AAIB
Air Accidents Investigation Branch

AAIB Bulletin 3/2026

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The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

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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:	ATR 42-500, G-LMRC	
No & Type of Engines:	2 Pratt & Whitney Canada PW127E turboprop engines	
Year of Manufacture:	1996 (Serial no: 480)	
Date & Time (UTC):	27 August 2022 at 1018 hrs	
Location:	During climb 14 nm north-east of Aberdeen Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 3	Passengers - 25
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	39 years	
Commander's Flying Experience:	4,900 hours (of which 243 were on type) Last 90 days - 147 hours Last 28 days - 36 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The ATR 42-500 aircraft (G-LMRC) experienced a loss of multiple flight deck displays during climb from Aberdeen Airport. At FL100 when the co-pilot turned off the landing lights as per normal procedure, both the commander's and co-pilot's Electronic Attitude Director Indicators (EADI) and Electronic Horizontal Situation Indicators (EHSI) and two other displays went blank, the autopilot disengaged, the air conditioning packs shut down, and the crew felt a momentary deceleration. The co-pilot quickly turned the landing lights back on. The failure lasted about 3 seconds and then the displays and systems returned. The aircraft returned to Aberdeen and landed uneventfully, but a similar failure occurred on the ground when the commander turned the landing lights off.

Investigations revealed a fault in the 1PA contactor, which was stuck in an intermediate position and unable to supply backup power to the emergency electrical network. This was a contributory factor but not a cause of the loss of power.

Despite extensive testing and examinations, the cause of the simultaneous loss of the emergency electrical network and a loss or undervoltage condition of DC BUS 2 could not be determined. However, no further failures occurred after replacement of the 1PA contactor, battery switch, and landing light relays. The aircraft manufacturer and EASA have taken safety action to require testing and replacement of 1PA contactors that have failed.

Given the potential seriousness of a repeat failure, were it to last for more than 3 seconds and occur at night or in IMC conditions, the AAIB has made a Safety Recommendation to the aircraft manufacturer to continue investigating possible causes of the electrical failure.

History of the flight

The aircraft was on a scheduled flight from Aberdeen International Airport to Sumburgh Airport, Shetland. Prior to this flight the aircraft had operated the same route and return without event.

After an uneventful start up and taxi out, the aircraft took off from Runway 34 at 1010 hrs. At the time the commander was the PF, and there was daylight.

As the aircraft was climbing through FL100, in VMC, the co-pilot actioned the '*FL100 Procedure'*, which included turning the landing lights off. As he did so, the crew heard a "clunk" that sounded similar to selecting external power and seemed to emanate from the electrical cabinet behind the co-pilot's seat. At the same time both Electronic Attitude Director Indicators (EADI) and Electronic Horizontal Situation Indicators (EHSI) went blank, the autopilot (AP) disengaged and both air conditioning packs de-powered. Additionally, they felt a momentary noticeable deceleration and saw the engine torque indications roll back to zero torque. The Multi-Function Control Display Unit (MCDU) and the Advisory Display Unit (ADU) also went blank (Figure 1). As a reaction to the failure, thinking that his action may have caused the failure, the co-pilot quickly turned the landing lights back on. The EADIs, EHSIs, MCDU and ADU were restored, with no additional action by the flight crew and the AP was re-engaged. The loss of power lasted about 3 seconds.

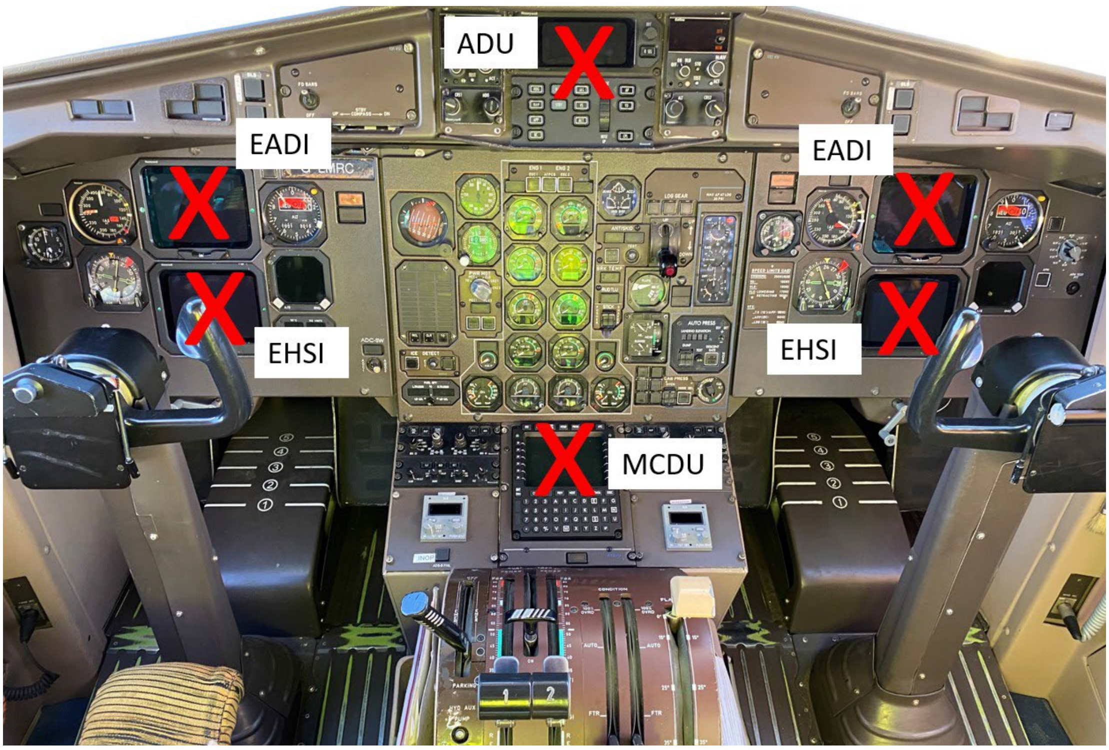

Figure 1

G-LMRC flight deck showing the displays that were reported lost during the failure

The crew elected to return to Aberdeen where they initially entered a holding pattern while they completed the necessary checklists and prepared the aircraft for the approach. The main system that was not recovered, after the electrical failure, was the blue hydraulic system pressure. The crew actioned the Quick Reference Handbook checklist for loss of blue hydraulic system pressure which involved turning the blue hydraulic pump off. It was later discovered that the system could not be recovered as a circuit breaker had tripped. The Aberdeen ATIS, recorded at 1020 hrs, stated that the surface wind was variable in direction at 2 kt, visibility was in excess of 10 km and there was scattered cloud at 700 ft aal and broken cloud at 1,500 ft aal.

Once the aircraft and crew were ready to make the approach to Aberdeen, they flew an uneventful radar vectored ILS and landing on Runway 34. After the aircraft vacated the runway, the commander actioned the After Landing Checklist. This included switching the landing lights off. As he did so the electrical failure reoccurred, with the same symptoms of the screens going blank and returning about 3 seconds later. The lights were left off and the aircraft was then taxied onto a stand and shut down without further event.

Flight crew training

Flight crew conduct training on flight instrument failures as part of the mandatory cycle of training items during their Licence Proficiency Check and Operator Proficiency Check, which are conducted in a simulator once every 18 months. These may not be a loss of all instruments leading to flight on the standby flying instruments, as the scenario is left to the examiner's discretion.

The commander commented that he had never flown the ATR 42 simulator on standby instruments alone.

Aircraft information

The ATR 42-500 is a twin turboprop regional aircraft with seating capacity of up to 48 passenger seats. G-LMRC was manufactured in 1996 and joined the operator's fleet in June 2020.

Electrical system

During flight, the ATR 42-500's electrical power is provided by the following sources:

- Two engine-driven 28V DC starter-generators, one on each engine (DC Gen 1 and DC Gen 2).
- One Main and one Emergency 24V DC battery.
- Two propeller-driven AC frequency generators providing 115V wild AC[1].
- Two DC-supplied static inverters, providing constant frequency 26V and 115V AC power.
- A Transformer Rectifier Unit (TRU) that can convert 115V wild AC to 28V DC.

Footnote

[1] Wild AC is an AC power source of variable frequency.

The distribution of the DC electrical network is shown in Figure 2, with the normal in-flight configuration shown with blue and red circuits. In normal in-flight configuration DC Gen 1 powers DC BUS 1 and DC Gen 2 powers DC BUS 2. These two main buses charge the emergency and main batteries which in turn provide power to the Emergency DC Bus (DC EMER BUS), DC Standby Bus (DC STBY BUS) and the DC Essential Bus[2] (DC ESS BUS) – these three buses are referred to as the 'emergency electrical network'. If power to both DC BUS 1 and DC BUS 2 is lost, then critical flight systems and equipment are retained because the batteries would still provide power to the three buses in the emergency electrical network for about 30 minutes. If both batteries were to fail or were turned off, then either DC Bus 1 or DC Bus 2 can provide power to the emergency electrical network, via contactors[3] 1PA, 58PA and 3PA shown in Figure 2.

The contactors are controlled by the Bus Power Control Unit (BPCU), two Multi-Function Computers (MFC) and two Generator Control Units (GCU).

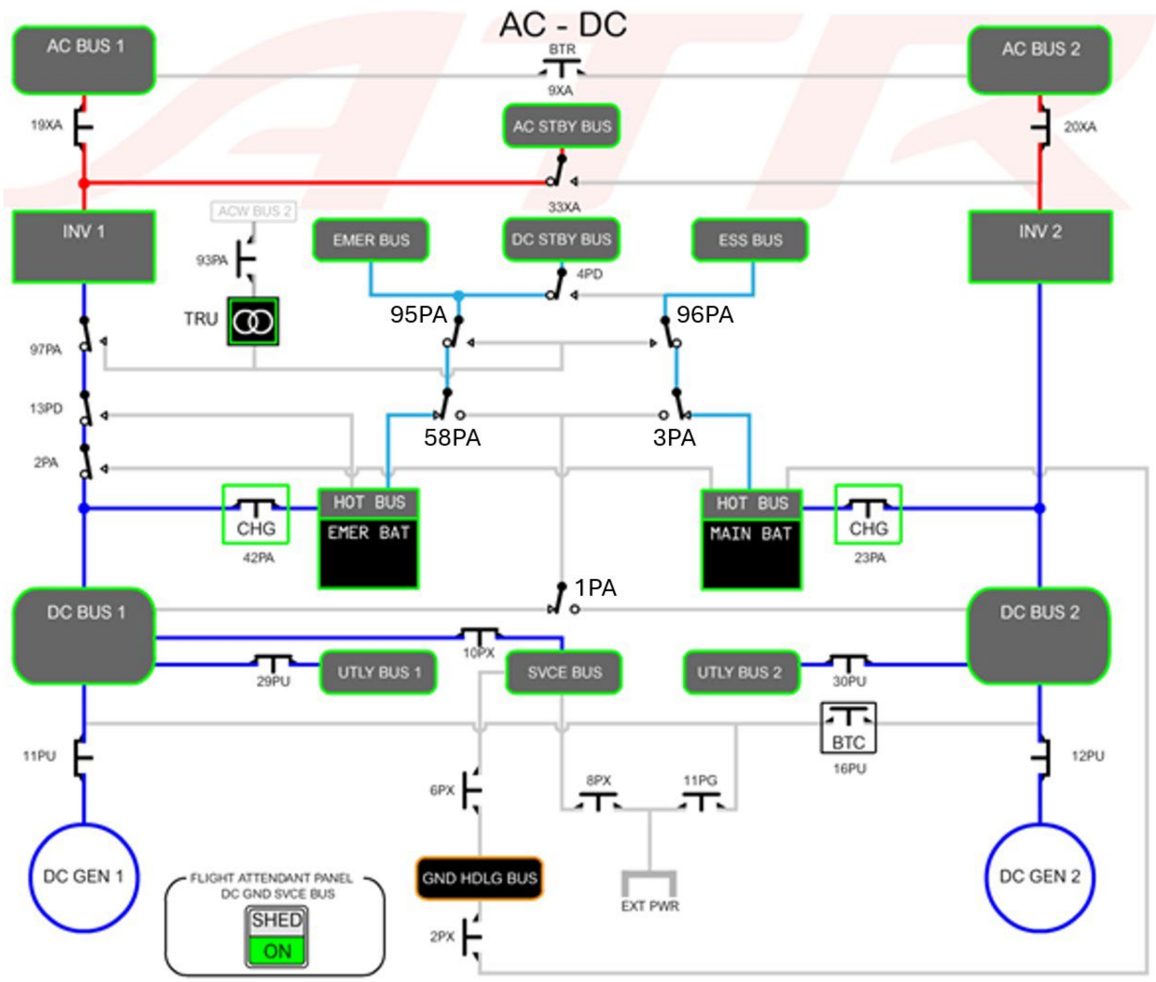

Figure 2

Schematic of DC electrical network – normal in-flight configuration

Footnote

[2] The DC Essential Bus (DC ESS BUS) is technically two busses composed of DC ESS BUS SECT 1 and DC ESS BUS SECT 2. For simplicity these are referred to as the DC ESS BUS in this report.

[3] A contactor is an electrically controlled switch which uses a low power circuit to switch a high-power circuit on and off.

Sources of electrical power to the equipment affected in this incident

During this incident power was briefly lost to many items of equipment. Some of these were identified from the flight crew reports and some were identified from the recorded data which is presented in the 'Recorded information' section. The primary and secondary sources of power for this equipment are shown in Table 1. Some buses have two sections, SECT 1 and SECT 2.

