runway before climbing back into the circuit. The circuit was busy with other traffic and on several occasions they needed to vary the circuit to fit in with it.

After the fourth circuit they planned to land, stop, then commence another takeoff. The approach and landing were good and the gyroplane came to a stop on the runway. The student then advanced the throttle to commence another takeoff. However, as the gyroplane accelerated along the runway the instructor realised that the student had allowed the stick to move too far forward and the rotor speed was not increasing. He instructed the student to abort the takeoff, telling him to reduce power and put the stick forward. However, the student pulled the throttle and stick back together causing the gyroplane to pitch-up sharply. Both occupants described the stick shaking violently and the gyroplane instantly rolling to the left.

The gyroplane fell onto its side and slid along the runway, coming to a stop on the left side of the runway (Figure 1 and 2). The occupants were trapped and could smell fuel. Airfield personnel were on scene quickly and were able to right the gyroplane and extract the occupants. The instructor was uninjured; the student had chest pains and later discovered he had broken a bone in his back.

Figure 1

Marks on the runway with accident site in the distance

Figure 2

G-TGLG after righting by emergency services

Instructor's comments

The instructor commented that the student's previous takeoffs during his training had been good and they had briefed the procedure for stopping after landing then commencing another takeoff. He was therefore confident the student could handle the takeoff. When he instructed the student to abort the takeoff, he was loosely holding the controls but was not able to prevent the abrupt rearward movement of the stick.

With hindsight the instructor felt he should have taken control and aborted the takeoff himself rather than instructing the student to abort. However, at the time, he wanted to give the student the opportunity to correct the mistake himself to maximise his learning.

The instructor commented that he was not able to see the instruments in the front cockpit due to the shape of the canopy. Airspeed, altitude and vertical speed instruments were fitted in the rear cockpit[1] but no rotor speed indicator. Had he been able to see the rotor speed, he felt he would have noticed earlier that the takeoff was not preceding correctly. He intends to have a rotor speed indicator fitted instead of the vertical speed instrument when the gyroplane is repaired.

Footnote

[1] These additional gauges were fitted as an approved 'minor modification' when the instructor started using this gyroplane for instructional flights.

Student's comments

The student pilot could not remember exactly what happened in the moments before the accident. He remembered safely landing then commencing the takeoff. However, as he started the takeoff, he realised he had not completed the normal verbal checks which includes stating "stick fully back and centred". He had not mentally reset from thinking about the landing into thinking about the takeoff. With hindsight he realised he should have aborted the takeoff himself when he became aware he had not done the checks.

The student also described that as he was flying downwind prior to the landing he was feeling quite tired due to the exertion of the long delay on the ground in the warm cockpit, the extended circuits and the concentration required to fly the previous circuits. At this point he thought that they should make this the final circuit, but he did not communicate this to the instructor. He felt that his tiredness was probably why he did not complete his normal checks leading to the incorrect stick position on the takeoff roll.

AAIB comment

This accident shows how challenging it can be for instructors to know when and how to intervene effectively. Instructors need to give students the opportunity to make mistakes and recover situations for themselves whilst ensuring they maintain a safe operation. One author on flying instruction suggests:

> *'There is an extremely fine balance between allowing the student to maintain control of the aircraft for as long as possible and intervening before they do anything that would compromise safety.'* [2]

The CAA Handling Sense Leaflet 'Gyroplane Handling Performance'[3] contains guidance about aborting a takeoff in a gyroplane. It contains the following advice:

> *'Every pilot should develop the habit of putting the actions in the event of a mishap on take-off at the very forefront of their thinking. In the case of the gyroplane pilot, this is immediately before releasing the pre-rotator. Good practice would be for every pilot, on every take-off, to say out loud "in the event of an aircraft malfunction or poor acceleration on take-off, I will abort the take-off by …'*

Footnote

2 Hatton, C. L. (2006) *You have control: being a better flying instructor*. Marlborough: The Crowood Press Ltd.
3 Available at http://publicapps.caa.co.uk/docs/33/20120816HSL04.pdf

AAIB Record-Only Investigations

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

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

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed: March - April 2022

6 Jan 2022 Robinson R22 Beta G-OVNR Denham Aerodrome, Buckinghamshire

Excessive yaw developed while lifting on the student's second solo flight. The helicopter was substantially damaged when the main rotors made contact with the tail boom.

30 Jan 2022 Pitts S-1S G-WIGY Sturgate Airfield, Lincolnshire

The aircraft ground looped after landing. The pilot considered that the landing should have been rejected and attempts to control the aircraft after landing were ineffective. The right landing gear and wing were damaged.

