AAIB
Air Accidents Investigation Branch

AAIB Bulletin 9/2019

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AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.

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AAIB Air Accidents Investigation Branch

AAIB Bulletin S2/2019 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	Piper PA-46-310P Malibu, N264DB
No & Type of Engines:	1 Teledyne Continental TSIO-520-BE engine
Year of Manufacture:	1984 (Serial no: 46-8408037)
Date & Time (UTC):	21 January 2019 at 2016 hrs
Location:	22 nm north-north-west of Guernsey
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Missing) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	Approximately 3,500 hours (of which approximately 30 were on type) Last 90 days - approximately 20 hours Last 28 days - approximately 7 hours
Information Source:	AAIB Field Investigation

Introduction

The accident occurred on 21 January 2019 at 2016 hrs. The wreckage was located on 3 February 2019 on the seabed approximately 22 nm north-north-west of Guernsey, within 100 m of the last secondary radar point recorded by the radar at Guernsey and at a depth of 68 m. There was one body present in the wreckage, which was recovered. The body was subsequently identified as that of the passenger.

The AAIB published Special Bulletin S1/2019 on 25 February 2019[1] to give preliminary information on the investigation and general information about how aircraft registered in the USA may be operated between the UK and France.

This Special Bulletin contains medical information relevant to the accident to highlight the implications of that information to the General Aviation community.

Results of toxicology tests

Toxicology tests on the blood of the passenger showed a carboxyhaemoglobin (COHb) saturation level of 58%. COHb is the combination product of carbon monoxide (CO) with haemoglobin, the oxygen-carrying protein molecule contained in red blood cells.

CO is a colourless, odourless gas produced from the incomplete combustion of carbon-containing materials. It readily combines with haemoglobin in the blood, decreasing the carriage of oxygen and causing a direct effect on the performance of those parts of the body which rely on oxygen for proper function. A COHb level of 50% or above in an otherwise healthy individual is generally considered to be potentially fatal.

In this type of aircraft, the cockpit is not separated from the cabin[2] and it is considered likely that the pilot would also have been affected to some extent by exposure to CO.

Symptoms following exposure to carbon monoxide

Exposure to CO can lead to damage to the brain, heart and nervous system. The symptoms of CO poisoning worsen with an increasing percentage of COHb as detailed in Table 1.

COHb level	Symptoms
Less than 10%	None
20 to 30%	Drowsiness, headache, slight increase in respiratory rate, dizziness
30 to 40%	Impaired judgement, difficulty breathing, blurring of vision, bad headache, increasing drowsiness, stomach pain
40 to 50%	Confusion, blurred vision, shortness of breath, pounding headache, vertigo, loss of coordination, chest pain, memory loss
Over 50%	Seizure, unconsciousness, heart attack

Table 1

Symptoms of increasing levels of COHb

It is clear from the symptoms that exposure to CO can reduce or inhibit a pilot's ability to fly an aircraft depending on the level of that exposure.

Footnote

1 https://www.gov.uk/aaib-reports/aaib-special-bulletin-s1-2019-on-piper-pa-46-310p-malibu-n264db
2 In this report, the word 'cabin' includes the cockpit.

Mitigation of the risks due to carbon monoxide

Piston engine aircraft produce high concentrations of CO that are conveyed away from the aircraft though the exhaust system. Poor sealing of the cabin, or leaks into the heating and ventilation system from the exhaust can provide pathways for CO to enter the cabin. Whilst piston engines produce the highest concentration of CO, exhausts from turbine engines also contain CO.

The best protection against CO poisoning is to avoid exposure but pilots must be aware of the danger and the possible symptoms in themselves or their passengers. Several devices are available which can alert pilots visually or aurally to the presence of CO. These range from stick-on pads that change colour in the presence of CO to powered detectors, either fitted to the aircraft or portable. These devices are not mandatory in aircraft under the European Union Aviation Safety Agency (EASA) or Federal Aviation Administration (FAA) regulations, but they can alert pilots or passengers to a potentially deadly threat.

