AAIB
Air Accidents Investigation Branch

AAIB Bulletin 4/2020

TO REPORT AN ACCIDENT OR INCIDENT PLEASE CALL OUR 24 HOUR REPORTING LINE

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AAIB investigations are conducted in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, EU Regulation No 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2018.

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.

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

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This bulletin contains facts which have been determined up to the time of compilation.

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Summaries of Aircraft Accident Reports

This section contains summaries of Aircraft Accident ('Formal') Reports published since the last AAIB monthly bulletin.

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

Aircraft Accident Report No: 1/2020

This report was published on 13 March 2020 and is available in full
on the AAIB Website www.aaib.gov.uk

Report on the accident to Piper PA-46-310P Malibu, N264DB 22 nm north-north-west of Guernsey 21 January 2019

Registered Owner:	Southern Aircraft Consultancy Inc.
Operator:	Private owner[1]
Aircraft Type:	Piper PA-46-310P Malibu
Nationality:	United States of America
Registration:	N264DB
Place of Accident:	22 nm north-north-west of Guernsey
Date and Time:	21 January 2019 at 2016 hrs (all times in this report are UTC unless stated otherwise)

Summary

The Air Accidents Investigation Branch (AAIB) became aware on 21 January 2019 at 2122 hrs that the aircraft had gone missing at approximately 2016 hrs. The search for survivors, coordinated by the authorities in Guernsey, was called off at 1515 hrs on 24 January 2019.

The aircraft was lost in international waters and, in such circumstances, Annex 13 to the Convention on International Civil Aviation places a responsibility on the State of Registration of the aircraft, in this case the USA as represented by the National Transportation Safety Board (NTSB), to commence an investigation. However, the State of Registration may, by mutual agreement, delegate the investigation to another State. On 22 January 2019, in anticipation that an accident investigation would be required, the NTSB delegated responsibility for the investigation to the State of the Operator, in this case the UK as represented by the AAIB.

In exercise of his powers, the Chief Inspector of Air Accidents ordered an investigation to be carried out in accordance with the provisions of Regulation (EU) 996/2010 and the UK Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2018. The sole objective of the investigation of an accident or incident under these Regulations is the prevention of accidents and incidents. It shall not be the purpose of such an investigation to apportion blame or liability.

Footnote

[1] Ownership through a UK Limited company.

In accordance with established international arrangements, both the NTSB, representing the State of Design and Manufacture of the aircraft, and the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA) in France, which had been supporting search activities, appointed Accredited Representatives to the investigation. The Junta de Investigación de Accidentes de Aviación Civil (JIAAC) in Argentina, representing the State of Nationality of the passenger, appointed an Expert. The European Union Aviation Safety Agency (EASA) and UK Civil Aviation Authority (CAA) assisted the investigation, and the NTSB was assisted by Advisors from the aircraft and engine manufacturers.

Prior to this Final Report, the AAIB published Special Bulletins on 25 February 2019[2] and 14 August 2019[3].

The investigation established that the aircraft departed from Nantes Airport, France, at 1906 hrs on 21 January 2019 carrying a passenger on a commercial basis to Cardiff Airport in the UK. At 2016 hrs, probably while manoeuvring to avoid poor weather, the aircraft was lost from radar and struck the sea 22 nm north-north-west of Guernsey. Neither the pilot nor aircraft had the required licences or permissions to operate commercially.

The investigation identified the following causal factors:

1. The pilot lost control of the aircraft during a manually-flown turn, which was probably initiated to remain in or regain Visual Meteorological Conditions (VMC).
2. The aircraft subsequently suffered an in-flight break-up while manoeuvring at an airspeed significantly in excess of its design manoeuvring speed.
3. The pilot was probably affected by carbon monoxide (CO) poisoning.

The investigation identified the following contributory factors:

1. A loss of control was made more likely because the flight was not conducted in accordance with safety standards applicable to commercial operations. This manifested itself in the flight being operated under Visual Flight Rules (VFR) at night in poor weather conditions despite the pilot having no training in night flying and a lack of recent practice in instrument flying.
2. In-service inspections of exhaust systems do not eliminate the risk of CO poisoning.
3. There was no CO detector with an active warning in the aircraft which might have alerted the pilot to the presence of CO in time for him to take mitigating action.

Footnote

[2] https://assets.publishing.service.gov.uk/media/5c73c02bed915d4a3d3b2407/S1-2019_N264DB_Final.pdf [accessed February 2020]

[3] https://assets.publishing.service.gov.uk/media/5d53ea15e5274a42d19b6c2e/AAIB_S2-2019_N264DB.pdf [accessed February 2020]

Safety action was taken to: raise awareness of the risk associated with unlicensed charter flights; and improve the guidance given to personnel undertaking inspections of exhaust systems.

Five Safety Recommendations have been made in this report concerning: flight crew licensing records; the carriage of CO detectors; and additional in-service inspections of exhaust systems.

Conclusions

Findings

1. There was no evidence to suggest the pilot and passenger were not fit and healthy prior to the flight or that the pilot was not well-rested.

2. The pilot was operating on an FAA PPL issued on the basis of his existing EASA PPL and subject to the validity of its ratings.

3. The SEP rating on the pilot's EASA licence expired in November 2018 and he had no night rating, so he was not qualified to fly the aircraft at the time of the accident.

4. The pilot's PPL did not permit him to receive remuneration for flying, but he was to be paid a fee for the accident flight.

5. It is likely that the pilot felt some pressure to complete the return leg of the flight even though it would be at night and in poor weather.

6. The aircraft had valid Registration, Airworthiness and Release to Service Certificates, and the required scheduled maintenance had been completed.

7. The aircraft was operated in accordance with 14 CFR Part 91, *General Operating and Flight Rules,* and maintained in accordance with Part 43, *Maintenance, Preventive Maintenance, Rebuilding, and Alteration*.

8. The regulations under which the aircraft was operated and maintained permitted it to be used for private use only. No permission had been sought or granted which allowed the aircraft to be operated commercially.

9. The aircraft was not being operated in accordance with safety standards applicable to commercial operations.

10. The autopilot and flight director had been diagnosed as having an intermittent fault and should have been placarded as inoperative.

11. Just after 2012 hrs, a series of turns was flown over about 90 seconds, probably so that the aircraft would remain in, or regain VMC. During the

turns, the flightpath was unstable and inconsistent with normal cruise flight or with use of the autopilot.

12. At 2016 hrs, the aircraft began a turn to the right and began to descend. As it descended through approximately 2,700 ft amsl, the angle of bank was approximately 90° and the airspeed was approximately 235 KIAS.

13. The aircraft attitude and speed were so far from typical values encountered in normal operations they indicated that the autopilot was not engaged and control of the aircraft had been lost.

14. At approximately 2016:30 hrs, as the aircraft descended below 2,700 ft, there was an abrupt nose-up pitch input when the airspeed was at least 100 kt above V_A, the speed above which full or abrupt control movements are not permitted.

15. During the subsequent pull-up manoeuvre, aerodynamic loads exceeded design limits and caused the structural failure of the elevator and horizontal stabiliser, followed by the structural failure of both wings at the splice joints.

16. The last secondary radar contact with the aircraft was at 2016:34 hrs.

17. The aircraft struck the sea in an inverted, left wing low, nose-high attitude.

18. The impact with the sea was not survivable.

19. There was no evidence of fire.

20. While the possibility of aircraft icing could not be discounted, it is unlikely that icing was a factor in the accident.

21. It could not be determined what caused the reported ‘bang’ and mist on the previous flight, and whether it was a factor in this accident.

22. The faults with the stall warning, brakes and oil leak reported by the pilot at Nantes were not a factor in the accident.

23. At the time of the accident, the passenger’s blood had a very high level of COHb, and it was likely that the pilot was also affected to some extent by CO poisoning.

24. Although the level of COHb in the pilot’s blood could not be determined, it was likely that his ability to control the aircraft was impaired during the later stages of the flight, thereby significantly increasing the likelihood that control would be lost.

25. The abrupt pull-up of the aircraft just before it broke up required the control wheel to be pulled aft, and therefore the pilot probably retained some level of function at this time.

26. The most likely reason for CO to have entered the cabin was a failure of the part of the exhaust tailpipe containing the heater muff, which allowed exhaust gas to mix with the ram air and enter the cabin through the cabin conditioning system.

27. The exhaust system, including the heater muff was visually inspected during the Annual maintenance 11 flying hours before the accident. In a different accident, a muffler has been known to fail six flying hours after inspection.

28. A pressure test of the heater muff was not carried out during the previous two Annual maintenance inspections. Under 14 CFR Part 91, the 100-hour / Annual maintenance schedule did not call for such a test to be carried out.

29. The 100-hour / Annual maintenance schedule did not directly reference the engine manufacturer's guidance on how to examine the exhaust system.

30. In-service inspections of exhaust systems do not eliminate the risk of CO poisoning.

31. There is no requirement for CO detectors to be carried on piston engine aircraft, although regulators advise pilots to do so.

Causal factors

1. The pilot lost control of the aircraft during a manually-flown turn, which was probably initiated to remain in or regain VMC.

2. The aircraft subsequently suffered an in-flight break-up while manoeuvring at an airspeed significantly in excess of its design manoeuvring speed.

3. The pilot was probably affected by CO poisoning.

Contributory factors

1. A loss of control was made more likely because the flight was not conducted in accordance with safety standards applicable to commercial operations. This manifested itself in the flight being operated under VFR at night in poor weather conditions despite the pilot having no training in night flying and a lack of recent practice in instrument flying.

2. In-service inspections of exhaust systems do not eliminate the risk of CO poisoning.

3. There was no CO detector with an active warning in the aircraft which might have alerted the pilot to the presence of CO in time for him to take mitigating action.

Safety Recommendations and Action

Safety Recommendations

The following Safety Recommendations are made in this report:

Safety Recommendation 2020-005

It is recommended that the Civil Aviation Authority ensure that the system in place to meet the requirements of EASA Part ARA.GEN.220 is effective in maintaining accurate and up-to-date records related to personnel licences, certificates and ratings.

Safety Recommendation 2020-006

It is recommended that the Federal Aviation Administration require piston engine aircraft which may have a risk of carbon monoxide poisoning to have a CO detector with an active warning to alert pilots to the presence of elevated levels of carbon monoxide.

Safety Recommendation 2020-007

It is recommended that the European Union Aviation Safety Agency require piston engine aircraft which may have a risk of carbon monoxide poisoning to have a CO detector with an active warning to alert pilots to the presence of elevated levels of carbon monoxide.

Safety Recommendation 2020-008

It is recommended that the Civil Aviation Authority require piston engine aircraft which may have a risk of carbon monoxide poisoning to have a CO detector with an active warning to alert pilots to the presence of elevated levels of carbon monoxide.

Safety Recommendation 2020-009

It is recommended that Piper Aircraft Inc. ensure that the 100-hour / Annual maintenance schedule for the PA-46 variants references the engine manufacturer's guidance, where available, on inspecting and testing the exhaust system.