26 Feb 2022 Piper PA-28-236 N81188 Bodmin Airfield, Cornwall

The aircraft landed short of Runway 13 at Bodmin, in turbulent air conditions, causing damage to the aircraft.

3 Mar 2022 Sherwood KUB G-TLEE Sywell Aerodrome, Northamptonshire

During the takeoff roll, the aircraft became briefly airborne several times before starting to climb away. However, at 20-30 ft the aircraft stalled, lost height and struck terrain to the left of the runway. The pilot recalled that he may have positioned the stick too far back for a takeoff and didn't recognise that the aircraft was stalled until it was too late to take any action. The aircraft was substantially damaged.

12 Mar 2022 Mooney M20J G-OBAL Elstree Aerodrome, Hertfordshire

The pilot lost control of the aircraft during a crosswind takeoff from Runway 26. CCTV showed the aircraft pitch up, then sink before rolling left then right causing the right wingtip to contact the runway surface. It touched down wings level on the adjacent grassed area. The right wing, landing gear doors and propeller were damaged.

26 Mar 2022 Frati Falco F.8L G-RJAM Lambley Airfield, Nottinghamshire

The aircraft became low on the approach when the pilot was distracted by obstacles directly beneath the flight path. The pilot was not able to correct the flight path before the aircraft struck a hedge, sustaining significant damage to the propeller, landing gear and wings.

26 Mar 2022 Piper PA-28-161 G-ISHA City Airport, Barton-upon-Irwell, Greater Manchester

The student was practising a flapless approach supervised by an instructor. The final approach was a little shallow and the aircraft caught the long grass in the undershoot. During the subsequent landing on soft ground the nosewheel sank in, the nose landing gear collapsed and the propeller struck the ground.

Record-only investigations reviewed: March - April 2022 cont

29 Mar 2022 Luscombe 8A G-AKTI Aughrim Airfield, County Down

After an uneventful flight the aircraft bounced on touchdown and veered to the left. The pilot was unable to regain control and the aircraft left the runway, passed though a small fence before hitting a wall at moderate speed.

30 Mar 2022 Piper PA-38-112 G-BSFE Glasgow Airport

The engine failed to start for the student. The instructor then checked that there wasn't any fuel on the ground under the engine, re-primed and attempted to start the engine. Whilst the engine was cranking he noticed flames coming from the engine intake and used a fire extinguisher to put out the fire as the AFRS arrived on the scene. It was suspected that the fire was caused by over priming the engine.

3 Apr 2022 Jabiru UL-450 G-ODGS Old Park Farm Airfield, Glamorgan

The pilot reported that the aircraft encountered a gust of wind on landing, causing the right wing to make contact with the runway. The wings and landing gear were substantially damaged and the two occupants were uninjured.

18 Apr 2022 Europa G-BWEG Tatenhill Airfield, Staffordshire

During a landing in a slight crosswind, the pilot encountered significant turbulence during the flare. Following a slight bounce, control of the aircraft was lost and it veered left and departed the runway onto rough ground. The propeller and left landing gear strut were damaged.

29 Apr 2022 Maverick 430 G-CBGO St Michael's Airfield, Lancashire

The engine lost power during takeoff. The aircraft stalled from about 20 feet and landed heavily on the runway damaging the landing gear and airframe.

30 Apr 2022 Sherwood Ranger ST G-CIWD Crowhurst Airfield, Surrey

The engine lost power one hour into the flight. During the subsequent forced landing the landing gear collapsed and the aircraft was damaged.

Miscellaneous

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

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

BULLETIN CORRECTION

Aircraft Type and Registration:	Cessna 172N, G-BONO
Date & Time (UTC):	20 February 2022 at 1700 hrs
Location:	Perranporth Airfield, Cornwall
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No 4/2022, page 41 refers

Following publication it was noted that the incorrect record-only accident text had been entered under entry for G-BONO. The original text read as follows:

> On landing, during braking, the aircraft slewed and then left the grass runway. The ring wing struck a hedge causing the wing to detach.

The text should have read:

> The aircraft had flown to Perranporth, in Cornwall, from Northern Ireland in challenging wind conditions. Whilst taxiing outside the hangar at Perranporth Airfield, a gust of wind under the right wing tipped the aircraft, causing the left wing tip and the propeller to hit the ground.

The online version of the report was amended on 12 May 2022.

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

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

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

Published November 2018.

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

Published March 2020.

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

Published May 2021.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

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

Air Accidents Investigation Branch