		Source of Power	
Equipment	**Equipment reported lost**	**Primary**	**Secondary**
Captain's EADI	Yes, flight crew report	DC STBY BUS	N/A
Captain's EHSI	Yes, flight crew report	DC STBY BUS	N/A
Co-pilot's EADI	Yes, flight crew report	DC BUS 2 SECT 1	N/A
Co-pilot's EHSI	Yes, flight crew report	DC BUS 2 SECT 2	N/A
Advisory Display Unit (ADU)	Yes, flight crew report	DC STBY BUS	N/A
MCDU	Yes, flight crew report	DC STBY BUS	N/A
Pack Valve No. 1	Yes, flight crew report	DC ESS BUS SECT 1	N/A
Pack Valve No. 2	Yes, flight crew report	DC ESS BUS SECT 2	N/A
Engine torque indications	Yes, flight crew report	DC EMER BUS	N/A
GPS	Yes, loss of data	DC STBY BUS	N/A
Propeller Electronic Control PEC 1	Yes, propeller rpm increased	DC ESS BUS SECT 2	DC EMER BUS
Propeller Electronic Control PEC 2	Yes, propeller rpm increased	DC ESS BUS SECT 1	DC EMER BUS
Cockpit Voice Recorder (CVR)	Yes, loss of recording	DC ESS BUS SECT 2	N/A
Flight Data Acquisition Unit (FDAU)	Yes, loss of data	DC ESS BUS SECT 1 (in-flight)	N/A
Hydraulic blue pump control	Yes, flight crew report	DC EMER BUS	N/A

Table 1

Sources of power for equipment detected or reported lost

There was evidence from recorded data to support a power loss from all three buses of the emergency electrical network: DC STBY BUS, DC EMER BUS and DC ESS BUS. In addition, the flight crew's report of the co-pilot's EADI and EHSI going blank would indicate loss of DC BUS 2[4]. The cabin crew also reported a loss of cabin lights – it was not clear if it was the lateral or ceiling lights or both. A loss of ceiling lights would be consistent with a loss of DC BUS 2, whereas a loss of lateral lights would also require a loss of DC BUS 1.

Footnote

4 The display signal input to the screens is provided by Symbol Generator Units (SGUs). SGU 2 for the co-pilots EADI and EHSI was also powered by DC BUS 2.

The standby attitude indicator can be powered from the HOT EMER BAT BUS, while the left altimeter and airspeed indicator are powered by the AC STBY BUS. As there was no evidence that these buses were affected, it is likely that these instruments remained powered.

Battery switch

The battery switch is located on the overhead panel (Figure 3) and has three positions, ON, OFF and OVRD (override). The switch position sends a signal to both MFCs which command the position of the 3PA and 58PA contactors. When the battery switch is in the OFF position, the MFCs see an open circuit which causes the 3PA and 58PA contactors to de-energise which disconnects the emergency and main batteries from the buses in the emergency electrical network. When the battery switch is in the ON position, the MFCs see a closed circuit which causes them to energise the 3PA and 58PA contactors which results in power being supplied from both hot battery buses to the emergency electrical network. The hot battery buses are powered by DC BUS 1 and DC BUS 2 respectively, or by their respective batteries if its DC bus has lost power. The OVRD position is used in the event of a failure when it is desired to override the logic and protections in the MFC and maintain battery power to the emergency electrical network. If in the event of a fault only one MFC sees an open circuit from the battery switch, the batteries are not disconnected from the emergency electrical network.

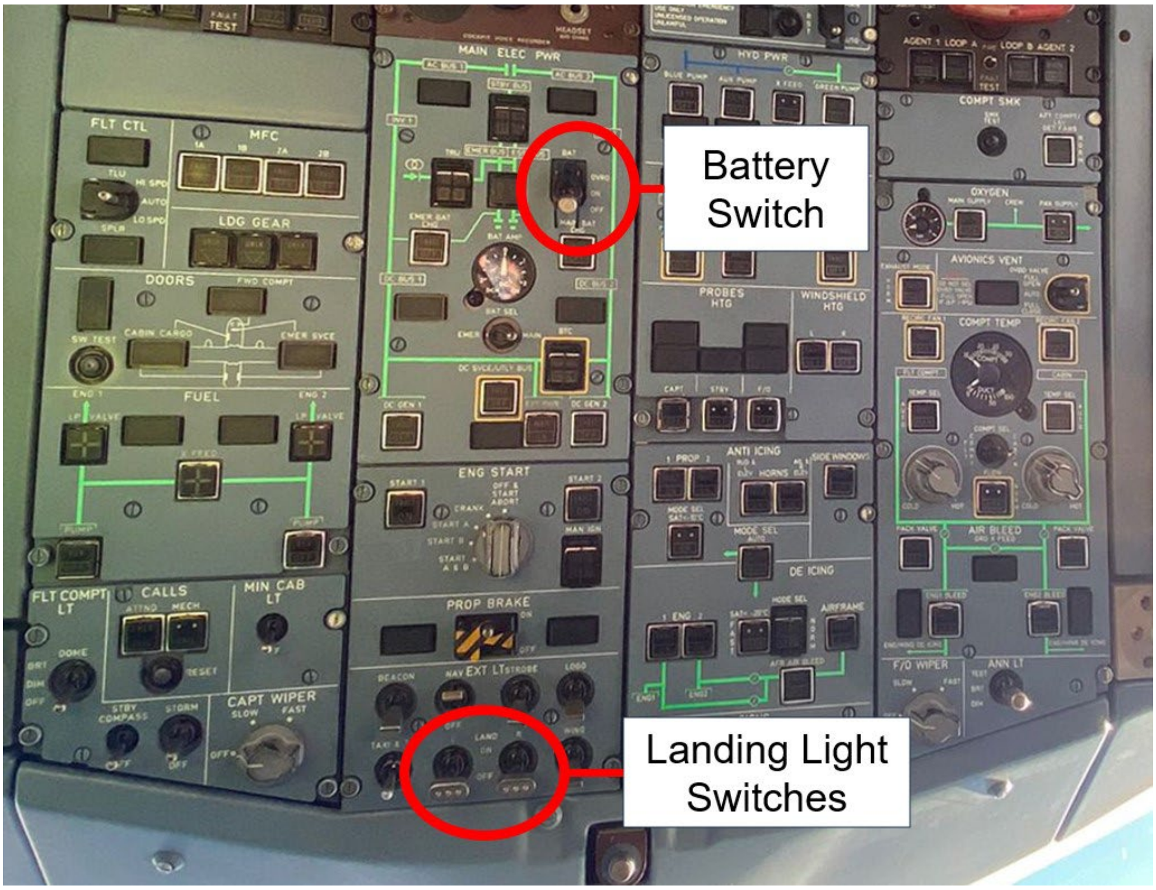

Figure 3

Location of battery switch and landing light switches on the overhead panel

Landing light switches

There are two landing lights, left and right, mounted on either side of the forward part of the main landing gear fairing. They are controlled by two switches, left and right, mounted on the forward section of the overhead panel (Figure 3). Each switch is connected to a relay; when the relay is energised by the switch using 28V DC, 115V wild AC is supplied to the respective landing light.

Contactor 1PA

The contactor in the 1PA position (part number SM150D19, Figure 4) can supply power from DC BUS 1 or DC BUS 2 directly to the emergency electrical network buses in the event that one of the following conditions occurs:

- There is a fault with the power supply from one or both batteries.
- The battery switch is inadvertently turned off.
- There is a fault with the battery switch.

The normal in-flight position of the 1PA contactor is for it to be energised and connected to DC BUS 1. If power to DC BUS 1 is lost, the contactor de-energises and switches to DC BUS 2. The 1PA contactor is located in an electrical cabinet behind the co-pilot's seat with other contactors of the same type - they make a "clunk" sound when operated.

Figure 4
1PA electrical contactor

A schematic of the contactor is shown in Figure 5. In the deenergised condition, a spring holds a plunger carrying the movable contact plate (shown in blue) against the upper main contacts B3 and B2. When the contactor is energised, by applying a 28V DC voltage between the solenoid terminals 7 and 8, the plunger moves downward against the spring force and the upper movable contact plate moves away from contacts B3 and B2, and the lower movable contact plate is pulled against contacts A1 and A2. At the same time, auxiliary contacts transition from 6/2 to 6/1, and from 9/4 to 9/5; these provide contactor state information to other systems. While the solenoid is energised there is continuity between main contacts A1 and A2.

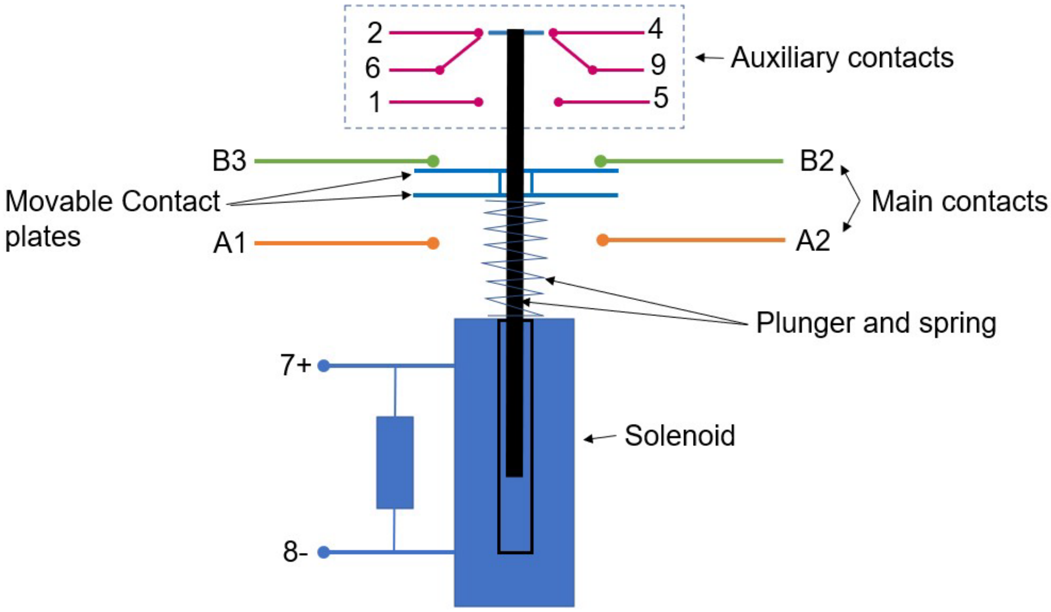

Figure 5

Contactor schematic diagram (shown de-energised)

The movable contact plates and spring assembly of the contactor, with main contacts B2 and B3 removed, are shown in Figure 6.

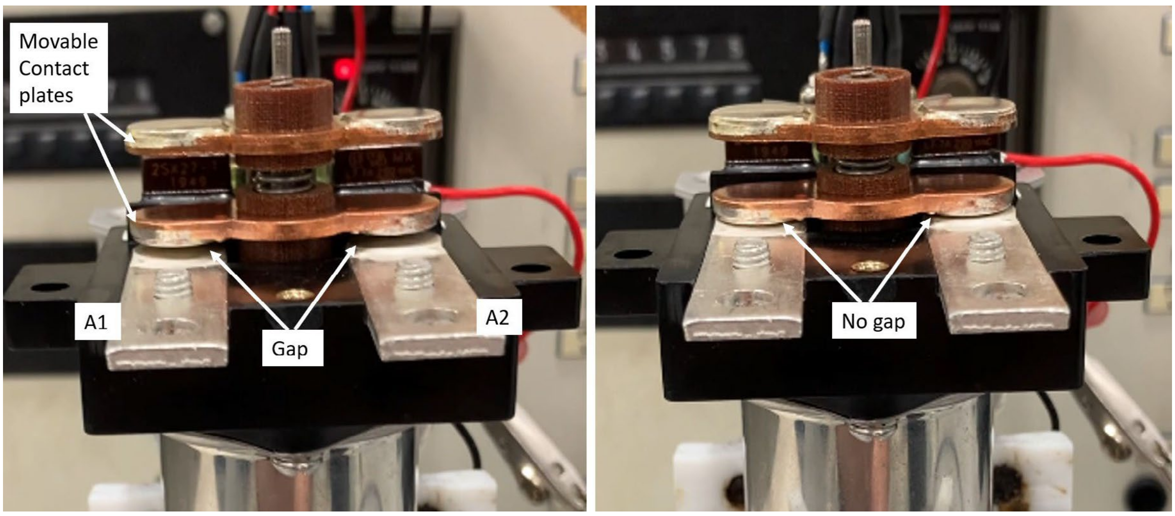

Figure 6

De-energised (A1 and A2 open) left; energised (A1 and A2 closed) right

Engine behaviour following loss of Propeller Electronic Control or Engine Electronic Control units

There is a Propeller Electronic Control (PEC) for each engine, PEC 1 and PEC 2, which commands the propeller blade angle to adjust the propeller rpm. With a power management selector on climb or cruise positions, the PECs maintain propeller rpm at 82%. In climb or cruise, if a PEC loses electrical power the respective propeller blade angle will move towards fine pitch, increasing rpm, until it is limited by the Overspeed Governor to 102.5% rpm. Any increase in rpm will cause a corresponding reduction in engine torque for a given power setting[5].