Safety Action

Following this accident, the following safety action was taken:

Safety action taken by the CAA

The CAA developed a campaign to raise awareness of unlicensed charters, including publishing a Leaflet, *Legal to Fly,* to inform passengers about flying safely in light aircraft and business jets.

Safety action taken by the engine manufacturer

The engine manufacturer stated that it would:

1. Work with Original Equipment Manufacturers to determine the best way to convey the importance of thorough exhaust system inspections.

2. Review its maintenance and overhaul manuals to determine whether additional elaboration would increase the chance of a qualified mechanic finding a potentially unairworthy condition. It undertook to complete this review in order to have any amplifications implemented in the next FAA approved version of its Standard Practice Manual (M-0).

AIRCRAFT ACCIDENT REPORT CORRECTION

Prior to publication the following information was found to be incorrect.

AAR 1/2020, page 61 refers:

In paragraph 1.18.1.10, 4th bullet point, the date that EASA SIB 2020-01 was issued is incorrect and should have said 27 January 2020. The sentence now reads:

> On 27 January 2020, EASA issued SIB 2020-01, Carbon Monoxide (CO) Risk in Small Aeroplanes and Helicopters[71].

AAR 1/2020, page 62 refers:

In the last sentence in paragraph1.18.1.10, 4th bullet point, there is a typo in that GEM should read GEN. The sentence now reads:

> *Annex II, ARO.GEN.135C'*[72].

In footnote 72, 'Part 21' is missing from the reference. The footnote now reads:

> 72 For a definition of 'unsafe condition', see AMC 21a.3B(b) to Part 21 in EASA ED Decision 20013/1/RM. Available: https://www.easa.europa.eu/sites/default/files/dfu/decision_ED_2003_01_RM.pdf [accessed February 2020]

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.

ACCIDENT

Aircraft Type and Registration:	Guimbal Cabri G2, G-CILR
No & Type of Engines:	1 Lycoming O-360-J2A piston engine
Year of Manufacture:	2015 (Serial no: 1090)
Date & Time (UTC):	22 July 2019 at 1730 hrs
Location:	Wycombe Air Park
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Private Pilot's Licence (Helicopters)
Commander's Age:	21 years
Commander's Flying Experience:	174 hours (of which 110 were on type) Last 90 days - 22 hours Last 28 days - 9 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter had flown from Dunkeswell, Devon, to Wycombe Air Park, Buckinghamshire. As the pilot was shutting down the helicopter, he noticed smoke emanating from the left side of the rotor mast. He evacuated the helicopter and tried, unsuccessfully, to extinguish the fire with the helicopter's on-board fire extinguisher. The helicopter was destroyed.

Examination of the wreckage identified that the electrical cable connecting the alternator to the starter relay had short circuited against the aluminium baffle that surrounds the engine, probably as a result of the cable clips being incorrectly fitted.

As a result of this investigation the helicopter manufacturer issued a service bulletin to instruct operators to inspect for correct installation of the cable clips and has also completed a redesign of the clips to ensure they cannot be fitted incorrectly.

History of the flight

The helicopter was being flown from Dunkeswell Airfield, Devon, to Wycombe Air Park, Buckinghamshire. Prior to the flight, the helicopter had last flown on 17 June 2019 with no reported issues.

The pilot conducted the pre-flight checks and found the helicopter to be in a satisfactory condition. The fuel level was below the minimum to hover-taxi to the pumps, so the pilot used a jerry can to uplift 20 litres of fuel before initiating the start procedure. When he attempted to start the engine the starter motor would not turn. The pilot thought that the battery may be low on charge due to the elapsed time since the helicopter's last flight so he charged it using a dedicated 12V DC charger. After charging the battery for approximately 2.5 hours the engine was successfully started. The pilot let the engine to idle for approximately 15 minutes, to further charge the battery, before he hover-taxied to the fuel pumps. Whilst waiting for the battery to charge the pilot contacted Wycombe tower to ask permission to land at the airfield outside of normal operational hours, which was granted.

Once the helicopter was fuelled, the pilot completed inter-flight[1] checks, started the engine and departed Dunkeswell at 1600 without issue. During the flight the pilot made specific note of the ammeter indication to confirm that the alternator was charging the battery. He noticed nothing unusual during the flight.

The pilot made a blind radio call on the Wycombe frequency before the helicopter entered the ATZ to the north of the airfield. After crossing Runway 06/24 the helicopter landed on helicopter pad 10. After landing the pilot commenced the normal shutdown procedure. He bought the engine to idle, disengaged the clutch, waited 10 seconds and then shut the engine down. As he did so he noticed a static noise being received on the radio. He also noticed that the ammeter was at its full negative deflection for approximately 2 seconds before stabilising at around 1/3 negative deflection. In addition the Exhaust Gas Temperature (EGT), which would normally read '- - -'[2] shortly after shutdown, indicated approximately 350°C and the carburettor temperature reading was steadily increasing from 30°C to above 50°C. The pilot applied the rotor brake and shortly before the rotor had stopped the he observed smoke rising over the left side of the helicopter. He left the helicopter and saw flames coming from within the cowling around the left side of the main rotor mast. He went back to the helicopter and pulled the emergency fuel shut-off and switched off all electrical switches before retrieving the on-board fire extinguisher. He expended its contents, half into the mast cowling and half onto the underside of the engine, but this had no effect. He then retrieved a personal bag from the cockpit before retreating to a safe distance.

A witness called the emergency services and a local fire and rescue appliance arrived approximately ten minutes later. The fire was extinguished but by this time the helicopter had been destroyed. There were no injuries.

Footnote

1 Inter-flight checks are defined in the Guimbal Cabri Flight Manual as those to be conducted between flights after completion of the Daily or Pre-flight inspection.

2 When the EGT is below its normal operating range and operating below the temperature sensing capability of the thermocouples the EGT reading on the display reads '---'.

Accident site

The helicopter was located at helicopter landing pad 10 at Wycombe Air Park. The entire helicopter, except the tail boom had been consumed by fire (Figure 1).

Figure 1

G-CILR prior to being moved

The engine remained attached to its support frame. The battery had been destroyed, however the electrical cables that had been connected to the battery were present. The insulation on the cables had been consumed by fire. The cable connecting the alternator output to the starter relay in the battery compartment was found to be in two pieces. Where it had broken the cable material had fused together, creating a globule of re-solidified molten material (Figure 2). Both ends of the broken cable was removed from the wreckage and taken to the AAIB for further assessment. A section of the helicopter's power generation and distribution circuit diagram can be found in Figure 3.

Figure 2

Helicopter cables within the wreckage

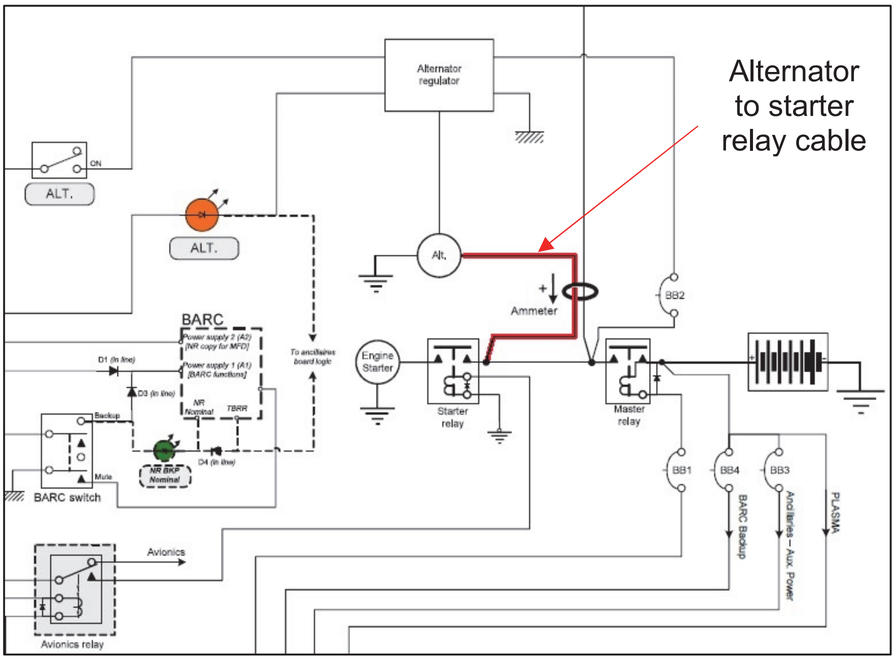


Figure 3

Section of Power Generation and Distribution diagram for Guimbal Cabri G2

Recorded information

A closed-circuit television camera captured the landing and subsequent fire. The first noticeable smoke coming from the rotor mast was observed approximately 244 seconds after the aircraft landed. At this time the rotor blades were slowing and the tail mounted strobe light was flashing, indicating that the master switch was ON.

Aircraft information

The Guimbal Cabri G2 is a light two-seat helicopter primarily used to train private pilots and for aerial photography and observation. It is the first helicopter to be primarily certified to EASA CS27 and then to achieve FAA FAR-27 certification for helicopters with a maximum takeoff weight of less than 3,175 kg (7,000 lbs).

The airframe is composed of three sections; main fuselage, engine section, and tail boom. The main fuselage is a carbon-fibre reinforced monocoque, constructed in five parts. In the cabin there are two side-by-side seats, with the pilot occupying the right position. The main fuselage also includes a central structure, baggage compartment and fuel tank. The engine section is isolated from the cabin by a firewall with the engine supported on a tubular steel frame. The composite tail boom incorporates a Fenestron tail rotor, vertical fin and a horizontal stabilizer.

The engine is mounted to the rear of the passenger compartment and drives a pulley at the front of the engine. A belt transmits the drive from the engine pulley to the main input drive of the rotor system via a pulley and freewheel coupling. A clutch mechanism is used to engage the drive from the engine to the rotor system. This is achieved by pivoting the engine about its rear mounts; an actuator lowers front of the engine which tensions the belt, allowing drive to be transmitted to the rotor system. When the clutch is disengaged, the actuator retracts, lifting the output pulley and disengages the drive. The engine output pulley moves approximately 15 mm when the clutch actuator moves from engaged to disengaged.