Should occupants of an aircraft detect an unusual smell that could be engine exhaust products, or begin to experience illness, the possibility of exposure to CO should be considered. The FAA has produced a leaflet, '*Carbon Monoxide: A Deadly Menace*'[3], which lays out the actions a pilot should take if the presence of CO is suspected:

- *Turn the cabin heat fully off.*
- *Increase the rate of cabin fresh air ventilation to the maximum.*
- *Open windows if the flight profile and aircraft's operating manual permit such an action.*
- *If available (provided it does not represent a safety or fire hazard), consider using supplemental oxygen.*
- *Land as promptly as possible.*
- *Do not hesitate to let Air Traffic Control know of your concerns, and ask for vectors to the nearest airport.*
- *Once on the ground, seek medical attention.*
- *Before continuing the flight, have the aircraft inspected by a certified mechanic*

Ongoing investigation

The AAIB is working with the aircraft and engine manufacturers and the National Transportation Safety Board (NTSB) in the USA to identify possible pathways through which CO might enter the cabin of this type of aircraft. Work is also continuing to investigate pertinent operational, technical, organisational and human factors which might have contributed to the accident. Whilst

Footnote

3 https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/cobroforweb.pdf

this work is ongoing, this Special Bulletin is issued to raise awareness within the General Aviation community of the dangers of exposure to CO and the measures available to detect its presence in the cabin in order to mitigate this potentially fatal risk. A final report will be published in due course.

Published 14 August 2019.

AAIB Field Investigation Reports

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

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

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

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320, EI-CVB
No & Type of Engines:	2 CFM56-5B4/P turbofan engines
Year of Manufacture:	2001 (Serial no: 1394)
Date & Time (UTC):	3 February 2018 at 1110 hrs
Location:	Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 164
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	12,000 hours (of which 8,800 were on type) Last 90 days - 182 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

A vehicle carrying out a runway inspection was cleared onto the active runway ahead of an aircraft decelerating after landing. The investigation identified shortcomings in runway inspection procedures and the management of the internal review conducted after the incident. One Safety Recommendation is made.

History of the flight

The aircraft, callsign EIN4211, was operating a scheduled flight to Gatwick Airport and, as cleared, landed on Runway 26L. There was light rain at the time and a tailwind of about 3 kt. At the time the aircraft landed, two airport operations staff members were waiting in their vehicle, callsign Leader 6, at Hold G1 towards the end of Runway 26L to conduct a runway inspection (Figure 1).

About 12 seconds after touchdown, with the aircraft decelerating on the runway, the following transmissions were made:

ATC:	EIN4211 ARE YOU MAKING FOXTROT ROMEO?
EIN4211:	ER WE'RE MAKING THE SECOND ONE EIN4211
ATC:	THANK YOU THAT'S FOXTROT ROMEO BREAK LEADER 6 ENTER 26 LEFT AT GOLF VACATE BEHIND THE XXXXXX (*AIRLINE NAME*) AT FOXTROT ROMEO
LEADER 6:	LEADER 6 CLEARED TO ENTER 26 LEFT AT GOLF AND VACATE BEHIND THE AIRCRAFT AT FOXTROT ROMEO WILCO LEADER 6