There is an Engine Electronic Control (EEC) for each engine, EEC 1 and EEC 2, which controls engine power. With the power lever in the climb power setting the EECs will be controlling fuel flow to maintain a constant engine power. If an EEC loses electrical power the fuel flow is fixed until the flight crew move the power lever and regain control of fuel flow in a manual mode. EEC 1 is powered by DC BUS 1 and EEC 2 is powered by DC BUS 2, with backup power supply for both from DC EMER BUS. If an EEC loses electrical power because its respective DC BUS and the DC EMER BUS have lost power, then the fuel control unit solenoid in the respective engine will also lose power. This configuration results in an immediate transition to manual mode, which will result in an increase in power and torque when the power lever is in the climb power setting.

Recorded information

The aircraft's flight data recorder (FDR) and cockpit voice recorder (CVR) were downloaded for analysis of the recorded information, together with ground radar data from Allanshill and Perwinnes. Relevant information from the CVR recording is included in the history of the flight.

The FDR – powered by the aircraft's AC STBY BUS[6] – was supplied data (including a clock time) from the aircraft's flight data acquisition unit (FDAU). Both the FDAU and CVR were powered by the aircraft's DC ESS BUS.

Loss of FDR and CVR recordings

The loss of power to the DC ESS BUS affected both the CVR and FDAU, so although the FDR continued to work, there was no data from the FDAU to record for the duration of the power losses.

Footnote

5 Engine power is proportional to propeller rpm multiplied by engine torque.
6 The AC STBY BUS receives power via an inverter from either DC BUS 1 or the HOT MAIN BAT BUS.

The FDAU subsequently also took a few seconds to power back up correctly during which time either too much or too little data was being streamed to the FDR.[7] This corruption of the data stream resulted in the loss of reliable data that was retrievable from the FDR recording.

The FDR recording included the ON/OFF status of the AC and DC Buses 1 and 2. The recording was every second but of each bus in turn (so a four-second sample rate per bus) and indicated that all four buses were on throughout the flight when sampled. These were the only recordings on the FDR associated with the aircraft's electrical system and so could have missed a bus status change during the four-second period between samples. The master warning was off when sampled (each second).

Duration of power losses

The clock time from the FDAU was recorded only every 4 seconds on the FDR with a resolution of 1 second, and its accuracy relied on being manually updated to the correct time. Altitude from the Mode S secondary surveillance radar (SSR) recordings were matched with FDR altitude data. This enabled these two sets of data to be aligned in time (against the GPS time of the SSR recordings)[8] before and after the power interruptions, so that an estimation of the duration of these interruptions could be made.

Figure 7 illustrates that during the flight no data was output from the FDAU, starting at time 10:18:32 hrs for a period of about 3.2 seconds. This meant that the FDAU lost power from the DC ESS BUS for 3.2 seconds. This was followed by 4 seconds of data that was found to be corrupted/unsynced on the FDR recording. The parameters plotted in the figure during these 4 seconds have been manually re-synced.

The figure also shows an extract from a spectrum analysis of the CVR's cockpit area mic (CAM) audio recording of the base frequency for propeller speed during the event. When aligned with the propeller speed from the FDAU recorded on the FDR, the figure shows that the CVR continued to function under its own temporary power for about 1.6 seconds following the power loss[9], during which the propeller speed can be heard increasing (to about 105%). Then, a discontinuity in the spectrum analysis of propeller speed suggests that the CVR was without power for about 1.6 seconds, after which the two recordings resume and are in alignment.

Footnote

[7] The FDR recording of data from the FDAU is compressed such that uncompressing it relies on specific additional data from the FDAU used by decompression software to reconstruct the flight data. The reconstruction also relies on the FDAU sending the exact amount of data each second in four-second packets of data that are not time stamped. If too little or too much data is sent in a packet, the data reconstruction becomes 'unsynced'. Unsynced data means that the position of data parameters (eg altitude, airspeed etc.) will be shifted left or right in the data stream compared to their documented position, and not knowing which bits of data are missing or extra requires educated guesswork to correct.

[8] The FDAU clock time lagged the SSR time by about 2 minutes 49 seconds.

[9] The CVR and FDR are required to continue functioning without being affected if exposed to transient power interruptions of at least 200 millisecond duration.

For the taxiing event (about 33 minutes later), the FDR and SSR altitude data could not be aligned in time as there was no variation in altitude before and after the event for a mismatch in altitude to be seen and used to align them. There was, however, a period of about 7 seconds of corrupted/unsynced data, including the FDAU clock time, recorded on the FDR. Once the data became synced, the sequence in FDAU clock time resumed where it would have been had there been no corruption in its data. The one-second resolution of the clock time means that any power loss would have been less than 1 second, otherwise a later time would have been sampled and the sequence would have been misaligned in time post the event.

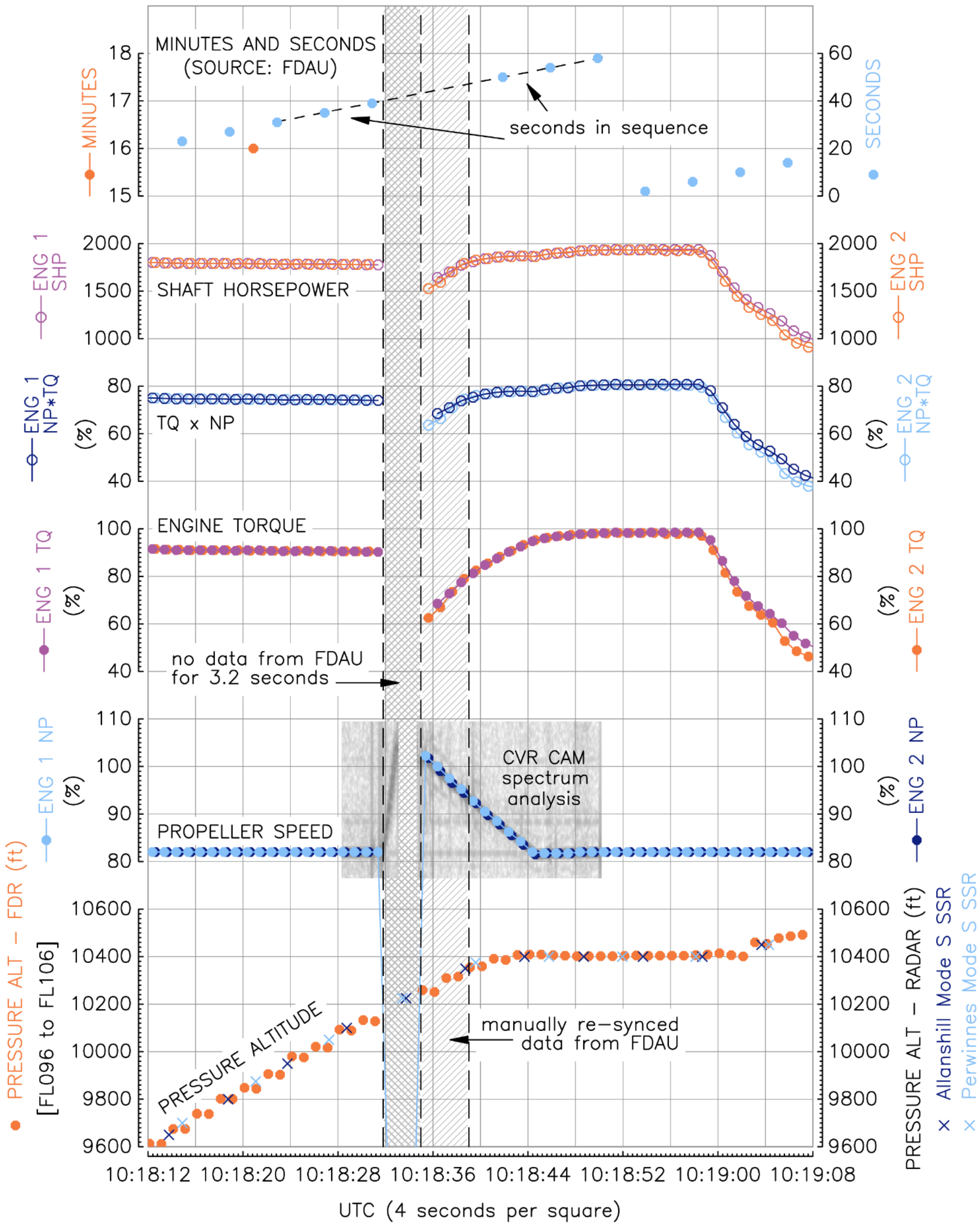

Figure 7

Recorded flight and radar data around the time of the in-flight electrical failure

Engine behaviour

When electrical power to the FDR was lost at 10:18:32 hrs, the propeller rpm was seen to increase to about 105% rpm from the CVR spectrum analysis, indicating that electrical power to the PECs was lost. When the FDR data was recovered the rpm was reducing from about 102% rpm. The rpm continued to decrease back to 82% rpm, indicating that electrical power to the PECs had been restored. The engine torque of both engines was also seen to reduce during the loss of electrical power, which was primarily a consequence of the propeller rpm increasing (for constant power the torque will decrease if a reduction in propeller angle has increased rpm). The calculated shaft horsepower parameter (based on torque and rpm) was seen to reduce by about 14% which explains the momentary deceleration felt by the flight crew.

Concurrent loss of FDR and CVR recordings

The FDR and CVR were powered by different buses to minimise the risk of both recorders not functioning due to a single electrical failure. This was a regulatory requirement at the time the aircraft type was certificated; however, the wording of the requirement did not preclude the loss of data to the FDR if the FDAU was powered by the same bus as the CVR.

Subsequent changes to the regulations in July 2019 (EASA CS-25 Amendment 23) rectified this by referencing 'recording functions', which for flight data would be the FDR and FDAU. It specifies that '*any single electrical failure that is external to the recorder does not disable both the cockpit voice recorder function and the flight data recorder function*'.

Aircraft examination

On-site aircraft examination

After the aircraft arrived on stand the engines were shut down and ground power was applied. One of the aircraft operator's maintenance engineers then initiated troubleshooting action. Both engines were started and the only fault noted was the lack of the blue hydraulic system. The landing light switches were cycled on and off multiple times, but no faults occurred. All the other light switches were also cycled, but no faults occurred. The engines were shut down and then the engineer noticed that the circuit breaker for the main power supply to the blue hydraulic pump had tripped. No other circuit breakers were found tripped.

The operator then contacted the aircraft manufacturer who provided a list of troubleshooting procedures to perform. These procedures resulted in the discovery of a fault with the 1PA contactor; when it was energised, it was not supplying power from DC BUS 1. The contactor was replaced as was the battery switch. Both landing lights were also removed, its wiring inspected and then lights re-installed.

The incident was reported to the AAIB on 30 August 2022, three days after the event. AAIB inspectors travelled to Aberdeen on 31 August to examine the aircraft with the assistance of investigators from the aircraft manufacturer. The original 1PA contactor and battery switch were re-installed and further tests and examinations were carried out which included:

- Isolation and continuity tests of the wiring related to the landing lights, battery switch and blue hydraulic system.
- Visual inspections of the battery switch and landing light switch wiring in the overhead panel.
- Checking landing light operation.
- Hydraulic system tests.
- Operational tests of the GCUs and BPCU.
- Troubleshooting procedures on the DC and AC systems.
- Tests with both engines running:
  - Engaging and disengaging DC generators.
  - Actuating landing light switches together, and individually, multiple times.
  - Repeating landing light switch tests both with and without AC wild power.

The incident fault could not be replicated, and no faults were detected beyond the fault with the 1PA contactor. It was noted that the standard test procedure that is called for when replacing the 1PA contactor does not detect a 1PA contactor that is in an intermediate position when energised. A different test procedure, that was only required to be carried out every 16,000 flight hours during a 2C check, could detect the fault. Because the 1PA contactor is not normally providing power to the electrical network, this type of fault remains undetected until an electrical failure occurs or a 2C check is carried out.

The 1PA contactor, battery switch, both landing light relays, both GCUs, the BPCU, both batteries and DC Gen 2 were removed from the aircraft for further examination. Subsequently, the aircraft operated for almost two years without a repeat of the failure event, until the aircraft was removed from service and scrapped in May 2024 for economic reasons.

MFC download

The fault messages from the MFC were downloaded but this was after ground testing had been carried out, so it could not be established which messages were from in-flight events and which were from ground testing.

DC Gen 2 wiring

When the maintenance engineers started to remove DC Gen 2, they discovered that the cable connecting DC GCU 2 to the excitation field of DC Gen 2 only had one or two strands of wire holding it to the lug on the starter-generator, instead of ten. When the engineer wiggled the cable, the remaining wires broke (Figure 8).

However, the post incident resistance measurements between DC GCU 2 and DC Gen 2 had been in the normal range, indicating that there had been good continuity prior to the disturbance, but in-flight vibrations could have affected continuity with few wires remaining.

Figure 8

Remains of wires in crimped lug from the cable connecting the DC GCU 2 to the DC Gen 2

Component examinations

Battery examinations

The main and emergency batteries were examined and underwent health checks at an approved battery overhaul examination. Both batteries were found to be healthy and after re-charging both reached 100% capacity.

Battery switch examination

The battery switch was tested and examined by the switch manufacturer under supervision of an investigator from the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) and an investigator from the aircraft manufacturer. The battery switch contains eight cells of individual switches, of which only five are used on this aircraft type. The cell which sends the battery ON command to the MFCs when the switch is turned on is the B-cell. The examination of the contact surfaces of this cell showed some loss of gold plating and some black deposits, but according to the manufacturer these were within the normal range and would not affect the operation. The measurements of voltage drop, working stroke and switching force were within specification. The deposits on the contacts were further examined by the BEA using their scanning electron microscope and compared to two other battery switches. The results showed similar deposits and similar levels of surface degradation between the switches.