An aluminium baffle is mounted to the front of the engine to aid cooling around the engine. The starter and alternator cables, which run from the battery compartment, on the left of the aircraft behind the firewall, to the engine mounted starter and alternator, pass through the baffle and are held in place by two cotton impregnated phenolic clips either side of the baffle. (Figures 4 and 5)

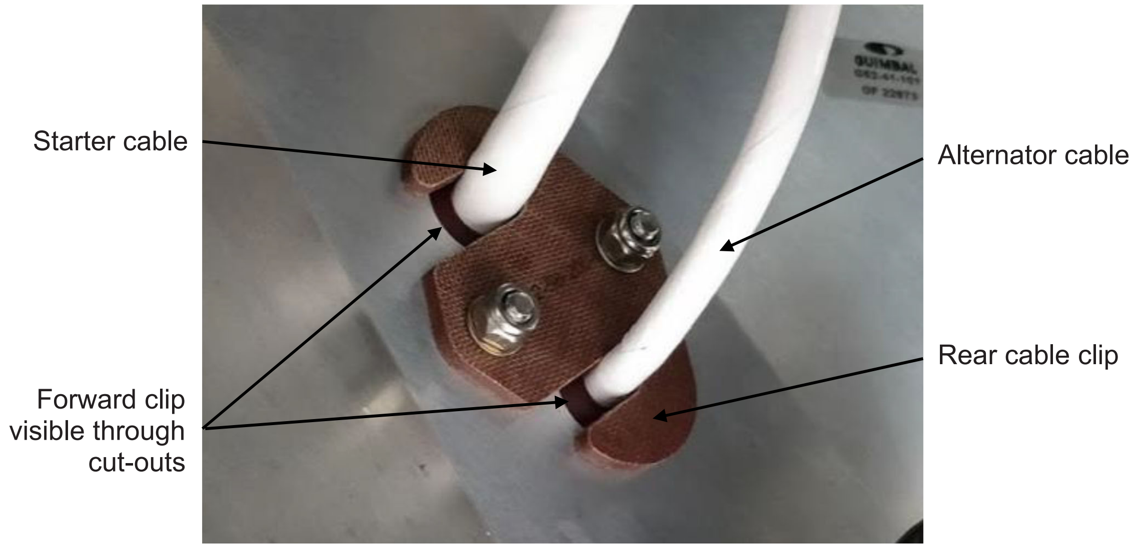


Figure 4

Starter and alternator cables passing through engine baffle (viewed from rear)

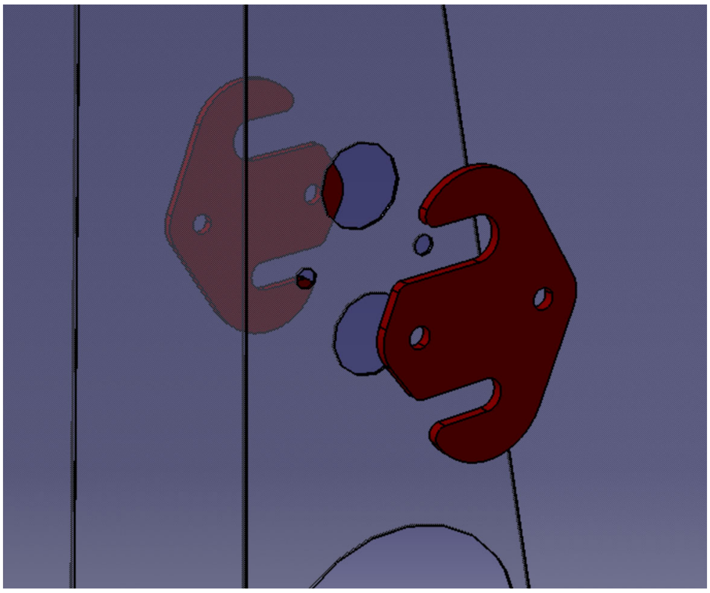


Figure 5

Exploded view of correct installation of cable clips

The clips are designed to hold the cables centrally within the pre-drilled holes in the baffle. The clips themselves are identical and should be fitted in opposition to each other, so they retain the cables between the bottom of each cut out.

A cooling fan, with a carbon fibre housing, is mounted in front of the engine baffle (Figure 6).

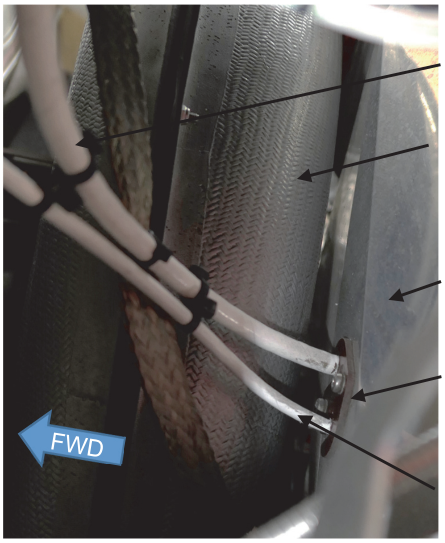


Figure 6

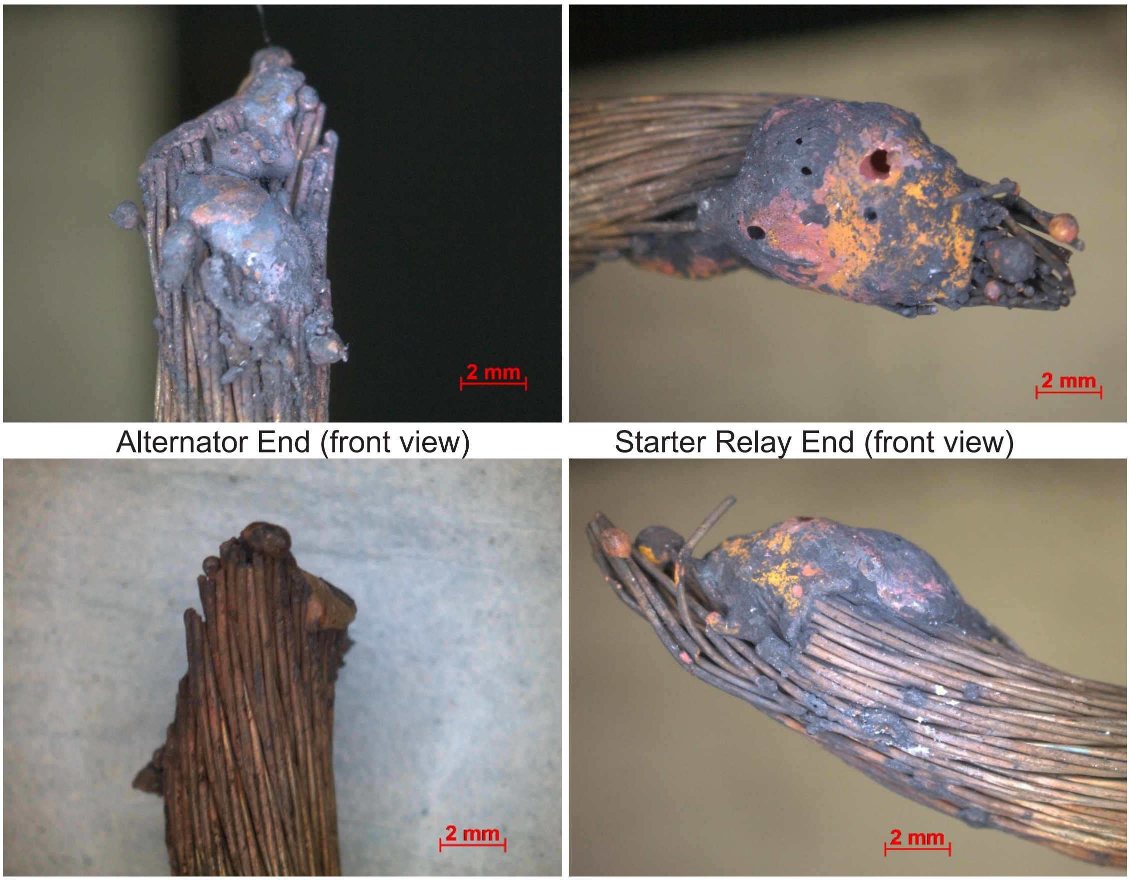
Starter and alternator cables passing through front of engine baffle (view from below)

G-CILR held a valid Airworthiness Review Certificate and was up to date with its required regular inspections. A review of its technical documentation found that the engine had been removed on 18 December 2018, 102.5 hours prior to the event, and that the 'engine cooler baffle' had been repaired on 21 March 2019, 47.6 hours prior to the event. As part of the engine removal the starter and alternator cables and clips would have been removed and replaced. Records were not available to determine whether the cables and clips were removed during the baffle repair.

Cable examination

Laboratory analysis of the cable removed from the aircraft found that the re-solidified molten material (Figure 7) was predominantly copper and nickel, the material of the cable itself. The cause of the fusing was as a result of extreme localised heating associated with electrical arcing. There were no traces of any other metallic elements within the re-solidified molten material to identify the component that the cable had arced against.

Measurement of the cable fragments against a cable of the same part number from another Guimbal Cabri G2 identified that the location of the break was coincident with the location that the wire passed through the aluminium baffle. The baffle on G-CILR had been destroyed in the fire and therefore could not be examined as part of the investigation.



Alternator End (front view) Starter Relay End (front view)

Alternator End (rear view) Starter Relay End (rear view)

Figure 7

Alternator cable break location

The starter cable, which ran above the alternator cable as it passed through the baffle, was still present and showed no evidence of arcing. The cotton impregnated phenolic clips that supported the cables as they pass through the baffle were not recovered. It is considered likely that they were destroyed in the fire.

Analysis

The laboratory analysis of the failed alternator to starter relay cable confirmed that localised heating of the cable was associated with arcing. The location of the failure along the length of the cable was coincident with where it passed through the aluminium baffle; therefore, the baffle is most likely to have been the component that the cable arced against. The arcing will have heated the aluminium baffle material and generated sparks. This would have been sufficient to ignite the cotton impregnated phenolic clips and then the carbon fibre fan housing forward of the engine baffle. Once the fan housing had ignited the fire would have propagated quickly.

To allow the core of the cable to contact the aluminium baffle, the cable must have been able to move against the baffle. This could have been due to the clipping either failing, being installed incorrectly or not being present at all. Once the cable had contacted the baffle material, the cable insulation would have to have been breached to allow an electrical circuit to be made. The ammeter reading observed by the pilot during the flight was positive, suggesting that the cable had not short circuited at this time. Only when the aircraft had landed did the ammeter read negatively suggesting that, in this case, the short circuit occurred whilst on the ground.

The clips that should have been fitted to the cable in the location of the baffle were not recovered from the accident site and, if fitted, were likely to have been consumed in the fire. It is therefore not possible to determine how they were fitted, or if they were fitted at all.

An assessment of the clip design identified that it was possible to fit the clips in the same orientation, rather than in opposition, resulting in the cable not being retained as intended. In this situation the cable has sufficient freedom of movement to contact the unprotected edge of the pre-drilled hole in the baffle.

The subject cable uses a polymer tape insulation wound around the wire bundle. The insulation was consumed during the fire but was probably cut or worn away by contact with the edge of the hole.

During the shutdown procedure the clutch is disengaged, pivoting the engine around its rear mounts. As it pivots, the baffle moves upward approximately 15 mm. With the cable being attached at its forward end to the starter relay, mounted in the battery compartment, and at its rearward end, the alternator, when the clutch is engaged or disengaged, there is relative movement that will flex the cable. The intent of the design is to allow the flex to be accommodated between the starter relay terminal and the cable clips mounted on the engine baffle. Without the clips holding the cable, engagement or disengagement of the clutch will have allowed relative movement between the cable and baffle. This relative movement would have been sufficient, over time, to wear through the insulation.

It is likely that during clutch engagement or disengagement the cable was able to move through the baffle hole, as it was unrestrained by the clips. As the clutch was disengaged the baffle would move upward and away from the battery compartment, tensioning the cable. It is likely that this relative movement allowed the cable to contact the hole edge, damaging the insulation and initiating the short circuit. In this instance the issue manifested itself on the ground, however in different circumstance, it may have occurred whilst the clutch was engaged and the helicopter was in the air.