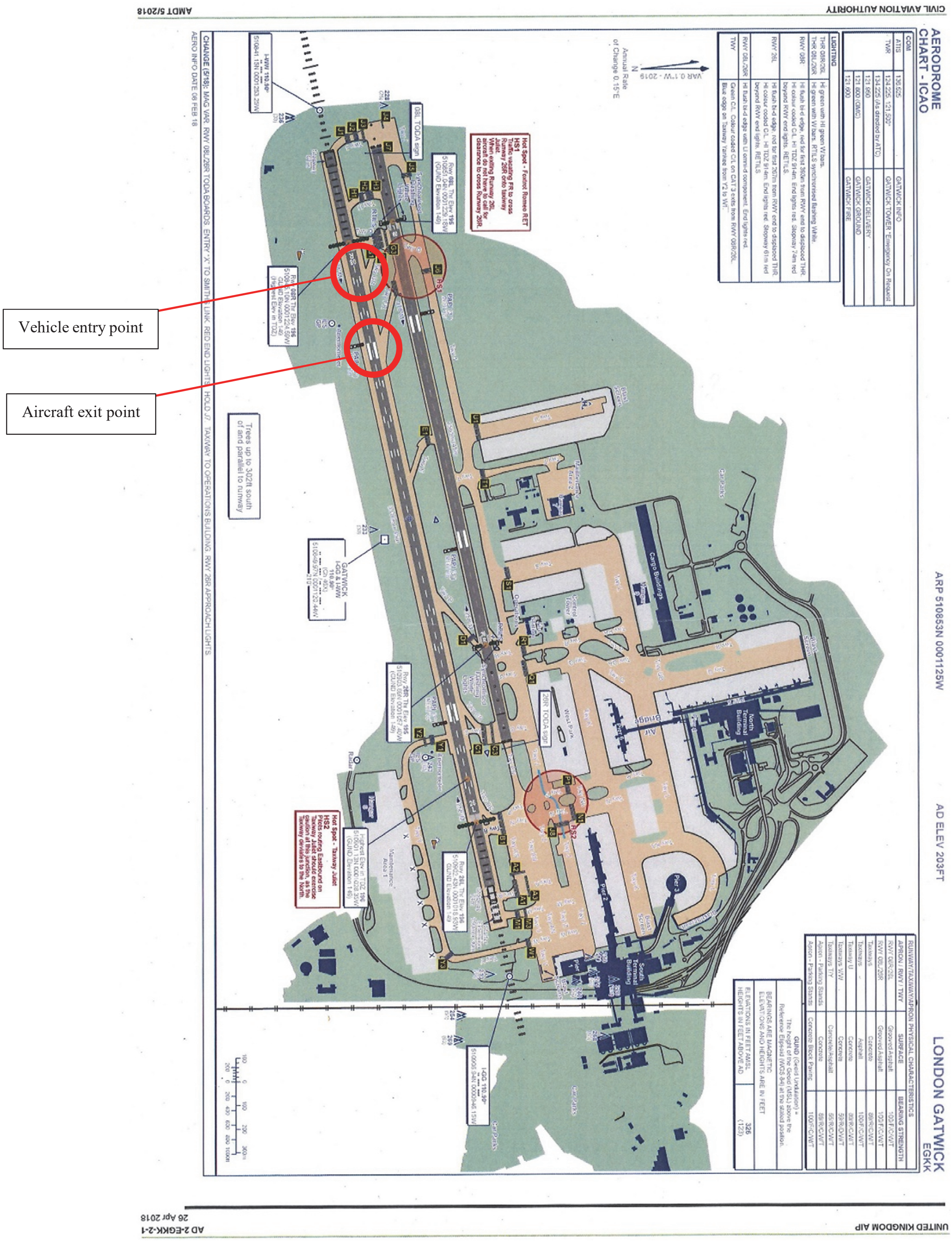

Figure 1

Gatwick Airport Layout

The aircraft was still on the runway at a reported speed of about 60 kt and approaching Rapid Exit Taxiway (RET) Foxtrot Romeo when Leader 6 entered the runway travelling east towards the aircraft. The aircraft vacated the runway at RET Foxtrot Romeo and changed to the ATC Ground frequency whilst Leader 6, having driven along the runway, then also vacated at RET Foxtrot Romeo.

The aircraft commander had been surprised to see the vehicle entering the runway and believed the vehicle's clearance had been conditional on the aircraft vacating first. As a result the commander submitted a safety report.

ATC investigation

As the commander had stated he would be submitting a safety report, the ATC provider for Gatwick Airport conducted its own investigation. This included comments from the airfield operations staff who had been driving the vehicle involved in the incident and who had subsequently spoken with the aircraft commander. The operations staff stated that the aircraft commander had told them he was '*concerned that after he had landed he could see a vehicle on the runway*' and that '*due to the wet weather he could have missed the exit (that he already confirmed with ATC that he would be vacating at)*.'

The report commented that the aircraft had slowed and moved off the centreline towards RET Foxtrot Romeo at the time the Leader vehicle had entered the runway.

The ATC investigation concluded that:

- the crew had misunderstood the clearance to the airport operations staff which had not been conditional on the aircraft vacating the runway before they could enter
- the crew were not familiar with the airport and runway exits available '*which suggests they were also not aware of the standard runway inspection procedures at the unit*'
- *'there were no issues with the runway inspection process at Gatwick in general, or with this particular event'*
- the runway inspection had been '*conducted appropriately by the ATCO and Ops vehicle, and so the investigation is therefore closed.'*

Although it was not mentioned in the ATC report, a senior ATC manager explained at a subsequent interview with the AAIB that the controller involved in the incident had considered that, as a result of the transmissions after touchdown, the aircraft's landing clearance had been amended for it to vacate the runway at RET Foxtrot Romeo. It was considered that this then allowed the operations vehicle to enter the runway ahead of the aircraft as the aircraft was not now cleared beyond the RET. The manager, however, further explained that the transmissions had not contained the necessary phraseology for the clearance to have been effective, nor for the pilot to have understood that the vehicle would be appearing ahead of the aircraft.