Landing light relay examinations

The landing light relays were taken to an organisation that specialises in forensic electrical component examinations. Both relays had date stamps which indicated they were manufactured in 1995 so may have been fitted to the aircraft since new. The relay coil and contact resistances were measured and were within specification. The relays were not fitted with a suppression diode across the coil, which was an option on other variants of the same type of relay. Without a suppression diode a transient voltage spike occurs when a coil is de-energised, which is referred to as 'back EMF' (back electromotive force). An oscilloscope was used to measure the voltage transient that occurred when the landing light relay coils were de-energised. A peak transient voltage of 347 V was measured for one of the relays and 400 V for the other relay. A reference relay was tested which had a peak transient of 390 V. The duration of the transient was less than half a millisecond. The relays were cut open and the contact surfaces examined, and no anomalies were found.

DC Gen 2, BPCU and GCU examinations

The DC Gen 2, BPCU and both GCUs were taken to the component manufacturer for test and examination under the supervision of an investigator from the BEA and from the aircraft manufacturer. The DC Gen 2 and BPCU passed all tests with no faults found. The GCUs passed all tests except for two findings which would not have had any bearing on the incident. Because there were only one or two strands of wire connecting the GCU to DC Gen 2, tests were carried out to observe the system behaviour in the case of a brief loss of excitation field output. A loss of excitation field output of less than 9 seconds did not trigger a latched undervoltage, which meant that normal operation would have resumed if the loss of connection had lasted less than 9 seconds. It was also determined that the resistance across the lug would have needed to increase to 13 Ω to trigger an undervoltage. The aircraft manufacturer stated that the resistance of only one strand of wire would have been less than 13 Ω (between 0.5 and 1 Ω), so a disconnect would have been required to cause a loss of DC Gen 2 power.

1PA contactor examination

The 1PA contactor was sent to the component manufacturer in the USA where it was tested and examined under the supervision of an investigator from the US National Transportation Safety Board and an investigator from the aircraft manufacturer. The contactor passed the de-energised continuity tests. When the contactor was energised the movable contact plates moved downwards, but not sufficiently to make continuity with the lower stationary contacts A1 and A2. When energised, the contactor was effectively in an 'intermediate position' with the movable contact plates not making continuity with either the upper or lower stationary contacts; this meant that while energised in-flight it could not have supplied power from either DC BUS 1 or DC BUS 2 to the emergency electrical network.

Internal examination of the contactor revealed that the coil had significant black discolouration from heat; however, the coil resistance was in the normal range so according to the component manufacturer it would have provided sufficient force to move the contact plates to make adequate contact. Plunger 'stall testing' revealed that the plunger was moving normally and smoothly and the contact surfaces only had slight wear. The significant finding was from internal measurements which revealed that there was insufficient stroke of the plunger caused by a geometric upwards shift of the plunger stop by about 0.4 mm – this was preventing sufficient downwards movement when the coil was energised. A close external examination of the coil casing revealed that it was dished inwards (Figure 9). This was the only damage found that could explain the 0.4 mm upwards shift of the plunger stop.

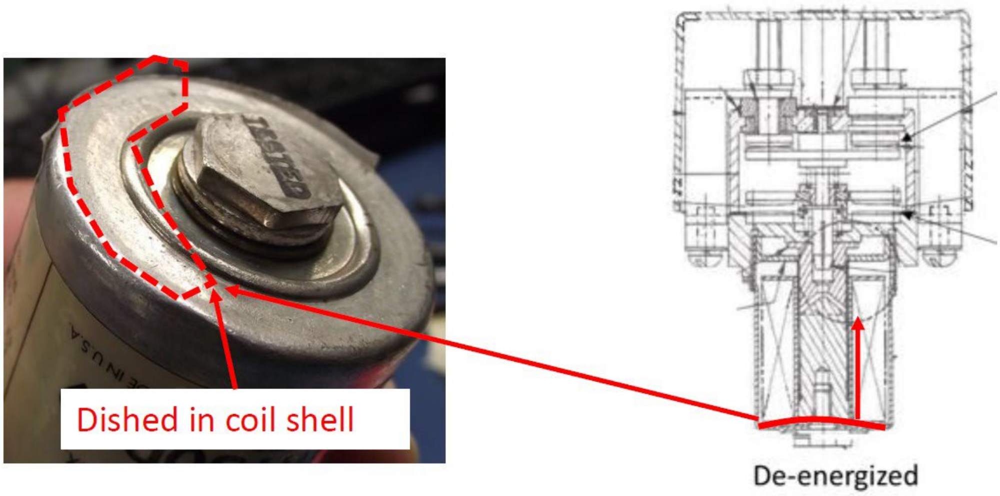

Figure 9

1PA contactor from G-LMRC showing dished in coil shell

During the course of this investigation and another AAIB investigation involving the same contactor type but with a different failure cause (AAIB investigation involving ATR 72-212A 600, EI-GPN[10]) the component manufacturer tested and examined eight other contactors. Two of these also had dished in coil shells; one was still functioning while the other had contacts that did not transfer. Three other contactors were identified that had failed in the intermediate position when energised, but these were due to a shift of the pin inside the plunger which was not the case with the G-LMRC contactor.

Until these investigations with the component manufacturer began in October 2022, the manufacturer was not aware that the contactors could fail in an intermediate position.

The component manufacturer carried out some tests to determine if the ‘dished in’ shell damage could be caused by a hammer or mallet. Tests were carried out with a 113 g (4 oz) hammer and a 170 g (6 oz) mallet. After three strikes with the hammer, only 0.1 mm of upwards core movement was measured and there was no visible damage to the coil shell. However, after one strike with the mallet, 0.3 mm of upwards core movement was measured, and after two strikes 0.55 mm was measured, which was more than the 0.4 mm seen on the contactor from G-LMRC. Similar ‘dished in’ damage of the coil shell was also observed after strikes with the mallet.

Maintenance history

The aircraft was first delivered to an aircraft operator in France in March 1996 and registered as F-GPYB. It was operated by five different airlines while under that registration. Between September 2019 and May 2020, the aircraft was in storage. In May 2020 it was delivered to the current operator and re-registered as G-LMRC. At that time, it had accumulated

Footnote

10 Link to AAIB report on EI-GPN https://www.gov.uk/aaib-reports/aaib-investigation-to-atr-72-212a-600-ei-gpn [accessed 16 February 2026].

34,117 airframe hours and 34,166 landings. At the time of the incident G-LMRC had accumulated 36,396 airframe hours and 36,724 landings. The aircraft did not have any downtime since entering operation in June 2020 other than for routine maintenance.

The operator reported that there had not been any maintenance or replacement of the 1PA contactor since it obtained the aircraft. And neither had the 7PA battery switch, landing light switches nor DC Gen 2 been replaced since the aircraft entered their service. There was no reported maintenance work on the '27VU' overhead panel in the cockpit which contains the landing light switches and battery switch. The maintenance data from the aircraft's previous operators was paper based rather than electronic so had to be searched manually. Two people searched 50 boxes of records but did not find anything that might be of relevance to this investigation.

Contactor tapping

The operator was asked if they were aware of any practices of hitting contactors during troubleshooting work. They were not aware of any such practices on the ATR fleet, but they reported that in the past they had electrical system failures on the Saab 340 fleet which could sometimes be resolved by tapping the contactors, which were called Power Distribution Units (PDUs). This practice was developed after consultation with the aircraft manufacturer and resulted in the operator publishing a Technical Instruction which stated that '*PDU tapping is an acceptable procedure for trouble shooting, but never a final rectification of a problem. Whenever time allows, carry out the replacement of a faulty PDU.*'. This was published in 2002, but the Technical Instruction was removed in 2021 after a review comparing it to the maintenance manual which did not contain such a procedure.

Aircraft manufacturer tests

One of the theories considered as a cause of the failure was that a bonding or grounding issue could have sent a false open circuit to the MFCs indicating that the battery switch was off when it was not. The ground reference used by the landing light switches and the battery switch are located in close proximity. Electrical ground and bonding tests were carried out by the aircraft manufacturer on an ATR 72-600, followed by an ATR 42-500. No issues were uncovered. These tests were then repeated by the aircraft operator on G-LMRC, and no issues were found.

The aircraft manufacturer also conducted some flights to measure the temperatures in the electrical cabinet where the 1PA contactor was located. During five flights on an ATR 72-600[11] in March 2023 temperature stickers were applied next to the 1PA and 95PA contactors which are close together. The maximum temperature measured was between 54°C and 60°C. The contactors are rated to operate in ambient temperature of up to 70°C.

The aircraft manufacturer carried out ground tests on an ATR 42-500 which showed that failing PEC 2 and pack valve No 2 resulted in an initial power and torque decrease on engine 2, while the propeller rpm increased. In one case the propeller rpm momentarily

Footnote

[11] The electrical cabinet and contactor configuration on the 72-600 is essentially the same as on the 42-500.

increased to 104% before stabilising at the limit of 102.5% rpm. Tests were also carried out to simulate the failure of the PEC, pack valve closure, EEC and fuel control solenoid on engine 2 (to simulate loss of DC BUS 2 and the DC EMER BUS), and this resulted in a significant power and torque increase.

Previous similar electrical failure events

The aircraft manufacturer was asked if they were aware of any similar electrical failure events having occurred on pre 600 series[12] ATR 42 or ATR 72 (stretched variant) aircraft before. The 600 series of aircraft have different avionics to pre 600 series aircraft such as G-LMRC. Their database revealed the following three similar events (Table 2), but none of them were the subject of an internal safety investigation or a state safety investigation so only the following limited information was available to them. The events involved two different operators and not the operator of G-LMRC.

SN	Aircraft Type	Date	Reported failures	Occurrence trigger	Investigation
720	72-500	14/02/2018	Multiple occasions of the captain's EADI and EHSI screens switching off momentarily.	Landing lights or anti-ice set to OFF	The aircraft later had an accident involving an unrelated engine failure resulting in the aircraft being scrapped. This ended the communications that were in progress between the manufacturer and the operator.
734	72-500	29/01/2019	During descent the co-pilot's EADI, EHSI and ADU switched off momentarily. On another day, while on the ground, the captain's EADI and EHSI switched off momentarily.	No particular action	The operator reported that replacing the 7PA battery switch resolved the issue.
745	72-500	05/11/2018	Multiple occasions of momentary loss of EADI, EHSI and ADU.	Landing lights set to OFF or Captain's wiper turned to OFF or Left landing light turned to OFF	The operator reported that replacing the 7PA battery switch resolved the issue.

Table 2

Other similar electrical failure events reported to the aircraft manufacturer

Footnote

12 Pre 600 series aircraft are also known as 'pre MOD 05948' aircraft. MOD 05948 installed a new "Glass cockpit" avionics suite.

Aircraft manufacturer information

The aircraft manufacturer stated that, with the 1PA contactor failed in an intermediate position, the only single additional failure that could cause a loss of all three buses on the emergency electrical network was both MFCs sensing an open circuit (greater than 1,000 Ω resistance[13]) from the 7PA battery switch. This failure mode had been seen before on the 600 series ATR aircraft where erosion of the B-cell contacts in the battery switch resulted in a very high resistance, causing the MFCs to incorrectly sense the battery switch had been turned off. However, the battery switch wiring on the 600 series aircraft was different to that on the 500 series aircraft, resulting in higher currents being passed through the B-cell contacts than on the 500 series aircraft, making the contacts more likely to erode[14].

The aircraft manufacturer provided two other scenarios that could lead to a power loss of the emergency electrical network with the 1PA contactor in an intermediate position. One is for both the 58PA and 3PA contactors to de-energise at the same time, and the other was a simultaneous failure of both MFCs at the same time. They considered both scenarios to be improbable, and in the G-LMRC case there were no faults identified with these contactors or the MFCs.

The aircraft manufacturer stated that there was no known common failure mode that would cause the simultaneous loss of the emergency electrical network and DC BUS 2. However, they considered that the damaged wire connected to DC Gen 2 could have been the cause of a voltage drop or a momentary loss of DC BUS 2 if the remaining wire strands had lost contact with the lug.

The landing light relays generated a back EMF of 347 to 400 V when the landing light switches were turned off. The aircraft manufacturer was asked if this back EMF could trigger interference or some other issue in the wiring of the nearby battery switch. The aircraft manufacturer stated that because the loss of power lasted about 3 seconds, this could not have been caused by a back EMF that lasted about half a millisecond.

During certification the aircraft manufacturer had considered failure modes of the 1PA contactor where it failed in either the rest or energised positions, but they had not considered it failing in an intermediate position when energised, as they were not aware of this potential failure mode. The contactor manufacturer stated that they had also not been aware of this failure mode until investigations began in 2022.

The aircraft manufacturer stated that they do not recommend tapping or hitting contactors during troubleshooting, and they had not been aware of this practice prior to this investigation.

Foonote

13 The aircraft manufacturer carried out tests which determined that exceeding 1,000 Ω was the threshold for the MFCs to trigger the logic for the battery switch being off.

14 To address this failure mode, the battery switch wiring on the 600 series aircraft was subsequently modified, and the battery switches were replaced at the same time. An inspection of the 1PA contactor was also introduced.