It is not possible to determine whether the low battery charge prior to the accident flight was associated with the short circuit event, however it is considered unlikely to have been linked.

These findings were highlighted to the helicopter manufacturer and as a result it has taken the following safety action:

> A Service Bulletin was issued by the helicopter manufacturer to inspect the clips to ensure correct installation.
>
> The helicopter manufacturer has completed a redesign of the clipping system to ensure the cable clipping cannot be installed incorrectly. The new design of clip is being fitted to new production helicopters and will be available via service bulletin from the manufacturer.

Conclusion

The helicopter caught fire shortly after landing because the heat generated from a short circuit in the engine compartment ignited a nearby carbon fibre structure. The short circuit was made between the cable that connected the output of the alternator to the starter relay and the aluminium air baffle through which the cable passed. It is likely that the cable clips that should have held the cable as it passed though the baffle were either not present or, most likely, incorrectly fitted. The upward movement of the engine as a result of the clutch disengagement was sufficient to allow the unsecured cable to contact the unprepared edge of the aluminium baffle, allowing the insulation to be cut and initiate the short circuit.

Report published: 19 March 2020.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZBI
No & Type of Engines:	2 CFM 56-5B5/P turbofan engines
Year of Manufacture:	2007 (Serial no: 3003)
Date & Time (UTC):	29 August 2019 at 0900 hrs
Location:	Nice Côte d'Azur Airport, France
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 157
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	62 years
Commander's Flying Experience:	19,991 hours (of which 7,235 were on type) Last 90 days - 137 hours Last 28 days - 58 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During their initial pre-flight preparation, the flight crew chose to calculate takeoff performance based on the most limiting intersection available, Bravo 3, on Runway 04R at Nice Côte d'Azur Airport. The aircraft departed from intersection Alpha 3 where the runway length available was 316 m greater than from Bravo 3. At lift-off the commander noted that the departure end of the runway was closer than he would have expected but did not perceive any other performance issues. Subsequent analysis of recorded flight data and the flight crew's takeoff calculations indicated that both pilots had inadvertently used performance figures for a departure from intersection Quebec 3. With both pilots making the same mis-selection, the takeoff performance cross-check was invalidated and the error went undetected. The available runway length from Quebec 3 was 701 m greater than from Bravo 3.

The flight crew considered that the software user-interface and data presentation was a factor in the intersection selection error being made and subsequently missed. The investigation found that the operator was planning an update to the performance software that would place greater emphasis on a graphical rather than textual representation of runway characteristics.

The aircraft manufacturer was in the process of releasing an enhanced automatic takeoff surveillance system for the A320 family of aircraft. The enhanced system could act as an additional safety barrier for incidents of this nature.

History of the flight

During their pre-flight preparation, the flight crew chose to calculate takeoff performance for Bravo 3 (B3), the most-limiting viable runway intersection on Runway 04R (RW04R) at Nice Côte d'Azur Airport (NCE) (Figure 1). The subsequent cross-check of their independent performance calculations revealed a 1 kt discrepancy between takeoff speeds. The pilots considered the discrepancy to be acceptable and used the most conservative figures for departure.

As they approached the runway, the flight crew were offered a departure from intersection Alpha 3 (A3). Believing that they had the more-limiting B3 performance figures entered into the flight management computer, the flight crew accepted this clearance. On reaching V_1, the aircraft commander considered that the runway remaining was less than he would have expected, but not alarmingly so. The departure used a standard reduced thrust takeoff and, although it was available, the commander '*did not feel TOGA*[1] *was required*' in that situation.

A takeoff performance calculation error was detected after flight by the operator's flight data monitoring (FDM) programme. Cross-checking FDM information with electronic flight bag (EFB) calculations indicated that both pilots had inadvertently selected the Quebec 3 (Q3) intersection, rather than B3, in their performance software. The mis-selection was not detected during an initial data validation '*departure distance check*' and cross-checking EFB calculation outputs did not trap the error.

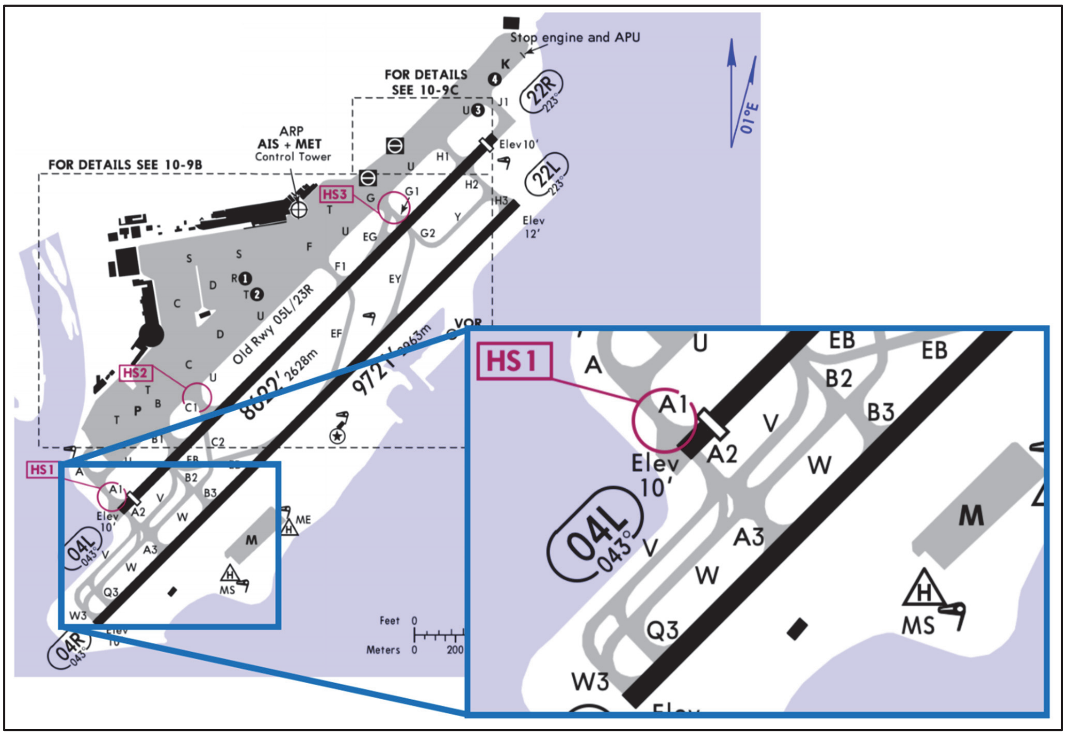


Figure 1

Overview of NCE with zoomed view of RW04R departure intersections

Footnote

[1] Take Off Go Around (TOGA) is the maximum available thrust setting on the Airbus A320 family of aircraft.

Aircraft performance

Revising takeoff calculations after engine start typically requires aircraft data entry modifications and possible changes to aircraft configuration during the taxi phase. This is an additional opportunity for error at a critical stage of flight. In order to avoid late changes, it is common practice for pilots to calculate takeoff performance for the most-limiting likely departure runway intersection. If they subsequently depart from an intersection with more runway distance available, they often do not recalculate takeoff parameters.

The operator's standard operating procedures (SOP) require that aircraft takeoff performance is calculated on company-issued EFBs. Calculations are conducted independently by each pilot and then validated by cross-checking outputs. One element of this process is to cross-check that the runway length displayed on the EFB matches the takeoff run available (TORA) listed on the '*Aerodrome Ground Chart or any applicable NOTAM*'. This process is designed to trap individual errors based on the presumption that both pilots are unlikely to make the same mistakes at the same time.

A comparison of the TORA from Q3, A3 and B3 is shown at Table 1.

Intersection	TORA (m)	TORA vs Q3 (m)
Q3	2,858	n/a
A3	2,473	-385
B3	2,157	-701

Table 1

TORA comparison between runway intersections Q3, A3 and B3

An indicative calculation conducted by the AAIB revealed that outputs from takeoff calculations based on B3 and Q3 differed significantly. For a departure from B3 rather than Q3, takeoff speeds were ≥13 kt slower, the thrust reduction (flex) temperature was 8° lower and a different flap setting was required (Figure 2). From A3 the speeds were 8 kt slower than from Q3, the flex temperature was 61° and Flap 2 was the optimum setting. Meaningful comparisons of takeoff run required could not be drawn because all three calculations used different settings to achieve balanced-field performance.[2]

Footnote

[2] In simple terms, a balanced field takeoff is one where the accelerate-stop distance required is equal to the takeoff distance required. This is achieved by optimising the aircraft configuration and takeoff thrust setting for the takeoff distance available (TODA).

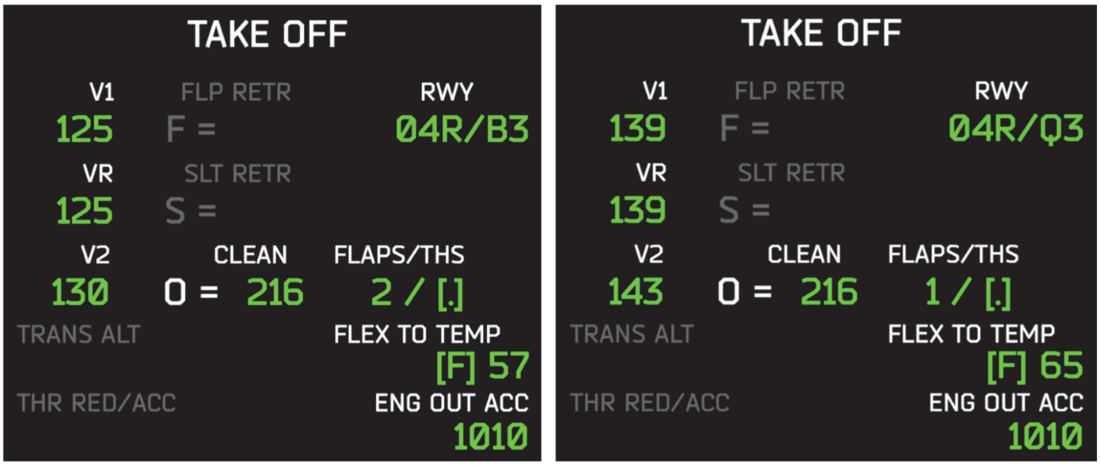


Figure 2

Indicative performance comparison for
NCE RW04R intersection B3 (left) and Q3 (right)

Personnel

The aircraft commander recalled carrying out a '*departure point distance confirmation*' during the pre-flight preparation. He made the following observation after the incident: "…although I believe we were thorough and conscientious, the error failed to be trapped". As a result of this incident, he has reinforced his departure threat and error management briefing to include a review of possible departure intersections and their associated takeoff performance implications. He has also added a dedicated TODA cross-check between EFB and airfield charts to his pre-takeoff PEDS[3] review.