Airport investigation

After the incident a verbal instruction was issued by the Head of Airside Operations that operations vehicles were not to enter the runway ahead of a landing aircraft, regardless of their clearance, unless the aircraft was seen to be fully committed to vacating the runway.

In addition, a further report was completed by the airport's Airside Operations Department on the incident. This largely reflected the ATC report with the 'root cause' section only quoting the ATC report findings. It included the same conclusions and also noted that the investigation was closed. However, the report then continued under a final section entitled 'Preventative and Corrective Measures' to state that a joint review of inspection procedures between airside operations and the ATC services provider would be conducted, to explore potential opportunities for improvements to the safety and efficiency of runway inspections.

Recent appointments in relevant senior management positions resulted in a reduced level of experience in some areas, leading to the management of the review falling to the duty manager who had previously investigated a vehicle incursion incident on 12 November 2017. Whilst he had considerable experience in other roles at the airport, he had only been a duty manager for a short time and had no formal training in investigating. There was no evidence of how this task was allocated nor any formal instruction provided of who should be on the working group or the scope of its activities.

An initial meeting was held on 19 April 2018 with the stated objectives of creating a collaborative working group between the airport and ATC to understand each other's issues, improve the safety and quality of runway inspections and to feed improvement suggestions and plans into the Local Runway Safety Team[1].

The main output from the meeting was an agreement for the airside duty team to provide 15 minutes notice to ATC before attempting to undertake a normal runway inspection. ATC also agreed to review the phraseology used by controllers to prevent pressuring the duty teams to expedite their inspections. These changes were then to be incorporated into a revised airport Standard Operating Procedure (SOP) to be compared against the ATC SOP to ensure compatibility.

A number of other suggestions were raised for further consideration at later meetings, which it was agreed would take place monthly. The next meeting was held on 18 May 2018, however, there was only one further meeting in 2018, which took place on 25 September 2018. The record from this last meeting indicates there had been an improvement in the coordination of runway inspections between the duty teams and ATC. The working group also discussed making use of the increased gap in traffic behind super-heavy aircraft (ie A380) in order to carry out inspections.

The reduced frequency of the meetings was due to difficulty in finding times when the relevant people were available. In particular, the duty manager leading the work, due to his shift pattern, had only five days each month coinciding with the working hours of the non-shift members of the group.

Footnote

1 Also referred to as the Local Runway Safety Group – see section on Airside Management and Safety Oversight.

Other work reported between January and March 2019 included:

- The creation of training material for use in ATC refresher training (January-March 2019).
- ATC refresher training focussing on conducting runway inspections, with inclusion of Airside Operations Controllers.
- Trialling of runway lighting inspections on first illumination each day rather than in the middle of the night.
- Established timings for each runway intersection of runway to assist ATC create appropriate gaps in traffic.
- Created a poster for ATC and operations staff advising of best practice.

Airport runway inspection procedure

UK Civil Aviation Publication (CAP) 168 - '*Licencing of Aerodromes*' required a minimum of four runway inspections at London Gatwick Airport per day. The change to EASA regulations in 2014 required a minimum of only two runway inspections per day, but the airport chose to continue with four.

The Aerodrome Manual, published by Gatwick Airport's Compliance Department on 1 July 2014, contained information on the runway checking requirements. Version 3 of this document was in force at the time. Part E, Section 9.2 contained the following information:

> *'Runways - Inspection teams will check the following:*
>
> - *the general condition of the runway strip, RESA, and CGA*
> - *the general runway condition including cleanliness, rubber build up and pit/ drain covers*
> - *no FOD[2] is present, if found removed immediately or close runway*
> - *damage to the friction course particularly cracking, spalling and loose joint seal*
> - *runway signs and paint markings for damage, wear and conspicuity*
> - *the physical condition of all PAPI units and Runway Guard Bars*
> - *the general security of runway lights and flush wing bars*
> - *the general drainage on and around the runway particularly any standing water*
> - *any obstructions infringing the runway strips and its safeguarded surfaces are marked/lit*
> - *work in progress is safely controlled and at the correct distances from runway centrelines*
> - *the condition and conspicuity of all windsleeves for day/night operations*

Footnote

[2] Foreign object damage or debris.