Safety actions

On 21 October 2022 the aircraft manufacturer published an *'Airworthiness Operator Message'* (AOM: 2022/04 Issue 1) which provided instructions for an operational test of the 1PA contactor and recommended that operators perform this test within 60 days and provide the aircraft manufacturer with feedback within 10 days after having completed the test. The AOM applied to all pre-600 series ATR 42 and ATR 72 aircraft but was not mandated by an accompanying Airworthiness Directive (AD).

The aircraft manufacturer reported that out of 659 aircraft affected by the AOM, 245 aircraft were tested (37%). Out of these 240 had no findings, and 5 found the 1PA contactor had failed in the rest position. No 1PA contactors were identified that had failed in the intermediate position like on G-LMRC.

In September 2023 the aircraft manufacturer published an amended AOM 2022/04 Issue 3, which was accompanied by an EASA AD (AD 2023-0181, issued 27 October 2023[15]) that required aircraft operators to test the 1PA contactor within 60 days and, thereafter, at intervals not to exceed 1,000 flight hours.

The aircraft manufacturer stated that their Flight Safety Department publishes summaries of investigation final reports concerning their aircraft which contain lessons learnt from investigations and best practices to prevent recurrence, and that they plan to provide the key aspects of this investigation.

The aircraft operator implemented the action required by the aircraft manufacturer's AOM and the EASA AD. Although the specific contactor involved in this incident had not been purchased by the operator, they updated their purchasing policy to only procure new contactors.

Analysis

Conduct of the flight

The aircraft suffered a severe electrical failure soon after takeoff, while in the climb to its cruising altitude. The failure seems to have been initiated when the co-pilot selected the landing lights OFF, in accordance with the normal operating procedures. While this failure was a surprise to the crew, the co-pilot thought that turning the lights OFF may have been the initiator of the event, so he reversed the action. The power to the buses was restored with the loss of power lasting about 3 seconds. Once most of the lost services had been restored the crew then handled the remaining faults appropriately and landed without further event.

Footnote

15 https://ad.easa.europa.eu/ad/2023-0181 [accessed 16 February 2026].

During the brief period when the flying displays were blank the aircraft was in VMC and it was daytime, so the commander was able to control the aircraft without the need to reference the flight instruments. Had the failure not rectified itself, and the aircraft been in IMC, or it had been night, the crew would have had an increase in their workload as they would have been flying the aircraft with reference to only the standby instruments. This is a scenario the commander had not trained for in the simulator, and there was no specific requirement to do so when obtaining a new type rating.

Cause of the electrical failure

There was clear evidence from the recorded data that electrical power had been lost from the DC STBY BUS, DC EMER BUS and DC ESS BUS (the emergency electrical network). There was no data that could show if DC BUS 2 had lost power, but the flight crew's evidence that the co-pilot's EADI and EHSI went blank was compelling, which supported the theory of a momentary loss of power from DC BUS 2. It was also supported by the cabin crew's reported loss of cabin lights – a loss of ceiling lights would be consistent with a loss of DC BUS 2. The contradictory evidence was the behaviour of engine 2. If DC BUS 2 had lost power, then EEC 2 and the fuel control solenoid on engine 2 would have lost power, which would have caused a reversion to manual mode and both engine power and torque to increase. However, engine power and torque were seen to decrease. One possible explanation for this was that DC BUS 2 suffered from an undervoltage condition rather than a complete loss of power. In an undervoltage condition some components connected to the bus can be affected while others are not, particularly if the power interrupt is very brief. A power interrupt on DC BUS 2 could have been shorter than the 3.2 second period that was seen in the data for the DC ESS BUS.

The behaviour of engine 1 was similar to engine 2 which supported either DC BUS 1 not having lost power, or it suffering a similar undervoltage condition to DC BUS 2. To extinguish all the cabin lights (lateral and ceiling) would have required a loss of DC BUS 1, but there was no other evidence to support a loss of DC BUS 1.

Loss of the emergency electrical network

With contactor 1PA failed in an intermediate position, the three buses on the emergency electrical network would have lost power if contactors 58PA and 3PA had de-energised, resulting in the three buses being connected to the 1PA contactor which could not supply power (Figure 2). The 58PA and 3PA contactors will both de-energise if both MFCs sense that the 7PA battery switch has been turned off. The battery switch is not near the landing light switches (Figure 3), and although it is possible that the co-pilot inadvertently turned off the battery switch instead of the landing light switches, this would not explain why the symptoms reoccurred on the ground when the commander turned off the landing light switches. It is unlikely that both the commander and co-pilot inadvertently turned off the battery switch instead of the landing light switches on separate occasions during the same flight.

If the battery switch was not moved, then a fault within the battery switch could trigger the MFCs to sense it had been moved off. The examination of the battery switch revealed that the B-cell contacts, which when closed send a battery ON command to the MFCs, showed some loss of gold plating and some black deposits. If the resistance across these contacts had been excessive then the MFCs would sense an open circuit and de-energise the 58PA and 3PA contactors. However, the voltage drop across these contacts, working stroke and switching force were within specification. And further examinations of the contact surfaces in a scanning electron microscope did not show anything unusual with the deposits.

The investigation then considered if a grounding issue could have sent a false open circuit to the MFCs. The ground reference used by the landing light switches and the battery switch are in close proximity, and it was the actuation of the landing light switches which triggered the failures in both the airborne and on-ground events. However, grounding and bonding tests on G-LMRC did not reveal any issues in that area.

The examinations of the landing light relays revealed that when they were de-energised (i.e. landing light switches turned off) there was a back EMF with high peak transient voltages. Back EMF can cause interference on other wires, but a reference relay had the same level of back EMF suggesting it was normal for that device, and according to the aircraft manufacturer the duration of the peak transient was too short to cause a 3 second loss of power.

Other failure causes, apart from a de-energisation of contactors 58PA and 3PA, were considered but these all involved multiple independent failures occurring simultaneously which was considered very unlikely. Although the cause of the loss of the emergency electrical network could not be determined, there were no further reoccurrences of the failure mode after the battery switch, landing light relays and 1PA contactor were replaced on G-LMRC. This suggests that the battery switch and/or landing light relays may have had a part to play; however, a functioning 1PA contactor could have masked a reoccurrence of the underlying fault by supplying backup power.

Two previous events involving unexplained loss of EADI and EHSI screens (Table 2) were related to turning the landing light switches off. And in two of the three previous screen loss events, replacing the 7PA battery switch reportedly resolved the issues.

Loss of DC BUS 2

A failure of the emergency electrical network cannot explain a loss of the co-pilot's EADI and EHSI because they receive power solely from DC BUS 2. No single-failure theory could be developed that would explain a simultaneous loss of the emergency electrical network and DC BUS 2. However, there was a wiring issue with DC Gen 2 which supplies DC BUS 2. The cable connecting DC GCU 2 to the excitation field of DC Gen 2 only had one or two strands of wire holding it to the lug on the starter-generator, instead of ten. If the resistance across this lug had increased to 13 Ω then this would have triggered an undervoltage condition on DC BUS 2 which could explain the loss of the co-pilot's screens. However, resistance measurements of a single strand of wire were between 0.5 and 1 Ω. So, there would have needed to have been a momentary complete disconnect of the remaining two wire strands from the lug, which might be possible to occur as a result of vibration. But it is unlikely that this would have occurred both at the moment the landing light switches were turned off in the air and then again when the switches were turned off on the ground. There is probably some other, not yet conceived, explanation for the simultaneous loss of the co-pilot's EADI and EHSI screens and the loss of the emergency electrical network.

Cause of the 1PA contactor failure

The only failure that could be identified from physical examinations and testing was the failure of contactor 1PA. When this contactor was energised the contacts did not move sufficiently to close the circuit of the lower contacts. It was effectively stuck in an intermediate position while energised and therefore could not supply backup power from DC BUS 1 to the emergency electrical network. The aircraft system was not designed to detect such a fault, as this type of fault had not been envisaged by either the contactor manufacturer or the aircraft manufacturer. The only test, at the time, that could have detected this fault was a test that was only carried out during a 2C check every 16,000 flight hours. This meant that the fault could have been dormant for a long time.

The contactor failure was caused by the fact that the plunger stop had shifted upwards by about 0.4 mm, preventing sufficient downwards stroke of the contacts when the coil was energised. This upwards shift was most likely a consequence of impact damage to the coil casing which was seen to be dished in. Testing on another contactor revealed that striking the top of the coil casing with a mallet could produce similar dished-in damage and a similar upwards shift in the plunger stop. The cause of this damage could not be determined but it is possible that the contactor had been dropped or possibly hit with a mallet during troubleshooting. The aircraft operator's maintenance records did not reveal any issues with this contactor so if it had been hit, it may have been by a previous operator.

It is possible that the damage occurred to the contactor some years ago, and that it was only the subsequent normal wear of the contact surfaces that opened the gap sufficiently to result in an open circuit.

Hitting contactors is not a technique recommended by the contactor manufacturer nor the aircraft manufacturer, but the AAIB had obtained anecdotal evidence that this had been done before in the aviation industry to release a 'sticky' contactor. It was also a technique that had been recommended to the aircraft operator by a different aircraft manufacturer, albeit with certain caveats.

Due to the importance of the 1PA contactor in providing backup electrical power to the emergency electrical network, EASA published an AD to require operators to test this contactor and then repeat the test every 1,000 flying hours.

Safety Recommendation

The failure of the 1PA contactor was a contributory factor to the loss of the emergency electrical network, but despite extensive testing the cause of the loss of the emergency electrical network and potentially also DC BUS 2 could not be determined. The consequence of such a failure, were it to last for more than 3 seconds and occur at night or in IMC conditions, would be severe for a flight crew. However, the standby instruments would be available.

The failures on G-LMRC were not unique. There have been three previous similar events reported to the aircraft manufacturer, but these were not fully investigated. Given the potential seriousness of a repeat failure, the aircraft manufacturer should continue to investigate possible causes; therefore, the following safety recommendation is made:

Safety Recommendation 2026-001:

It is recommended that the aircraft manufacturer ATR continues to investigate the possible causes of electrical failures that result in the loss of both the commander's and co-pilot's primary flight displays on ATR 42-500 and 72-500 aircraft and develop safety action to address them.

Conclusion

There was clear evidence from the recorded data that electrical power had been lost from the DC STBY BUS, DC EMER BUS and DC ESS BUS (the emergency electrical network) for about 3 seconds. There was additional evidence from the flight crew and cabin crew reports that DC BUS 2 had lost power or suffered from an undervoltage condition for about 3 seconds. The only failure that could be identified from physical examinations and testing was the failure of contactor 1PA which was stuck in an intermediate position when energised. This meant that it could not supply backup power to the emergency electrical network, so it was a contributory factor but not a cause of the loss of power.

A single failure involving the battery switch or the wiring between the battery switch, the MFCs, and ground, could explain a loss of the emergency electrical network but no such faults were found.

The failure occurred twice, in the air and then subsequently on the ground, when the landing light switches were turned off, but no faults with the landing light relays or lights were found. The aircraft manufacturer discounted the high back EMF from the landing light relays as a potential cause due to it being too short in duration. No link between activation of the landing light switches and a loss of power from DC BUS 2 could be identified.

Two previous events on ATR 72-500 aircraft involving unexplained loss of flight display screens were related to turning the landing light switches off. And in two of the three previous screen loss events, replacing the 7PA battery switch reportedly resolved the issues.

Although the cause of the loss of the emergency electrical network on G-LMRC could not be determined, there were no further reoccurrences of the failure mode after the battery switch, landing light relays and 1PA contactor were replaced. This suggests that the battery switch and/or landing light relays may have had a part to play; however, a functioning 1PA contactor could have masked a reoccurrence of the underlying fault by supplying backup power.

Given the potential seriousness of a repeat failure, were it to last for more than 3 seconds and occur at night or in IMC conditions, the AAIB has made a safety recommendation to the aircraft manufacturer to continue investigating possible causes of the electrical failure.

The aircraft manufacturer and EASA have taken safety action to require testing and replacement of 1PA contactors that have failed.

Safety actions taken

- On 21 October 2022 the aircraft manufacturer published an *'Airworthiness Operator Message'* (AOM: 2022/04 Issue 1) which provided instructions for an operational test of the 1PA contactor and recommended that operators perform this test within 60 days and provide the aircraft manufacturer with feedback within 10 days after having completed the test. The AOM applied to all pre-600 series ATR 42 and ATR 72 aircraft but was not mandated by an accompanying Airworthiness Directive (AD).
- In September 2023 the aircraft manufacturer published an amended AOM 2022/04 Issue 3, which was accompanied by an EASA AD (AD 2023-0181, issued 27 October 2023[16]) that required aircraft operators to test the 1PA contactor within 60 days and, thereafter, at intervals not to exceed 1,000 flight hours.
- The aircraft operator implemented the action required by the aircraft manufacturer's AOM and the EASA AD. Although the specific contactor involved in this incident had not been purchased by the operator, they updated their purchasing policy to only procure new contactors.

Safety Recommendations

Safety Recommendation 2026-001:

It is recommended that the aircraft manufacturer ATR continues to investigate the possible causes of electrical failures that result in the loss of both the commander's and co-pilot's primary flight displays on ATR 42-500 and 72-500 aircraft and develop safety action to address them.

Published: 5 March 2026.

Footnote

16 https://ad.easa.europa.eu/ad/2023-0181 [accessed 16 February 2026].