Other information

The flight crew considered that the performance calculation software's user-interface was a factor in the intersection selection error being made and missed. It was the aircraft commander's view that "EFB Toughbook data entry is clumsy and often requires re-entering especially runway details and, at NCE, B3 and Q3 appear next to each other and are easy to mis-select". The investigation found that the operator was in the process of introducing an EFB performance software update that placed greater emphasis on a graphical, rather than text-based, representation of runway dimensions and associated intersections. The accuracy of outputs from the revised system would still be subject to the normal limitations of human performance associated with data entry tasks.

The aircraft manufacturer was in the process of making its '*second step of the Takeoff Surveillance (TOS2) functions,* [first] *introduced on A350 aircraft in 2018*,'[4] available on the A320 and A330 families of aircraft. TOS2 is an automated function which includes checks

Footnote

[3] A final review of calculated takeoff performance (P), emergency turn procedure (E), expected departure routing (D) and initial stop-climb altitude (S).

[4] Safety First, The Airbus Safety Magazine: Takeoff Surveillance & Monitoring Functions, October 2019. Available at: https://safetyfirst.airbus.com/takeoff-surveillance-and-monitoring-functions [accessed 18 December 2019].

to confirm that the aircraft is on the intended runway and that the takeoff performance data entered by the flight crew is '*compatible with the runway distance available*.' The ability to retrofit TOS2 on an individual A320-family aircraft is dependent on that aircraft's '*exact system configuration.*' The incident aircraft was not TOS2-capable.

Analysis

Comparison of indicative takeoff performance parameters for B3 and Q3 departures indicated that the only credible explanation for the calculation error was mis-selection of Q3 by both pilots. It was not determined why the '*departure point distance confirmation*' check referred to by the commander did not alert the crew to the mis-selections. This incident showed that simultaneous independent errors were possible and that an EFB output cross-check and TORA cross-check would not necessarily trap them.

The aircraft commander reported that the EFB software user-interface was "clumsy"and prone to errors which, once made, were difficult to detect. The operator's proposed EFB software update would bring an improved graphical user-interface. The limitations of human performance mean that any system relying on user-entered data is unlikely to be infallible.

An independent automated check, such as the Airbus TOS2 function, could provide an additional barrier to prevent a performance calculation error contributing to an accident.

Conclusion

This incident resulted from identical independent errors not being trapped by a TORA cross-check or by EFB output validation. While revised software with a graphical runway presentation could have helped reduce the likelihood of this occurrence. Automated systems, such as TOS2, could, in the future, provide an effective barrier to incidents of this nature.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-PRPK
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2008 (Serial no: 4203)
Date & Time (UTC):	22 July 2019 at 0630 hrs
Location:	En route from Edinburgh Airport to London City Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 56
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	12,582 hours (of which 8,332 were on type) Last 90 days - 180 hours Last 28 days - 56 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a scheduled flight from Edinburgh Airport to London City Airport the CABIN PRESS warning illuminated and the crew initiated an emergency descent. The aircraft diverted to Birmingham and landed without further incident. Following some rectification work the aircraft was returned to service later that day.

During the ensuing weeks the aircraft experienced several more pressurisation events until the operator decided to withdraw it from service for in-depth engineering investigation, after which it was returned to service again. To date no more pressurisation events have been reported.

The operator has taken safety action intended to enhance the monitoring of recurring aircraft faults.

History of the flight

The aircraft was on a scheduled flight from Edinburgh Airport to London City Airport. While in the cruise at FL250, in the vicinity of Manchester, the CABIN PRESS warning illuminated. The flight crew checked the cabin pressurisation indications and noticed that the cabin altitude indicated 10,000 ft with no indication of it increasing. Also, there was no FAULT light illuminated on the pressurisation control panel.

The PF called for the appropriate checklist, the first item of which was to determine whether the cabin altitude exceeded 10,000 ft, before determining whether an emergency descent was required. As the cabin altitude was now indicating at or slightly above 10,000 ft with a slow rate of climb, the PF called for an emergency descent, which was initiated. After donning their oxygen masks the crew notified ATC and obtained clearance to descend, initially to FL200 and then to FL100 having declared MAYDAY.

During the descent, at about FL150, the CABIN PRESS warning light extinguished, and the cabin pressure indications appeared normal in terms of rate change and cabin pressure. This suggested to the flight crew that the pressurisation controller was still operating. During the descent, the PM called the cabin crew and updated them on the situation.

When level at FL100, the flight crew decided to divert to Birmingham and the senior cabin crew member was called to the flight deck and given a NITS[1] briefing. The cabin crew reported no injuries or concern from the passengers.

Once below FL100 the crew removed their oxygen masks. As pressurisation indications now appeared normal, the MAYDAY was cancelled, and the aircraft landed without further event at Birmingham. After shutdown, the flight crew isolated the CVR and FDR by pulling their respective circuit breakers in accordance with the operator's procedures.

Aircraft examination

Soon after being notified of the event the AAIB released the aircraft for maintenance action and entry back into service. The operator assumed this included the CVR and FDR. The CVR was subsequently overwritten after the aircraft returned to service and thus not analysed.

During the engineering investigation no faults were indicated on the cabin pressure control panel. Also, there were no messages on the central diagnostic system when the aircraft was pressurised in automatic and manual modes to the maximum permitted differential pressure. The aircraft was returned to service the same day when it flew from Birmingham to Edinburgh without event.

Additional events

Between 23 July 2019 and 17 September 2019, in the course of over 260 sectors, the aircraft had a further nine pressurisation events that caused the commander on each occasion to raise an entry in the aircraft's technical log pages (TLP). After each TLP entry some form of maintenance action was subsequently carried out. During this time there were several periods were the aircraft flew for over a week with no reported pressurisation issues.

On 17 September 2019, another pressurisation event resulted in another emergency descent in which the crew donned their oxygen masks. At this point the operator withdrew the aircraft from service for an in-depth engineering investigation.

Footnote

[1] A standard form of briefing that considers the Nature of the situation, Intentions, Timings and Special instructions (NITS).

As a result of the rectification work the aircraft was returned to service on 28 September 2019. From then until the time of writing this report the aircraft flew 109 sectors with no further pressurisation events reported.

Operations manual

Part A Section 2.3.6 of the operator's operations manual states:

> *'Any safety events occurring during … aircraft operations are to be reported using the Company safety reporting processes* [an Air Safety Report].*'*

Operator's investigation

During the operator's internal investigation into this and the additional nine pressurisation events it was noted that an Air Safety Report (ASR) had not been raised for six of these events. As a result, the operator issued a notice to all its flight crew (NOTAC 101/19) on 9 August 2019 with guidance on the reporting of such events.

However, there were four further events (not all involving the pressurisation system) involving this aircraft for which the crew did not raise an ASR. The operator reported that its safety team visited all its bases to reinforce to its crew and engineers that, without exception, safety reports must be submitted for all safety related events.

Engineering monitoring

The pressurisation events on G-PRPK reported between 23 July and 17 September 2019 were discussed during the operator's daily Technical Operations review meetings, but the aircraft continued to operate until it was withdrawn from service by the Duty Technical Manager in Maintenance Control.

These recurring events were not noted in the operator's Aircraft Maintenance and Engineering System (AMOS) maintenance database until 12 September 2019.

Engineering reliability programme

AMC (Acceptable Means of Compliance) to Annex I of Part M to Regulation (EU) No 1321/2014[1] states the following:

> *'M.A.302 (d) 6: Some approved aircraft maintenance programmes,…,utilise reliability programmes. Such reliability programmes should be considered as a part of the approved maintenance programme.*
>
> *M.A.302(f) 5: A reliability programme provides an appropriate means of monitoring the effectiveness of the maintenance programme.'*

The operator commented that its reliability department did not discuss the pressurisation issue on this aircraft between July and October 2019.

Discussion

This pressurisation event and subsequent emergency descent on 22 July 2019 appear to have been handled appropriately, and the diversion to Birmingham was completed without further incident. However, the conduct of the crew could not be analysed because the CVR had been returned to service and overwritten.

Subsequent pressurisation events highlighted an inconsistency in the completion of ASRs by the operator's crews.

There were several periods during which the aircraft flew with no reported pressurisation issues. This may have led the engineers to believe they had resolved the issue.

After the ninth event, involving another emergency descent, the operator withdrew the aircraft from service and conducted an in-depth investigation into the recurring fault. Several bleed air and pressurisation components were replaced before the aircraft returned to service.

The absence of further reported pressurisation faults since the aircraft returned to service indicates that this intervention was successful. It is therefore possible that several events, including the second emergency descent, would have been avoided if this intervention had occurred sooner.

Safety actions

The operator has taken safety action in the following areas as a result of these occurrences:

> The operator issued a notice to all its flight crew (NOTAC 101/19) on 9 August 2019 with guidance on the reporting of safety events. It also conducted a 'roadshow' for crews and engineers at all its bases, encouraging the submission of ASR reports.
>
> The operator has initiated a review of its reliability program to, among other things, enable more robust monitoring of recurring defects.

SERIOUS INCIDENT

Aircraft Type and Registration:	Embraer E55P Phenom, D-COLT
No & Type of Engines:	2 Pratt & Whitney Canada PW535E turbofan engines
Year of Manufacture:	2014
Date & Time (UTC):	12 March 2019 at 1505 hrs
Location:	Runway 23R, Manchester Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	4,933 hours (of which 746 were on type) Last 90 days - 22 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries made by the AAIB

Synopsis

While the aircraft was lining up on Runway 23R from intersection J1 at Manchester Airport, the sun's glare on the wet runway made it difficult for the pilot to see the runway markings. He aligned the aircraft with the runway edge stripe, rather than the centreline and, as instructed by ATC, commenced a rolling takeoff.

The ATCO noticed the misalignment and instructed the aircraft to abandon its takeoff, which it did without damage or injuries to those onboard. Several safety actions have been undertaken by the airport authority and the air traffic service unit.

Description of the event

The pilot was performing his third departure in D-COLT from Manchester Airport, the first on that day. He reported that while holding at holding point J1 (Figure 1), he received an ATC instruction to line up and wait on Runway 23R after a landing aircraft. He recalled that when lining up, he accepted an ATC request for a rolling takeoff[1] because of an aircraft on final approach. D-COLT was then cleared for takeoff.

Footnote

[1] A 'rolling takeoff' involves an aircraft taxiing on to the runway and commencing its takeoff roll without stopping. The air traffic services unit stated that this is not a standard phrase in use at Manchester and did not provide a recording or transcript to determine if it was used on this occasion.

The pilot reported rain and gusty conditions. While he was lining up, the sun breaking through the clouds caused glare from the wet runway, making it difficult to see. As he taxied past the angled edge of the turning circle, he perceived it to be the edge of the runway shoulder[2] (Figure 1). Then on sensing that the aircraft was running over runway lights, he thought the aircraft was on the centreline. He turned the aircraft accordingly and was facing the low sun as he began the takeoff roll.

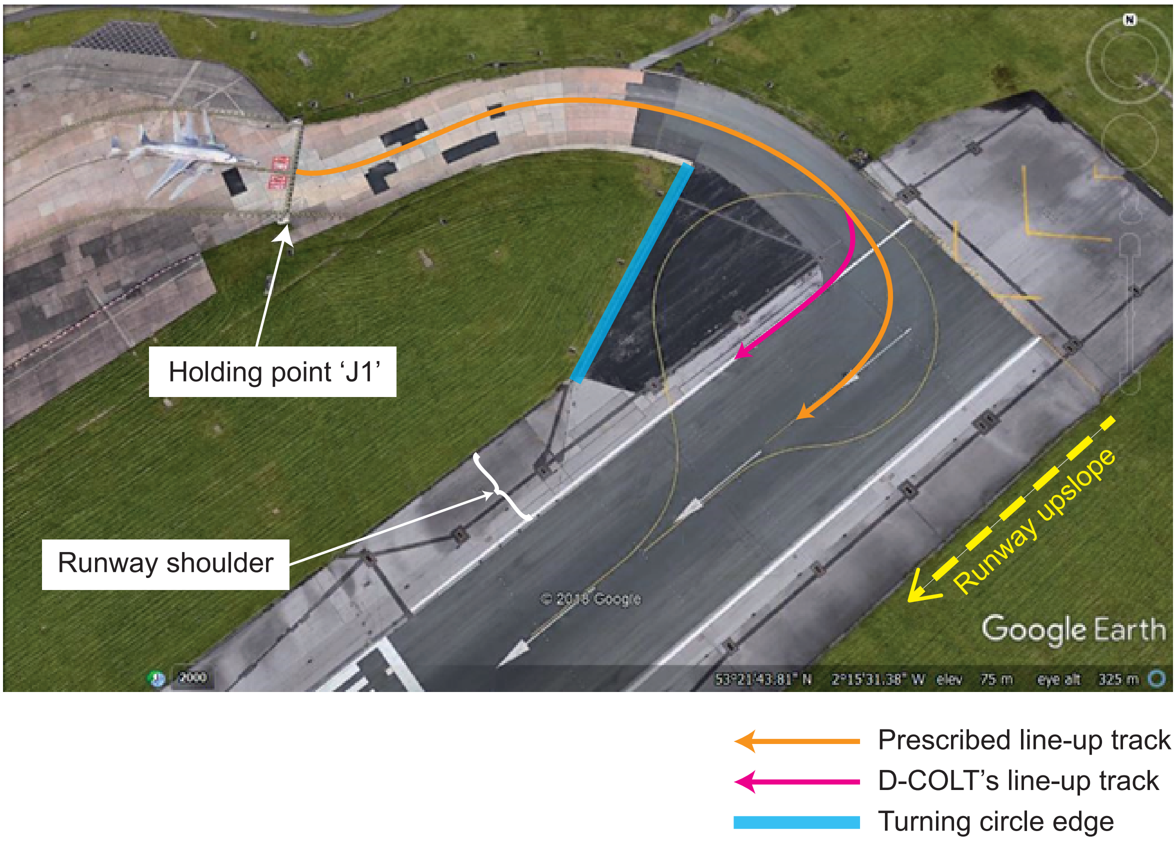


Figure 1

J1 intersection showing D-COLT's line-up track

The runway's lighting was on a 'day' setting which meant the runway edge lights were in operation, and the lead-on[3] lights were not.

The ATCO, watching from the visual control room (VCR), realised the takeoff didn't look "right". He checked the surface movement radar (SMR) which showed D-COLT tracking the right runway side stripe, so instructed the aircraft to stop and cancelled its takeoff clearance. He instructed the aircraft on final approach to go around.

Footnote

2 An area between the edge of the runway and the adjacent surface, for assisting aircraft running off the pavement; drainage; and sometimes blast protection.

3 Alternating green and yellow lights which guide aircraft on and off the runway.

D-COLT's pilot recalled hearing "D-COLT, stop taking off, stop taking off" from ATC so promptly rejected the takeoff[4]. He recalled the aircraft's airspeed to have reached around 80-90 KIAS. While decelerating, he realised the aircraft was misaligned on the runway. He reported that the aircraft came to a halt next to F1 (Figure 2), then after a conversation with ATC he taxied again for departure without delay.

Aircraft information

The Embraer E55P Phenom is a twin engine corporate jet flown in this case by a single pilot[5].

Airfield information

Aeronautical Information Publication

The UK Aeronautical Information Publication for Manchester Airport stated that Runway 23R was 45 m wide, with widened runway shoulders of 23 m on either side of the side stripe markings, giving a total paved width of 91 m.

It outlined *'Surface movement guidance and control system markings'*[6] including:

> *'Runway marking aid(s): …05L/23R: Runway designation. Runway threshold, runway centre-line, edge, TDZ and fixed distances. Runway width is designated by side stripe markings…*
>
> *Stopbars[7] at runway entrance points are in operation H24…*
>
> *Pilot attention is drawn to the use of additional paint markings at specified runway entrance and exit points. These markings are provided as an additional measure to raise situational awareness and to reduce the runway incursion risk.'*

Pilots' airport charts

The pilot was using commercially available airport charts[8] for Manchester[9].

Chart 10-1P2 '*Airport briefing' – 'Taxi procedures*' section stated:

> *'RWY05L/23R has a turning circle at the Northeastern end, ABEAM Link J, for use by ACFT up to A380…*
>
> *All turning circles have unlit painted centerline and blue edge lighting beyond the RWY edges.'*

Footnote

4 This is a recollection and not a transcript of the words transmitted by the ATCO.
5 Referred to as a single-crew operation – as opposed to a multi-crew operation which requires two or more pilots.
6 AD 2.EGCC-1 (31 Jan 2019)
7 Stopbar – a set of unidirectional red lights embedded in the pavement across the width of the taxiway at runway holding positions. Aircraft should not cross stopbars when they are illuminated.
8 Airfield charts – booklets which present information from the AIP for operational use by pilots.
9 Accessed 15 Aug 2019 – some of the individual charts cited in this report had been amended after the date of the accident. However the information quoted was validated using Manchester's AIP, or because it referred to dimensions and structural characteristics of the runway surface, and therefore was unlikely to have changed.

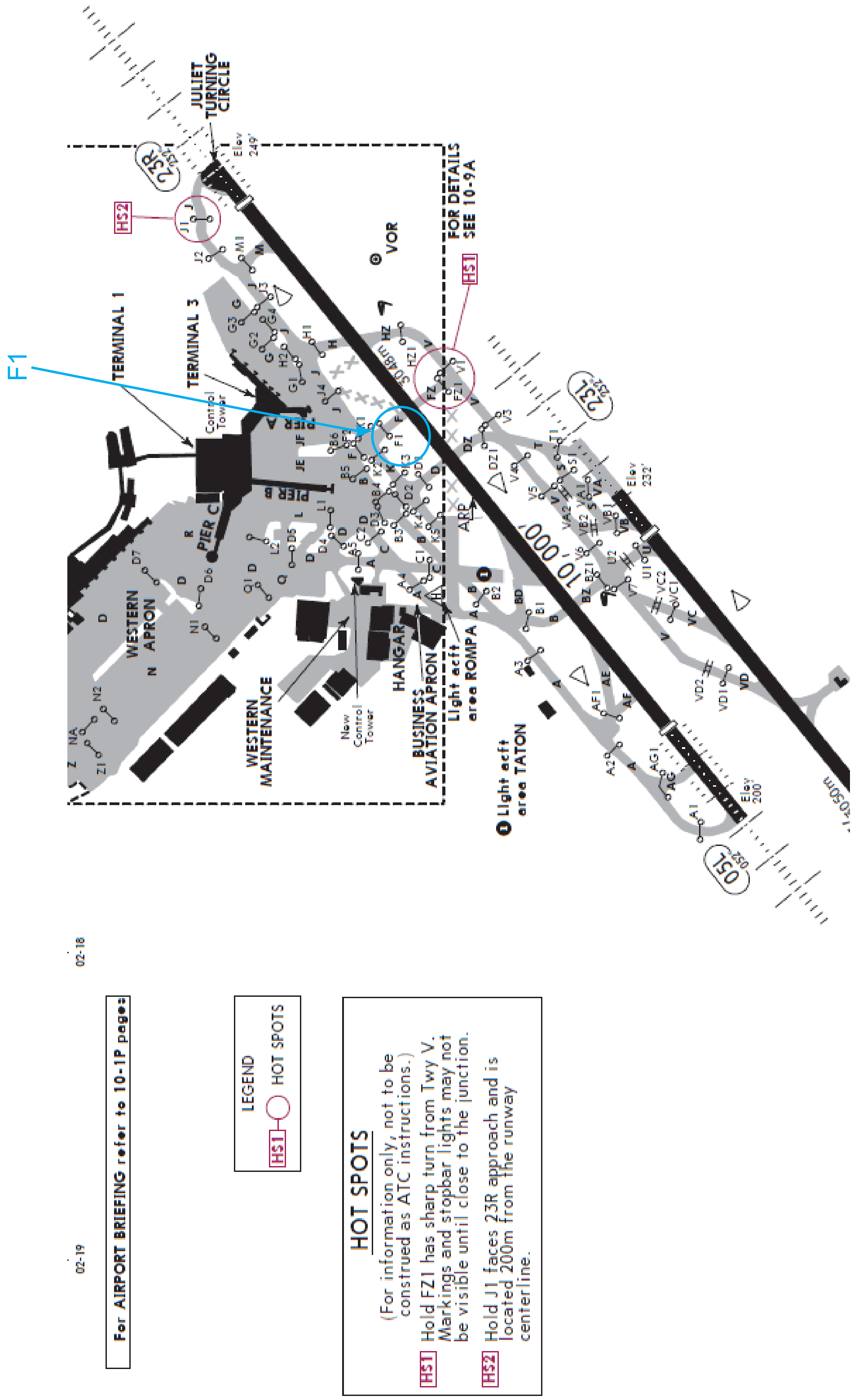


Figure 2

Excerpt from chart 10-9

The section later stated:

> *'RWY05L/23R: The hard shoulders outboard of the RWY side stripes have only 25% of the RWY bearing strengths and should not be used by ACFT turning on the RWY or when backtracking…'*

Chart 10-1P3 stated:

> *'Pilots should note that RWY05L/23R has a convex profile, the highest point is ABEAM TWY HZ.'*

Chart 10-1P6 stated:

> *'When lined up for take-off from RWY05L/23R, the full length of the RWY surface may not be visible from the flight deck.'*

The pilot used chart 10-9 during taxiing (Figure 2). Following is an excerpt of that plate, including Runway 05L/23R; Juliet turning circle; Hot Spot 2[10] and its definition; and HZ.

Previous event

On 7 March 2018 at 1527 hrs a Cessna Citation, S5-ICR, lined up on Runway 23R via intersection J1 and began its takeoff roll. The ATCO, who was the same person as the ATCO subsequently involved in the D-COLT occurrence, noticed S5-ICR appeared to be tracking the right runway side stripe. This was confirmed by checking the SMR. He reported attempting to alert the crew saying '[CALLSIGN] YOU APPEAR TO BE OFFSET TO THE RIGHT OF THE RUNWAY, CONFIRM YOU ARE CORRECTING TO THE CENTRELINE'. However, he stated that he used the incorrect callsign, and received no response. Then S5-ICR became airborne.