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:	Britten-Norman Islander, VP-MNI
No & Type of Engines:	2 Lycoming O-540-EC45 piston engines
Year of Manufacture:	1971 (Serial no: BN2A-27)
Date & Time (UTC):	16 August 2025 at 1805 hrs
Location:	John A. Osborne Airport, Montserrat
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left aircraft mainwheel brake calliper damaged. Two airfield lights at Runway 10 threshold damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	31 years
Commander's Flying Experience:	1,868 hours (of which 49 were on type, 640 on class) Last 90 days - 49 hours Last 28 days - 36 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft struck runway lights at the Runway 10 threshold during a go-around from Runway 28. The left mainwheel brake calliper was damaged. The aircraft diverted to Antigua, where it landed safely. None of those on board were injured.

History of the flight

Due to challenging operating environment at Montserrat Airport, the Governor had issued special instructions for Air Operator Certificate (AOC) operators. Among these was a requirement to establish a crew training programme for all PIC to be completed before they operated from Montserrat. During his scheduled operations on 15 August 2025 the incident pilot was joined by a company training captain who flew with him on two approaches and landings on Runway 28 at Montserrat to satisfy the training requirement.

On 16 August 2025, the incident pilot was scheduled to operate two sectors from Montserrat to Antigua and return. Another BN2 Islander, which took off just ahead of the incident aircraft, made an airborne weather report cautioning windshear, turbulence and strong up and down drafts on the climb out path. The incident pilot recalled that the wind was between 10 and 15 kt and recalled his departure as being without incident. The pilot flew to Antigua without incident though he stated that on the approach, due to a strong crosswind, he "required full left aileron and right rudder all the way to touchdown."

Following the turnaround in Antigua the pilot flew back to Montserrat. Runway 28 was in use and ATC passed a wind of 240° at 7 kt, occasionally 240° at 14 kt gusting 26 kt. Another BN2 Islander ahead passed warnings of windshear, up and down drafts and turbulence on the approach path. The pilot described conditions on approach into Montserrat as "very bumpy and turbulent". He described strong right drift from 7 nm out and stated that he used full left aileron and right rudder along with right rudder trim to track the runway centreline. The pilot recalled that, despite these control inputs, the aircraft was still drifting right and he decided to go around as the approach was unstable.

On the second approach to Montserrat the pilot described similar conditions. The pilot however, continued this approach and stated that he "was in a position to execute a good landing within the touchdown zone". The pilot recalled that within a few feet of touchdown the aircraft was affected by a gust which caused the aircraft to float much further along the runway than he anticipated. The pilot believed that the aircraft did not touch down but that as he passed Taxiway Alpha (Figure 1) he initiated a go-around to avoid a long landing. The pilot carried out the go-around actions, applying full power and retracting the flaps from full to the take off setting. He stated, "I attempted to stay in ground effect for as long as possible to ensure full runway utilisation and attain maximum forward speed*".*

In a video taken by the Airfield Fire and Rescue Service (AFRS), the aircraft was seen to touch down before Taxiway Alpha but bounce and then remain airborne until after Taxiway Alpha before touching down a second time with approximately 200 m of runway remaining. The pilot initially felt the aircraft had not touched down, and stated "the end of the runway was fast approaching and I attempted to lift off. I vividly remember my airspeed reading 75/80 kt. We should easily have rotated at the speed however, the plane would not lift off the runway.*"* The aircraft crossed the Runway 10 threshold striking two lights and was then seen to sink below the elevation of the runway before recovering.

The pilot then decided to divert to Antigua. When doing the landing checks prior to the approach there, he noticed there was no pressure on the left mainwheel brake. He looked through the window and saw the left brake calliper hanging from the hydraulic hose, and so he informed ATC that he would have no brakes during landing. The aircraft landed and decelerated safely, and the pilot was able to exit the runway using differential thrust. No one on board was injured.

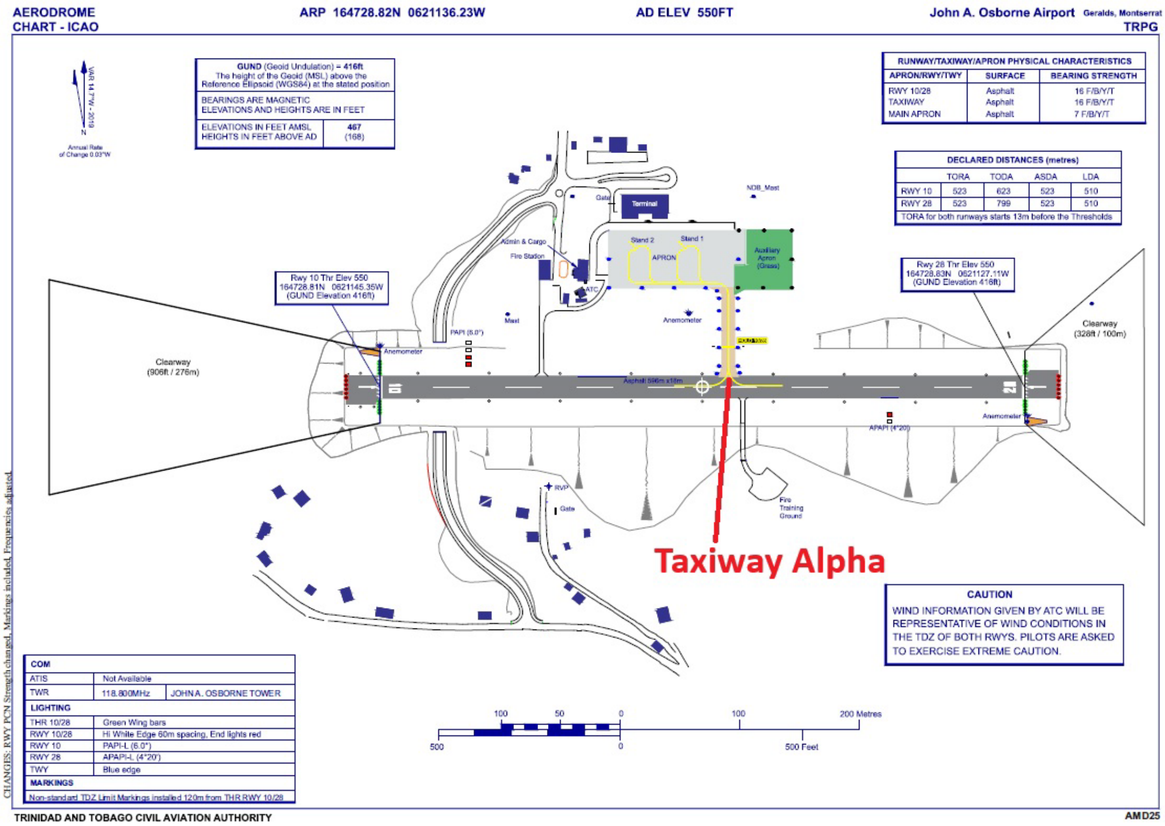

Figure 1
Montserrat Airport Chart

Meteorology

The TAF for Montserrat issued at 1137 hrs gave a general wind from 210° at 9 kt. Over the period of the incident the forecast also indicated temporary conditions of wind from 210° at 15 kt, gusting 25 kt, visibility reducing to 4,000 m in thunderstorms and FEW CB at 1,400 ft aal. The METAR issued at 1800 hrs reported a wind of 270° at 12 kt, visibility greater than 10 km and FEW clouds at 1,900 ft aal. The full TAF and METAR are at Figure 2.

TAF TRPG 161137Z 1612/1712 21009KT 9999 SCT018 SCT036 TEMPO 1612/1624 21015G25KT 4000 TSRA FEW012CB BKN014 BKN036

METAR TRPG 161800Z 27012KT 9999 FEW019 SCT040 27/23 Q1010=

Figure 2
Montserrat TAF and METAR

Personnel

The pilot stated that he had 49 hours on type all of which were as PIC. The operator's training manual specifies the following for conversion to the BN2A:

> *'A Conversion/Differences course will include:*
>
> *a. Ground training and checking including aeroplane systems, normal and abnormal and emergency procedures including Multi-Crew Co-operation training where appropriate.*
>
> *b. Contents of the Operations manual, self briefing and a minimum of 2 hours dual instruction plus test.'*

The pilot's licence was correctly endorsed with a Multi-Engine Piston (MEP) Class Rating. The BN2A falls within the MEP Class and no specific Type Rating is required.

The pilot had an FAA Licence and a Certificate of Validation for Montserrat. He therefore completed his logbook as per the requirements of FAR Part 61. The regulator was satisfied that the pilot had recorded his flight time appropriately.

Organisational information

Crosswind Operations

The company operations manual contained the following guidance for operating with a crosswind:

> *'The aeroplane is capable of taking off and landing with a 30 kts crosswind. On a contaminated runway the take off and landing is limited to 15 kts crosswind.*
>
> ***Note:** Runways reported as "water patches" or "Flooded" should be considered to be contaminated.*
>
> ***Note:** Where conditions permit this operation is facilitated by setting flaps to T.O. or UP and increasing the airspeed accordingly.*
>
> *For landing in strong crosswinds, the wing down sideslipping technique is preferred.'*

Although the note suggested using flap at T.O. or UP to facilitate handling in a crosswind, the Approved Flight Manual (AFM) for the BN2A contains no performance adjustments for landing in those configurations. The operator did not recommend such configurations to its crews.

The crosswind at Montserrat was within the prescribed operating limits for the aircraft.

Pilot Experience Requirements

The company operational manual detailed a minimum experience level for pilots operating to Montserrat as follows:

> ***‘Minimum qualifications and experience***
>
> 1. *CPL or ATPL*
> 2. *Minimum total time of 500 hours*
> 3. *Minimum of 100 hours on type.’*

The pilot had a Commercial Pilot's Licence (CPL) but only 49 hours on type. He had 640 hours on MEP aircraft.

Note: For commercial flights, the Governor’s instructions required a pilot to have a minimum of 100 hours PIC on the type or class of aeroplane being flown.

Stabilised Approach Criteria

The operator’s manual defined the following as stabilised approach criteria to be achieved by 500 ft aal in VMC:

> *‘An approach is stabilised when all of the following criteria are met:*
>
> - *The aircraft is on the correct flight path.*
> - *Only small changes in heading/pitch are necessary to maintain the correct flight path.*
> - *The airspeed is not more than VREF + 20kts indicated speed and not less than VREF.*
> - *The aircraft is in the correct landing configuration.*
> - *Sink rate is not greater than 1000 feet/minute; if an approach requires a sink rate greater than 1000 feet/minute a special briefing should be conducted.*
> - *Power setting is appropriate for the aircraft configuration and is not below the minimum power for the approach as defined by the operating manual.*
> - *All briefings and checklists have been conducted.’*

No reference was made in these criteria to persistent full scale control deflections as described by the pilot for his approach.

Windshear

The operator's manual cautioned that: '*The greatest danger to aircraft of windshear is on Takeoff, initial climb, Approach to landing and Landing.*' In the event of windshear conditions being encountered the operator's manual stated:

> '*If windshear is encountered after lift off or on approach immediately take recovery action. If on approach DO NOT ATTEMPT TO LAND.*'

If windshear conditions are suspected the manual also required stabilised approach criteria to be met by 1,000 ft aal rather than 500 ft.

Analysis

The possibility of challenging, inconsistent and unpredictable meteorological conditions was acknowledged by the Governor's Instructions and the training/experience requirements in the operator's manuals. The pilot had sufficient experience of MEP aircraft and had a valid Montserrat check in accordance with the Governor's Instructions. The company training requirement was 100 hours on type, but with 49 hours on the BN2A the pilot did not satisfy this requirement. However, the intent was that the manual should reflect the Governor's Instructions requirement of 100 hours on the type or class.

Just before the incident pilot's initial departure from Montserrat, the pilot of another departing aircraft gave an airborne weather report of windshear conditions The VP-MNI pilot got airborne without incident and flew to Antigua. He described the approach as more '*turbulent than normal with a strong crosswind that required full left aileron and right rudder all the way to touch down.*' With full left roll control applied the aircraft would have no ability to correct any additional right roll and so full control of the aircraft was compromised. The aircraft landed without incident, however.

On return to Montserrat the pilot approached Runway 28 and ATC passed a wind of 240° at 7 kt, occasionally 240° at 14 kt gusting 26 kt. This would indicate a maximum crosswind of approximately 18 kt, well within the limit for the aircraft. An aircraft ahead passed warning of windshear, up and downdrafts and turbulence on the approach. Again, the pilot used full left aileron with right rudder to track the centreline but even with these control inputs the aircraft was still drifting to the right and the pilot decided the approach was unstable and executed a go-around. Full control of the aircraft was again compromised.

On the second approach the pilot encountered the same conditions but felt he was in a good position to execute a landing. His decision to land may have resulted from a continuation bias, leading him to continue the approach despite emergent cues suggesting it should have been rejected.

When it became clear that the aircraft would make a long landing the pilot initiated a go-around. It is probable that the aircraft's performance was affected by the uncertain wind conditions/down drafts and it did not climb as the pilot expected. The aircraft overran the surface striking two lights at the Runway 10 threshold and sustaining damage to the left mainwheel brakes. After passing the Runway 10 threshold the aircraft sank below the elevation of the airfield before recovering to a climb. The subsequent diversion to Antigua was uneventful.

Conclusion

The aircraft made an approach in challenging wind conditions including turbulence, windshear and downdrafts. Influenced by a gust late in the approach the aircraft "floated" along the runway and the pilot initiated a go-around to avoid a long landing. Performance was compromised by the conditions and the go-around performance expected by the pilot was not achieved. The aircraft struck lights at the Runway 10 threshold and sustained damage to the left mainwheel brakes. None of those aboard were injured.