The air navigation service provider (ANSP) Management System Safety Report for that occurrence described the weather as 'good daylight', and the runway as mainly dry. It stated that the crew subsequently reported having no recollection of anything unusual.

Information from the pilot

D-COLT's pilot stated that when lining up he would normally taxi the aircraft forward to the runway centreline and then turn in the takeoff direction. In this event he believed he was distracted by a combination of the takeoff clearance discussion during line-up and the disorienting effect of the sun's glare on the wet runway. He was conscious of the inbound traffic, and the rolling takeoff reduced the opportunity to check his position.

Footnote

10 A location on an aerodrome movement area with a history or potential risk of collision or runway incursion, and where heightened attention by pilots/drivers is necessary. (ICAO Doc 9870, Manual on the Prevention of Runway Incursions).

The pilot commented that he mainly operated D-COLT at smaller airfields with runway widths of less than 30 m. He indicated that he was aware of the convex profile of Manchester's Runway 23R but the "picture" of what he thought was the lit centreline in front of him, with 23 m of paved surface to the side, seemed normal to him.

The pilot reported the event has reminded him not to forget "aviation basics". He cited other ways to orientate the aircraft's position during lining up, including using the ILS localiser[11], the aircraft's synthetic vision system[12], and thorough briefing.

The sun's orientation could be considered in threat and error management[13] (TEM).

Information from ATC

Manchester air traffic services unit

The ATCO reported that while he saw D-COLT moving on to the runway he was also monitoring the aircraft vacating the runway and the aircraft on final approach. The General Manager of the air traffic services unit (ATSU) reported that it can be difficult to determine the precise position of aircraft entering the runway at J1, which is some distance from the VCR and involves a large expanse of tarmac. The ATCO stated that in both occurrences he used SMR to confirm the aircrafts' positions (Figure 3).

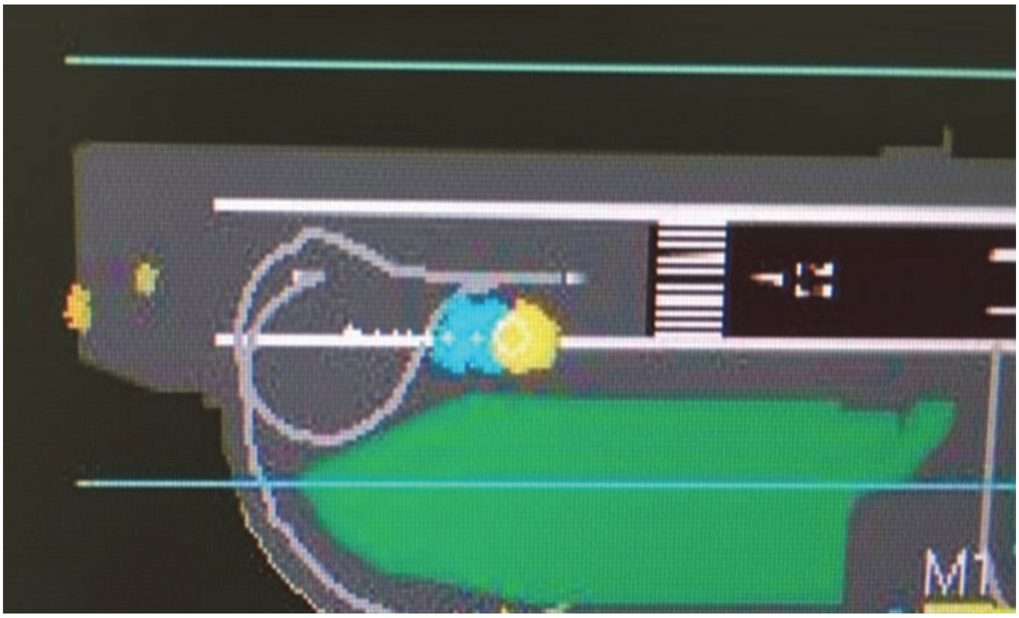


Figure 3

Image of SMR at the commencement of D-COLT's takeoff roll

Footnote

11 The part of the instrument landing system which guides aircraft in azimuth.
12 Combines three-dimensional data into intuitive displays, for improved situational awareness of flight crew.
13 TEM – dynamic process by which pilots identify threats and potential errors, and implement strategies to manage them. TEM can be included in crews' departure and arrival briefings.

The ATCO stated that upon realising D-COLT was tracking the runway edge stripe, he considered its airspeed as being in the mid-range of its takeoff roll. Given the runway shoulder's lower load bearing strength, he was concerned about potential debris from it, so he instructed the aircraft to stop. He recalled it was in the vicinity of M1 (Figures 2 and 3) when he did so.

The ATSU Investigation Report for the D-COLT occurrence stated:

> *'The controller reacted swiftly and showed good scanning technique in observing the incorrect positioning of the aircraft at such an early stage.'*

Under the heading '…Learning points to be shared within unit and across NATS' that report stated:

> *'The importance of using the SMR to ensure that departing aircraft are correctly lined up on the runway prior to departure. This is especially pertinent when small aircraft are operating on large runways (and with large shoulder areas) like Manchester Runway 23R via HP. J1'*

Regulations

The CAA's CAP 493, Manual of Air Traffic Services (MATS), Part 1, states under *'Cancelling Take-off Clearance'*:

> *'…In certain circumstances the aerodrome controller may consider that it is necessary to cancel take-off clearance after the aircraft has commenced the take-off run. In this event the pilot shall be instructed to stop immediately and to acknowledge the instruction.*
>
> *…The cancellation of a take-off clearance after an aircraft has commenced its take-off roll should only occur when the aircraft will be in serious and imminent danger should it continue.*
>
> *…As the aircraft accelerates, the risks associated with abandoning the take-off increase significantly. For modern jet aircraft, at speeds above 80kt flight deck procedures balance the seriousness of a failure with the increased risk associated with rejecting the takeoff. For example, many system warnings and cautions on the flight deck may be inhibited during the take-off roll, and between 80kt and V1 most aircraft operators define a limited number of emergency conditions in which the take-off will be rejected. Consequently, at speeds above 80kt, the take-off clearance should normally only be cancelled if there is a serious risk of collision should the aircraft continue its take-off, or if substantial debris is observed or reported on the runway in a location likely to result in damage to the aircraft. The critical speed will be dependent on the aircraft type and configuration, environmental conditions and a range of other factors but, as a general rule, for modern jet aircraft, it will be in the region of 80kt airspeed. The typical distance at which a jet aircraft reaches 80kt is*

approximately 300m from the point at which the take-off roll is commenced. The unit MATS Part 2 shall contain further guidance on the likely position on the runway at which those aircraft types commonly using the aerodrome typically reach 80kt.'

Manchester's MATS, Part 2, stated under *'Cancellation of takeoff clearance'*:

'MATS Part 1 provides guidance for controllers when considering the cancellation of a take-off clearance after an aircraft has commenced its take-off roll.

There are very few circumstances in which it is appropriate to cancel a take-off clearance when an aircraft is travelling at significant speed. The following maps[14] present a guide to controllers on the points beyond which it is likely that an aircraft taking off will be travelling in excess of 80kt. If the aircraft has passed the appropriate point, the cancellation of a take-off clearance should only occur when the aircraft is in serious and imminent danger.'

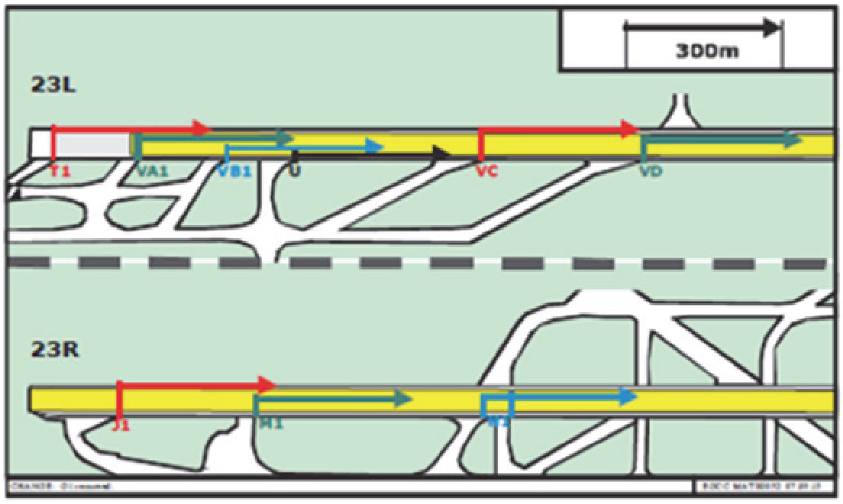


Figure 7 Cancellation of Take-Off Clearance map - Westerlies

Information from the airport authority

The airport authority reported that, in accordance with its procedure for runway excursions[15], a runway inspection was performed immediately after the event[16] and assessed the condition of the painted line leading on to the runway as "good". It explained that hot spots are normally associated with runway incursion[17] events.

Footnote

14 Only the map for westerly takeoffs is included in this report because of its relevance to this serious incident.
15 Runway excursion – A veer off or overrun of the designated runway surface.
16 A runway inspection was also performed after the S5-ICR occurrence.
17 Runway incursion – The incorrect presence of an aircraft, vehicle, or person on the designated runway surface.

Analysis

Lining up

Both the D-COLT and S5-ICR serious incidents involved aircraft lining up on the right edge stripe of Runway 23R, via intersection J1.

J1 was already a hot spot for runway incursions because of its obtuse orientation to, and distance from, the runway centreline. The shape of the turning circle, the 23 m widened runway shoulders, the lit runway edge lights and the unlit lead-on lights, may have contributed to the pilots' mis-perception of the centreline position. Furthermore, the relatively small size of both aircraft would have caused increased difficulty for the pilots seeing over the runway's convex profile, along its full length.

D-COLT's pilot was operating as the sole pilot, without what would be the additional support provided by a multi-crew operation. Despite the painted runway lead-on line, the sun's glare on the wet runway caused him difficulty in seeing. Further, the amended line-up clearance due to inbound traffic, and the prompt nature of the rolling takeoff, reduced his opportunity to check the aircraft's position. Therefore, though he had departed Manchester on two previous occasions, the pilot was unaware he was tracking the edge stripe until after he had been asked to stop by ATC. Because he was used to operating D-COLT from smaller airfields, lining up on a lit stripe with 23 m of paved surface to the side looked normal to him.

As a result of the two occurrences the airport authority has undertaken to instate a 'runway excursion' hotspot at J1, in addition to the incursion-related hotspot 2. It is reconfiguring its lighting so that J1's lead-on lights will always illuminate when its stopbar is lowered, regardless of the ambient light conditions. It intends to apply green paint to the areas of the J1 turning circle outside of the runway edge lighting, giving the impression of grass.

The ANSP confirmed it is undertaking safety action to promulgate the lessons from both occurrences across all its airport units, by including them in its upcoming annual refresher training course for ATCOs and otherwise. This will highlight the use of SMR for monitoring aircraft lining up, particularly small aircraft on large runways with wide shoulders.

That monitoring function would be particularly beneficial for aircraft operated by a single pilot.

The D-COLT and S5-ICR events occurred at a similar time of day, a similar time of year, and therefore with a similar orientation of the sun. Ambient light conditions could be included in threat and error management by pilots and ATCOs.

Further, aside from careful taxiing using airfield charts, the aircraft's line-up track could be briefed by pilots, and then confirmed by the localiser and synthetic vision system.

Cancelling of takeoff clearance by ATCOs

Despite it being difficult to determine the precise position of aircraft entering the runway at J1 as seen from Manchester's VCR, on both occasions the same ATCO noticed the involved aircraft's misalignment, checked SMR, and transmitted messages to alert the aircraft.

MATS parts 1 and 2 explain that the risks associated with abandoning the takeoff increase significantly as the aircraft accelerates. For speeds above 80 KIAS, most operators define a limited number of conditions which require the takeoff to be rejected. Therefore, ATCOs should only cancel a takeoff clearance for aircraft travelling above 80 KIAS if there is a serious risk of collision, or if substantial debris is observed or reported on the runway in a location likely to result in damage to the aircraft.

In the S5-ICR event, the ATCO attempted to alert the crew by describing the problem: "… YOU APPEAR TO BE OFFSET TO THE RIGHT OF THE RUNWAY, CONFIRM YOU ARE CORRECTING TO THE CENTRELINE". However, he used the incorrect callsign, which may be why he received no response.

In the D-COLT event, although the ATCO could not see any debris, he was concerned about the risk of it from the lower-strength runway shoulder, so instructed the aircraft to stop. The aircraft was in the vicinity of M1 – which is around the '80 KIAS' point described by MATS 2 – with a reported airspeed in the vicinity of 80 KIAS, when he did so. The aircraft stopped safely and taxied back for a second departure without delay.

Through effective scanning by the ATCO and aircraft handling by the pilot, and prompt reactions by both, the outcome of the D-COLT event was successful. However, in cases involving accelerating aircraft that are not in serious and imminent danger, it is possible that pilots would prefer to receive a concise description of the problem, similar to the message transmitted to S5-ICR. They can then make a 'stop or go' decision based on an assessment of airspeed, risk of stopping, and their operator's procedures.

Conclusion

The aircraft began taking off on the edge stripe of Runway 23R at Manchester after lining up via intersection J1. The sun's glare on the wet runway, and the orientation, dimensions and slope of the intersection and runway surfaces, contributed to the pilot misidentifying the centreline. The rolling takeoff reduced his opportunity to check the aircraft's position.

As a result of this and a previous similar event, the airport authority is implementing several safety actions to assist pilots lining up at J1.

The ANSP stated that it intends to include the lessons from both events in its annual refresher training for ATCOs, and in other training opportunities.

Safety actions

As a result of the D-COLT and S5-ICR serious incidents the following safety actions have been taken.

The airport authority has undertaken to:

- Instate a 'runway excursion' hotspot at J1.
- Reconfigure J1's lead-on lights so that they will always illuminate when its stopbar is lowered.
- Apply green paint to the areas of the J1 turning circle outside of the runway edge lighting, giving the impression of grass.

The ANSP has undertaken to:

- Promulgate the lessons learned from both occurrences across all its airport units, by including them in its upcoming annual refresher training course for ATCOs and otherwise; and by highlighting the use of SMR for monitoring aircraft lining up, particularly small aircraft on large runways with wide shoulders.

ACCIDENT

Aircraft Type and Registration:	Velos Single Rotor, (UAS, registration n/a)
No & Type of Engines:	2 Xnova 4035-400KV 3Y
Year of Manufacture:	2018 (s/n VUAV10417006)
Date & Time (UTC):	18 September 2019 at 1435 hrs
Location:	Hangingstone Hill, Dartmoor, Devon
Type of Flight:	Aerial Work
Persons on Board:	Crew - N/A Passengers - N/A
Injuries:	Crew - N/A Passengers - N/A
Nature of Damage:	Damaged beyond economical repair
Commander's Licence:	Other
Commander's Age:	48 years
Commander's Flying Experience:	533 hours (of which 21 were on type) Last 90 days - 18 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The single rotor UAS was being flown back to its landing site when it pitched up, uncommanded, and lost control. Assessment of the UAS flight data identified that an ESC fault caused one of the UAS's motors to run down. The increased load required to maintain the aircraft in flight depleted the battery power rapidly, resulting in the loss of control. The telemetry screen, that would have alerted the pilot of the ESC failure, was not in the pilot's field of view.

History of the flight

The single rotor UAS had completed a 13-14 minute automated survey flight in an area of the Dartmoor national park. Once the survey had been completed the pilot took control of the UAS and flew it back towards the Take Off and Landing Site (TOLS). During the return flight the pilot noticed that the aircraft was slowly descending, so he increased the collective input in an attempt to climb back to the original height. This did not have an effect, so he gently reduced the collective input and pulled back on the cyclic control to reduce forward speed. As he did so the UAS pitched up violently and then fell to the ground from approximately 30 ft agl.

Aircraft information

The Velos single rotor UAS helicopter (Figure 1) is capable of carrying varied deployable and fixed payloads such as survey equipment and cameras.

Figure 1

Example of Velos single rotor UAS with underslung camera as payload
(image reproduced with permission)

Two individual Electronic Speed Controller (ESC) controlled motors combine to provide power to a 1,950 mm diameter main rotor. In the event of a single ESC or motor failure, the UAS can fly using the remaining functional ESC and motor. The controls are the same as a conventional helicopter with a collective control which changes the pitch of all the main rotor blades simultaneously to control vertical movement, and a cyclic control which controls the pitch of individual blades to provide pitch and roll control, a yaw control provides directional control through a variable pitch tail rotor. The total mass of the UAS involved in this accident was 19.8 kg.

The pilot was operating the UAS by visual line of sight, supplemented by two First Person View (FPV) cameras on the aircraft which transmitted forward and rearward video streams to two monitors positioned in front of the pilot. Another monitor, which displayed the aircraft telemetry, was positioned behind the pilot and was not directly in his line of sight.

Recorded data

Recorded data from the accident flight was downloaded and interpreted by the UAS manufacturer. The manufacturer determined that the UAS was returning to the TOLS after completing its desired activity when the accident occurred. It was toward the end of the flight and the batteries were in a low energy state.

The data showed that three minutes prior to the end of the flight the left ECS malfunctioned. This resulted in it and the left motor shutting down, for the remainder of the flight. As the malfunction occurred, a short circuit was recorded across the batteries. This lasted for approximately one second and reduced the battery voltage to below their minimum operational level.

After the loss of the left motor, the right motor was commanded to increase its output. This increased the right motor current load, which in turn reduced the battery voltage further[1]. To maintain the main rotor speed the governor started to compensate for the lowering voltage by increasing the current demand.

Approximately one minute before the loss of control, the right governor was demanding 100% power to maintain the required rotor speed, however the available voltage diminished to a level where the batteries no longer had sufficient charge to maintain it. The rotor speed then dropped below that able to sustain flight, resulting in the aircraft pitching up.

It was not possible to determine the cause of the ESC failure; however, it should have been possible for the UAS to land away from the TOLS in the event of a single ESC failure. The pilot flying the UAS was operating alone in visual line of sight, supplemented by using FPV and was not monitoring the telemetry which was shown on a separate screen positioned behind him as he flew the aircraft. Had he been monitoring the telemetry screen he may have noticed cautions regarding the ESC failure and the rapidly diminishing battery charge which should have prompted the pilot to land the UAS immediately. The position of the screens had been optimised for the planned mission but did not allow easy viewing of vital information which could have prevented the accident.

Footnote

[1] During normal operation the load is shared between the two motors, but when operating on a single motor, the load on that motor is more than double the normal load.

AAIB Record-Only Investigations

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

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

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed January - February 2020

27-Jun-19 **Piper PA-25-235 Pawnee** **G-BETM** Sutton Bank Airfield

On landing the pilot found the right brake ineffective and the aircraft struck a hangar to its left. The pilot reported that the right brake shoe was missing.

04-Aug-19 **Societe Menavia Scintex CP301-C3** **G-BIVF** Eshott Airfield, Northumberland

The pilot lost of control of the aircraft during landing and the propeller struck a fence.

19-Oct-19 **Piper PA-28-161** **G-BHRC** Nottingham Airport

The aircraft caught fire after starting. The pilot believed this may have been caused by overpriming the engine.

09-Nov-19 **Evans VP-1 Series 2** **G-BIFO** Eshott Airfield, Northumberland

A loss of control on landing resulting in a landing gear collapse and the propeller striking the ground. The pilot had just completed a tail wheel conversion course and this was the first flight in G-BIFO.

29-Dec-19 **Piper PA-28-181** **G-LVRS** Elstree Aerodrome, Hertfordshire

An engine bay fire started on the ground after a fourth attempt to start the engine. It is likely that the engine was over-primed.

03-Jan-20 **Piper PA-28** **G-LIZI** Sibson Aerodrome, Cambridgeshire

The aircraft hit a tree during glide approach practice in low light conditions, but was able to land after going around. The pilot reported that the approach profile and light conditions contributed to the accident.

18-Jan-20 **Cessna 150** **G-BFIY** Blackbushe Airport

The aircraft caught fire during start, possibly because of over-priming of the engine.

07-Feb-20 **EuroFox 912(S)** **G-OASK** Fife Airport

The aircraft landed in soft ground short of tarmac Runway 06 at Fife Airport. It tipped onto its nose and sustained damage to the propeller and nose landing gear. The pilot assessed that he had misjudged the final approach due to lack of currency.

Record-only investigations reviewed January - February 2020

08-Feb-20 **Piper PA-28** **G-BTGO** Gloucester Airport

A student pilot, who was on a cross country flight, was returning to his home airfield. During the takeoff run, with a strong crosswind, the aircraft departed the left side of the runway and onto the grass. There was minor damage to the nosewheel assembly.

01-Mar-20 **Piper PA-46** **G-XSCP** Gloucester Airport

The propeller and landing gear were damaged when the aircraft left the paved runway surface on landing, having been affected by a gusting crosswind.

Miscellaneous

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

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

BULLETIN CORRECTION

Aircraft Type and Registration:	Sikorsky S-61N Sea King, G-ATBJ
Date & Time (UTC):	1 February 2018 at 1100 hrs
Location:	Marchwood, Hampshire
Information Source:	AAIB Field Investigation

AAIB Bulletin No 3/2020, page 20 refers

The report published on 30 January 2020 and which is also included in AAIB Bulletin 3/2020, incorrectly stated that the swashplate vertical play was measured as **0.008 in, 0.001 in** outside of limits.

The text should read:

> During the assessment, the vertical play was measured as **0.080 in, 0.010 in** outside of limits and so the shim was adjusted to increase spherical bearing clamping.

The online version of this report was corrected on 12 March 2020.

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

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

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

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

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

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

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

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

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

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

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

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

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

Air Accidents Investigation Branch