Safety actions

The operator took the following Safety Action:

- The references to 'type' in the operator's manuals were replaced with 'class.'
- The operator amended its operations manual guidance for crosswind landing to emphasise use of the crab method, thus removing the need for sustained roll control input to track the runway centreline.

Accident

Aircraft Type and Registration:	CZAW Sportcruiser, G-DVOY
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2010 (Serial no: LAA 338-14976)
Date & Time (UTC):	11 July 2025 at 1543 hrs
Location:	Firs Farm Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Substantial
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	1,250 hours (of which 650 were on type) Last 90 days - 90 hours Last 28 days - 16 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot backtracked along Runway 05 for departure, after having completed his engine power checks, and chose to keep the canopy open due to the hot weather. He then carried out his pre-takeoff checks, which included securing all hatches and harnesses. Shortly after takeoff from Firs Farm, at approximately 500 ft during flap retraction, the canopy lifted by one to two inches. As he reached to close it, the canopy suddenly opened almost fully, causing the aircraft to pitch down toward the ground.

The pilot was able to grab the left gas strut and pull the canopy down until it was open by about a foot. However, with one hand holding the canopy, he could not release the control stick to reduce power or fully retract the flaps. Consequently, the aircraft continued to descend and struck the ground.

The pilot was uninjured and managed to switch off the ignition and the aircraft's electrical system but was unable to turn off the fuel due to airframe damage before exiting the cockpit. There was no fire, but the aircraft sustained substantial damage.

The pilot attributed the accident to his failure to fully latch the canopy in his pre-takeoff checks but commented that an iPad mounted to the canopy may have acted as a sail, contributing to the canopy's sudden opening.

Accident

Aircraft Type and Registration:	Jodel D112, G-BEZZ	
No & Type of Engines:	1 Continental Motors Corp A65-8F piston engine	
Year of Manufacture:	1956 (Serial no: 397)	
Date & Time (UTC):	29 April 2025 at 1607 hrs	
Location:	Manchester Barton Aerodrome	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Serious)	Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	165 hours (of which 88 were on type) Last 90 days - 3 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During a return flight from East Kirkby Airfield to Manchester Barton Aerodrome (Barton) the aircraft performed two go-arounds. On the second, the engine stopped just after the go-around was initiated. The aircraft dropped a wing and struck the ground within the perimeter of the airfield.

It was suspected that the engine failed due to fuel starvation, but the investigation did not establish if this was because the aircraft ran out of fuel or because the fuel supply was interrupted for another reason.

History of the flight

The pilot and his passenger had planned to fly from Manchester Barton airfield to East Kirkby airstrip returning the same day. The aircraft was refuelled to full using super unleaded petrol from a jerrycan prior to departing Barton. With a full fuel tank, the endurance of the aircraft was approximately three hours. The return flight was calculated to take 2 hours 22 minutes using Sky Demon software, and no fuel was available at East Kirkby. The pilot stated that he had no concerns over having enough fuel to complete the round trip, having completed flights of similar distance previously.

The Jodel D112 is not fitted with an electric starter motor and must be started by hand swinging the propeller. The aircraft is not fitted with a mixture control that can be operated in flight. Initially the aircraft struggled to start, but eventually it started and departed for East Kirkby at around midday. Other than taking 10 minutes longer than planned, the outbound flight was uneventful. The pilot reported that he had to hold for a further 10 minutes before landing at East Kirkby, due to a Lancaster aircraft doing taxi demonstrations on the runway. This made the total flight time for the outbound flight 1 hour 35 minutes. During preflight planning, the pilot had calculated this flight would take 1 hour 17 minutes. He calculated that the return flight would be 1 hour 5 minutes. Previous flights by the pilot to East Kirkby using the same route had taken 1 hour 15 minutes and 1 hour 25 minutes respectively.

The fuel quantity was not visually checked by dipping the fuel tank prior to the return flight to Barton. Instead, the float gauge on the tank was used to check the contents, having first established that the float was floating freely and indicating accurately. The pilot assessed the available fuel remaining as sufficient to allow for the return flight of one hour plus sufficient safety reserves.

The pilot reported that the return flight to Barton used more fuel than anticipated, but he still felt comfortable that the fuel remaining would be sufficient to complete the trip. When he arrived at Barton, the weather conditions were settled with wind less than 5 kt and no cloud below 5,000 ft. The temperature was 24°C.

The first approach to Runway 26L resulted in a go-around because the aircraft had been flying too fast on the approach and bounced back into the air when it passed over a bump on the grass runway. The pilot reported that the Jodel is difficult to land in still wind conditions as flaps are not fitted to the aircraft and slowing it can be difficult. On the second approach the aircraft was again too fast, and the pilot performed a go-around just before touchdown. The aircraft lost power during the initial part of the go-around and was observed to drop its right wing and come to rest upside down just to the left of Runway 26L. The pilot and passenger were extracted from the wreckage by airfield emergency services. The aircraft sustained severe damage during the accident, but there was no fire or fluid leakage.

Aircraft description

The Jodel D112 is a single engine, 2 seat, low wing, tail wheel monoplane constructed of wood and fabric. The aircraft has conventional controls and is not fitted with wing flaps. It has a single fuel tank located in front of the pilot behind the engine. The maximum useable fuel capacity is 65 l, and fuel quantity is indicated to the pilot via a metal wire attached to a cork float in the fuel tank. The aircraft does not have an electrical system and starting the engine is performed by swinging the propellor. Communication is achieved using a handheld battery powered radio that is wired to allow an intercom between the pilot and passenger. G-BEZZ was operated on a Permit to Fly issued by the CAA on LAA recommendation and is revalidated through the LAA, this was valid at the time of the accident.

Aircraft performance

G-BEZZ had a 65 HP engine, and the day of the accident was hot with little wind. The aircraft was within the published weight and balance envelope for the flight, so should have had the performance required to perform the go-around manoeuvre.

Personnel

The pilot held a valid PPL with a Single Engine Piston (SEP) rating which was issued in 2016, and he had a valid self-certified medical at the time of the accident. The pilot had flown a total of 88 hours in the Jodel prior to the accident and was a member of the syndicate that owned G-BEZZ.

Analysis

The flight to East Kirkby took slightly longer than anticipated and there was a further 10 minutes delay before landing. In total, the flight took nearly 20 minutes longer than planned. It was a hot day, the aircraft was heavy but within limits, and it is possible that more power would have been required for cruise flight, increasing fuel consumption. The pilot did not check the fuel at East Kirkby by dipping the tanks, instead relying on the wire gauge and float indicator within the fuel tank, but such indicator systems can be unreliable. The CAA recommends within CAP 1535, *The Skyway Code*[1], that aircraft fuel indication systems should not be used for preflight indications of fuel quantity and, instead, physical dipping of the tank should be done. With a planned flight time back of 1 hour 5 minutes and an estimated 1 hour 23 minutes of fuel available for the return flight, the fuel remaining at Barton would have been less than that required for the 30 minutes of flight recommended by the CAA when landing at destination on a VFR flight.

On arrival at Barton, the first go-around would have used more of the planned 18 minutes worth of fuel left and, during the second go-around, the engine stopped, probably due to fuel starvation. The possibility that the fuel starvation was due to a blockage of the fuel line could not be excluded, but the likely cause of the engine stopping was that the aircraft had run out of fuel.

Conclusion

The aircraft used more fuel than planned on the outbound leg to East Kirkby and on return to Barton had to perform two go-around manoeuvres. It is likely that this combination of events used more fuel than expected resulting in fuel starvation to the engine and the subsequent accident.

Footnote

[1] https://www.caa.co.uk/publication/download/16110 [accessed February 2026].

Accident

Aircraft Type and Registration:	EV-97 teamEurostar UK, G-CDNM
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: 2407)
Date & Time (UTC):	11 May 2025 at 1130 hrs
Location:	Athey's Moor Airfield, Northumberland
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Significant damage to airframe, landing gear and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	4,575 hours (of which 1,612 were on type) Last 90 days - 85 hours Last 28 days - 30 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During an instructional demonstration of an engine failure after takeoff (EFATO) the right wingtip of an EV-97 teamEurostar contacted the ground. The aircraft yawed and slid across the ground with the landing gear collapsing. Both occupants vacated the aircraft with no serious injuries.

History of flight

The instructor provided a comprehensive briefing to the student on the day's training exercise, which was circuit emergency procedures. The weather was settled with good visibility, little cloud and a light south-easterly wind.

The air exercise began with an orbit of the airfield at 1,500 ft agl to look at the surrounding terrain for suitable landing areas in the event of an engine failure in the circuit. The student completed the circuit. The instructor then demonstrated an abandoned takeoff which was then satisfactorily performed by the student.

The instructor took control to demonstrate an EFATO. On passing 150 ft agl the throttle was brought to idle, the nose was lowered to the gliding attitude and an assessment of a suitable landing area conducted. Landing ahead on the remaining runway was not possible and there was insufficient height to land beyond the trees at the upwind end of the airfield in the pastures beyond. The instructor commenced a turn to the right through approximately 45-50°, levelling the wings around 50-70 ft agl for the landing area ahead.

The demonstration was concluded at around 15-20 ft agl and full power was applied to climb away. The engine responded normally, but the aircraft suffered significant sink with wing drop, and the right wingtip contacted the ground. The aircraft yawed to the right and slid sideways to the left, with the left landing gear hitting the ground and collapsing. This was followed by the nose landing gear collapsing and the propeller striking the ground at high power. The tail plane hit the ground resulting in significant damage, with additional damage to the left wing due to the landing gear collapse (Figure 1).

Figure 1

Ground strike during engine failure after takeoff demonstration

Both occupants sat in silence for a few seconds before the instructor switched off the fuel and electrics and they vacated the aircraft. There were no serious injuries.

Comment from the instructor

The instructor had conducted this exercise many times before and believed that turbulent air over the trees caused the sink and subsequent wing drop. The instructor stated that he should have initiated a climb away earlier as the EFATO procedure had been adequately demonstrated to the student.

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 UAS investigations reviewed: December 2025 - January 2026

1 Dec 2025 **DJI M30T** Willington, Durham

Whilst searching for a missing person at night, the UA entered automatic return to home mode due to a low battery. This was cancelled and the UA was manually flown but subsequently it collided with an unsighted power line.

5 Dec 2025 **DJI M30** Ely, Cardiff

The UA was inadvertently flown into a tree.

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

AAIB File:	AAIB-29685
Aircraft type and registration:	Boeing 737-8K5, G-TAWD
Date and Time (UTC):	20 October 2023 at 1153 hrs
Location:	Leeds Bradford Airport
Information Source:	AAIB Field Investigation

AAIB Bulletin No 12/2024, page 3 refers

The AAIB received representations regarding this report and, as a result, the following changes have been made along with changes to Figure numbers required as a consequence.

Synopsis

Original text of the second paragraph of the synopsis:

> The investigation found that one of the aircraft's nosewheel bearings had suffered a catastrophic failure, likely during the rollout at LBA. The resultant juddering was unexpected, and the crew were uncertain as to its impact. However, the investigation found that there was in fact no mechanical impediment to the use of additional rudder and braking to prevent the runway excursion.

Amended text:

> The investigation found that one of the aircraft's nosewheel bearings had failed, likely during the rollout at LBA. The resultant juddering was unexpected and led the PF to limit his rudder input. However, there was, in fact, no mechanical impediment to the use of additional rudder, and differential braking was also available to maintain directional control.

History of the flight

Original text of the first sentence of the final paragraph on page 4:

> The full range of rudder application was not used to correct the drift, as the crew reported feeling a significant 'judder' when the right pedal pressure was applied which led the PF to reduce the rudder input repeatedly.

Amended text:

> The crew reported feeling a significant 'judder' when right pedal pressure was applied. The PF reported that the judder was accompanied by an un-commanded yaw to the left. He stated that subsequent right rudder inputs were effective initially but then there was a return to left yaw beyond mid-deflection of the rudder. This repeatedly led the PF to reduce the rudder input and meant that the full range of rudder application was not used to correct the aircraft's drift to the left of the runway centreline.

Manufacturer's data analysis

Original text:

The flight data was provided to the aircraft manufacturer who were asked to assess the landing using their aircraft model. The data allowed an assessment of how well the braking system could achieve deceleration from the runway conditions and the lateral controllability of the aircraft.

The amount of braking force the braking system can apply is dependent on the normal load on the tyre and the surface friction. If the surface friction level reduces to the point that the tyre begins to lock up, the antiskid system should detect this and will release the brake to prevent the skid and, for this case, the tyre/runway interface is described as being 'friction-limited'.

A measure of the amount of friction available is the braking coefficient[1] which the manufacturer calculated for this landing roll. They confirmed that for this landing, the aircraft was not friction-limited at any point and that *'the airplane likely achieved a braking action commensurate with DRY'.* This can be seen in the initial braking phases where the autobrake system achieved the target deceleration for the MAX setting.

The manufacturer was also able to use their six degree of freedom non-linear engineering simulation to assess the lateral performance during the landing. They used data from the FDR recording along with METAR data from the time of the event and a runway surface condition of wet.

They stated that:

> *'Under similar crosswind/headwind conditions as indicated in the provided METAR and with the braking assumptions listed, it is expected that approximately 2-3 degrees of right rudder pedal, increasing to 4 degrees by the time that the airplane comes to a stop, would be required to maintain the airplane on the runway centerline'.*

The 2° to 3° degrees of right rudder pedal used in the simulation was a continuous pedal application (rather than application followed by a periodic return to the zero position), increasing to 4°.

Initially after touchdown, there was left control wheel input which is normal for landing with a crosswind from the left. As the aircraft decelerated through 86 kt, there was application of right control wheel. These inputs were all considered in the simulations and the manufacturer stated that the contribution of this control wheel input to the loss of lateral control was negligible. They also stated

Footnote

1 Braking coefficient is defined as the ratio of deceleration force from the wheel brakes relative to the normal force acting on the wheels.

that they had observed such control wheel inputs, which may have been an instinctive response, during prior lateral runway excursion events.

Amended text:

Ground track analysis

The aircraft manufacturer carried out a ground track analysis of the flight data using a combination of inertial data, localiser deviation and airfield information, cross-referenced against gear marks on the runway and final resting location of the aircraft. This provided a baseline against which further results could be compared.

Calculated airplane braking coefficient

The airplane braking coefficient was calculated for the landing. The coefficient is the ratio of the deceleration force from the wheel brakes (calculated from total aircraft deceleration, minus aerodynamic drag and thrust components) to the normal force acting on the main gear wheels (aircraft weight minus lift). It is an all-inclusive term that incorporates effects due to the runway surface, contaminants, and aircraft braking system (e.g. anti-skid efficiency, brake wear, tyre condition etc.). It is not equivalent to the tyre-to-ground friction coefficient and does not rely on METAR information or reported runway conditions. If the surface friction level reduces to the point that the tyre begins to lock up, the antiskid system should detect this and release the brake to prevent the skid. In such circumstances, the tyre/runway interface is described as being ‘friction-limited’.

The manufacturer found that the measured deceleration while maximum autobrakes were selected (0.45 g) was consistent with the expected deceleration (0.435 g). They stated that braking was not friction-limited at any point during the landing.

Landing simulation

A desktop engineering simulation was used to recreate the landing rollout. The simulation was a six-degrees-of-freedom non-linear model updated to match flight data, and it was driven by recorded control positions from the actual landing, along with the METAR data nearest to the time of the event and a runway surface condition of wet. The simulation was used to assess aircraft lateral performance during the landing, and the simulated results were a reasonable match to the aircraft’s actual track over the ground (Figure 6).

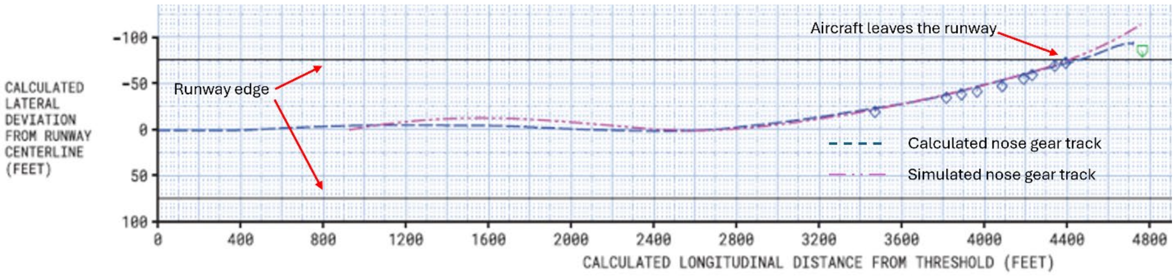

Figure 6

Landing simulation (The Boeing Company)

The model was also used to estimate the magnitude of rudder pedal application during landing that would have kept the aircraft on the runway centreline. The manufacturer stated that:

> *'Under similar crosswind/headwind conditions as indicated in the provided METAR and with the braking assumptions listed, it is expected that approximately 2-3 degrees of right rudder pedal, increasing to 4 degrees by the time that the airplane comes to a stop, would be required to maintain the airplane on the runway centerline'.*

The 2° to 3° of right rudder pedal used in the simulation was a continuous pedal application (rather than application followed by a periodic return to the zero position), increasing to 4°.

The manufacturer commented that:

> *'Throughout the ground roll, there was additional directional control authority at the flight crew's disposal, via rudder and asymmetric wheel braking, that was not utilised.'*

Initially after touchdown, there was left control wheel input, which is normal for landing with a crosswind from the left. As the aircraft decelerated through 86 kt, there was application of right control wheel. These inputs were considered in the simulations and the manufacturer stated that the contribution of this control wheel input to the loss of lateral control was negligible. They also stated that they had observed such control wheel inputs during previous lateral runway excursion events and commented that such inputs may have been instinctive responses.

Analysis

Approach preparation

Original text of the second paragraph:

> The landing performance was calculated and within limits to land at Leeds with a margin of 91 m[2] when using auto brake MAX. The crew referred to limiting landing performance which prevented them from commencing an approach when the wind was from 060° at 19 kt, which was the basis for the pilot's request to join the hold whilst on initial approach to Leeds. This performance landing limit could not be recreated by the investigation using the manufacturer's performance tool and the reported environmental conditions.

Amended text:

> The landing performance was calculated and within limits to land at Leeds with a margin of 91 m[3] when using auto brake max.

Runway surface

Deleted the final sentence of the first paragraph under this heading:

> The aircraft deceleration rate and braking forces applied confirms that the aircraft was not friction-limited at any point and hydroplaning was not a contributory factor in this event.

Inserted the following text between the first and last paragraphs under this heading:

> During the period after touchdown when maximum autobrake was used, actual deceleration was as expected. The eight second period after autobrake disengagement, during which there was no wheel braking applied, corresponded to a period when the aircraft's heading remained broadly constant (although slightly left of the runway centreline). This showed that there was sufficient friction for effective directional control during this period. In addition, the manufacturer assessed that the aircraft was not friction-limited at any point during the landing, so hydroplaning was not considered to be a contributory factor in this event.

Nosewheel bearing

Original text:

> It could not be confirmed when the nosewheel bearing began to fail, but it is likely that it suffered catastrophic failure during the rollout at LBA and was contributory to the vibration through the rudder pedals as felt by the commander. The failure of the bearing did not prevent the nosewheel from rotating nor did it affect the ability to steer the nosewheels.

Footnote

2 Calculations inclusive of the required legal safety margins.
3 Calculations inclusive of the required legal safety margins.

At speeds above 60 kt the rudder is the primary method of yaw control. As the aircraft decelerates towards taxi speed the nosewheel steering becomes the primary control. There was no evidence that the bearing's failure physically reduced or restricted the pilot's ability to control the aircraft in yaw.

The PF recalled the nosewheel judder increasing as he increased the right rudder pedal, which caused him to reduce the input. Both crew members recalled the judder as being significant and unusual and the CVR recording contained a 'juddering/rattling' sound during this period. There was no evidence of a physical restriction of the rudder, rudder pedal movement or that the rudder position required to prevent the runway excursion was unobtainable.

Amended text:

It was not confirmed when the nosewheel bearing began to fail, but it is likely that it occurred during the rollout at LBA and was contributory to the vibration through the rudder pedals, as felt by the crew. Both crew members recalled the "judder" as being significant and unusual, and the CVR recording contained a confirmatory sound during this period. The PF recalled the vibration increasing as he increased right rudder pedal input, effectively limiting the amount of rudder he felt he could apply. However, no evidence was found that the bearing failure did, in fact, limit rudder pedal or rudder movement.

Aircraft handling

Original text:

The guidance for pilots on handling deviations from the runway centreline in high crosswinds and on slippery runways is to release the wheel brakes and cancel reverse thrust, but using this technique will increase the LDR. The runway was wet but there is no evidence that the aircraft skidded at any point, nor did the aircraft drift down wind of the runway centreline during the landing roll. It may have been that the pilot cancelled the reverse thrust earlier than normal SOP in an effort to apply a known procedure (Figure 11) in response to the nosewheel judder.

In this event, there was an adequate, but not significant, margin between the landing distance required and that which was available. The recorded data shows there was a significant amount of right rudder input available to the pilot which was not used. The simulation calculated by the manufacturer suggests that the available rudder would have been sufficient to correct the deviation and prevent the runway excursion without cancelling the autobrake and cancelling reverse thrust.

Based on analysis of the data from the event, the manufacturer stated: '*Throughout the ground roll, there was additional directional control authority at the flight crew's disposal, via rudder and asymmetric wheel braking, that was not utilised.'*

Although a nosewheel judder would not necessarily be considered an ‘intense stimulus’, if it was perceived by the PF as such, it is possible he momentarily experienced a startle reflex. This would explain an interruption of the task of increasing the rudder input to prevent the deviation from the centreline. However, given that maintaining the aircraft’s nose on the centreline is a routine, simple and instinctive task, the interruption was likely to have ranged between 100 ms to three seconds. The rollout from touchdown until the aircraft stopped lasted just under 30 seconds, whilst the deviation from the centreline occurred approximately 18 seconds before the aircraft came to a stop. Therefore, it is more likely that, if he experienced a physiological response, that it was as a result of surprise, the effects of which typically last longer than startle.

Pilots are trained to deal with non-normal and emergency events and the aircraft deviation from the runway centreline may have been considered a challenging situation by the crew. There was limited time for the crew to assess the cause of the judder and the practical impact it had on the directional control of the aircraft and surprise or startle may have been a factor. However, as the aircraft approached the side of the runway, it is not clear why the PF did not attempt to use all right rudder available, in spite of the judder, to prevent the runway excursion.

Amended text:

After touchdown, the rudder pedal input reduced to zero at 12:53:02 (Figure 5) for two seconds and the aircraft heading began to turn into wind, as would be expected in a strong crosswind. The autobrake was disengaged, and the right rudder pedal input was increased to an average of about 2° over a period of about 10 seconds (from about 12:53:07 to 12:53:17), with a maximum of 2.5°. The increased rudder pedal input stabilised the aircraft’s heading for about six seconds (until 12:53:11), although it was not sufficient to return the aircraft to runway heading. The manufacturer’s report concluded that 2° to 3° of right rudder pedal would be required to maintain the runway centreline initially, increasing to 4° as the aircraft slowed and came to a stop. At 12:53:11, the aircraft had slowed to about 80 kt, the rudder was less effective, and, in the absence of an increase in rudder input to about 4°, the aircraft began to turn progressively into wind until it left the runway at 64 kt. The manufacturer commented that additional directional control was available by using increased rudder (which is effective down to 60 kt) and differential braking.

Differential braking was applied momentarily at 12:53:12, but it was not applied for long enough to have an effect.

The bearing failure was not considered to have physically prevented the application of further rudder. Nevertheless, the PF felt constrained not to apply more rudder than he did because of the vibration it caused and his perception that increasing right rudder pedal beyond mid-application led to left yaw.

Had increasing right rudder input led directly to left yaw, it would have been an unexpected aerodynamic response and it is likely that the manufacturer's simulated landing data would have diverged from the recorded data (Figure 6). However, the manufacturer's modelling of the landing was closely correlated with the actual performance of the aircraft, and so the left yaw response reported by the PF was likely to have been an indication that even the increased rudder input was insufficient to counter the left yaw in the strong crosswind.

Inserted a new paragraph heading, *Landing distance*, after *Aircraft handling*.

Landing distance

New text under *Landing distance:*

The guidance for pilots on handling deviations from the runway centreline in high crosswinds and on slippery runways is to release the wheel brakes and cancel reverse thrust, although this technique will increase the LDR. The runway was wet but there was no evidence that the aircraft skidded at any point, nor did the aircraft drift downwind of the runway centreline during the landing roll. It may have been that the pilot cancelled the reverse thrust earlier than normal SOP in an effort to apply a known procedure (Figure 11) in response to the nosewheel judder.

In this event, there was an adequate, but not significant, margin between the landing distance required and that which was available. The recorded data shows there was a significant amount of right rudder input available to the pilot that was not used. The simulation calculated by the manufacturer suggested that the extra rudder and differential braking available would have been sufficient to correct the deviation and prevent the runway excursion without cancelling the autobrake and cancelling reverse thrust.

Inserted a new heading, *Startle and surprise,* after *Landing distance.*

Startle and surprise

New text under *Startle and surprise:*

It is possible that the pilot was startled by the sudden onset of vibration of the nosewheel and, as he perceived it, an adverse reaction to increased rudder pedal input. However, the use of rudder to steer an aircraft is an embedded skill for pilots, so any startle response was likely to have been short. Surprise – a mismatch between expectation and reality – can last longer and may have played a role in events. The PF's expectation was that increased right rudder input would correct the aircraft's deviation from the centreline, but it was actually met with vibration and a feeling of left yaw, and he was required to reassess his expectations related to directional control with limited time and in difficult conditions.

Conclusion

Original text of the second paragraph:

> The deviation from the centreline, resulting from the strong crosswind from the left, required more right rudder input than was applied, in order to correct it. Additional use of differential braking to assist was also available. There was an unusual juddering from the nosewheel reported by the crew likely resulting from the failure of a nosewheel bearing. There was no mechanical defect identified by the investigation which would have prevented the crew from applying the additional right rudder that was available to keep the aircraft on the runway. However, the crew's actions may have been influenced by the nosewheel juddering.

Amended text of the second paragraph:

> It was likely that a nosewheel bearing failed during the landing causing an unusual vibration that increased with rudder input. This, combined with the PF's perception that increased rudder input was causing an adverse yaw response, led him to consider that he was limited in the amount of right rudder he could apply. However, the bearing failure did not physically prevent the application of more rudder, and the manufacturer's modelling showed that increased rudder and differential braking would have been effective in maintaining directional control during the landing.

The original report was amended online on 11 February 2026.

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GLOSSARY OF ABBREVIATIONS

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

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