Inspections are carried out to a minimum of four times per day typically:

- *a first light inspection prior to daytime operations*
- *a mid-morning inspection*
- *a mid-afternoon inspection*
- *a last light inspection prior to night operations*

In addition to the above inspections, Airside Operations also carry out the following checks:

- *an evening runway lighting inspection*
- *a midnight multi - vehicle surface inspection*
- *a mid-morning observation check by bird controller*
- *a mid-afternoon observation check by bird controller'*

Further information was contained in a SOP entitled *'Standard Operating Procedure for Level 1 08R/26L Runway Inspection by Vehicle'* published by the airport's Standards Department. The version in force at the time of the incident had been issued in November 2016. No SOP existed for Runway 08L/26R. Among its other requirements, the SOP imposed a maximum speed of 40 mph whilst on the runway.

At the time of the incident there was no liaison between airport operations and ATC to arrange suitable times for the runway inspections. Instead, operations staff wishing to conduct an inspection would contact ATC by radio from their vehicle at the time they required clearance to enter the runway. ATC would, if necessary, then attempt to adjust air traffic movements to create sufficient time for the inspection to take place. It was apparent from AAIB interviews that under this system both airport operations and ATC staff felt under pressure to complete runway checks in existing gaps between movements. They commented on increasing traffic volumes and similarly increasing pressure, with both sides considering they were having to be flexible to accommodate the other's demands. They described the existing inspection regime as fitting in runway checks around aircraft movements rather than managing movements at certain times to accommodate the checks.

The runway inspection SOPs gave no instructions on the direction in which the inspections should occur (i.e. with or against the traffic flow), but on Runway 26L inspections were routinely conducted with the traffic flow from the threshold (entering at M1) up to RET Foxtrot Romeo. The remainder of the runway inspection was conducted against the flow, with the vehicle entering at Juliet 1 and exiting at RET Foxtrot Romeo. This meant that for runway lighting inspections, whilst the driver looked ahead, the other operations staff member in the vehicle was having to check the serviceability of lights between Juliet 1 and Foxtrot Romeo by looking at the lights behind the vehicle rather than in front.

Due to the limited time available between movements, it was often not possible to conduct the inspection in one pass, but instead multiple entries and exits from the runway would need to be made between movements, as cleared by ATC. A survey carried out by the Airfield Operations Department during April and May 2018 recorded that an average time of

18 minutes was required to conduct a complete runway visual inspection, with the longest time recorded of 39 minutes and the shortest 3 minutes (consistent with a single pass down the runway at 40 mph).

ATC runway inspection procedure

The air traffic service provider at Gatwick Airport provided information on runway inspections in its Manual of Air Traffic Services, Part 2, Chapter 10, a copy of which was held by the Airfield Operations Department. This included a statement that inspections should not be unduly delayed and that it may be necessary to increase spacing between aircraft on final approach to accommodate them. It also stated that there was no reason for the whole runway length to be inspected in one run and that it may be more convenient to inspect one section of the runway at a time, with airfield operations teams able to vacate the runway at short notice.

As a result of the runway inspection review, ATC published a Temporary Operating Instruction, TOI 028, which became effective on 23 July 2018. This provided procedures for the conduct of runway inspections and placed responsibility on the tower controller, when necessary, for managing suitable gaps in air traffic movements to allow inspections to take place. It included advice that a runway inspection carried out in one run was preferable, but where this was not possible that shorter runs were acceptable, with preferably no more than three short runs taking place. It further advised that to complete a full run took four minutes, roughly equating to a 10 nm gap in inbound traffic, dependant on the prevailing wind.[3]

TOI 028 gave no instruction on the direction of the runway inspection but stated that where an inspection was done in more than one run, the final section may be done against the flow of traffic. Where this happened, it stated that:

> *'vacating aircraft must be notified about the against traffic inspection plan and must clearly be established in the turn off the runway-centreline into the runway exit before the ops vehicle is instructed to enter the runway.'*

As part of producing TOI 028 a hazard analysis and risk assessment was conducted which identified two hazards:

- attempting to conduct an inspection in an inappropriate gap size
- a vehicle entering the runway ahead of an aircraft before the aircraft was established on a turn into a runway exit.

The frequency of each event and the potential severity of the outcome led to the hazards being deemed acceptable by ATC.

The hazard analysis did not consider the implications of an aircraft failing to exit the runway at its stated or cleared exit point, for whatever reason, and continuing on the remaining

Footnote

[3] The minimum distance between landing aircraft on approach is 4 nm.

runway. However, senior ATC staff interviewed by the AAIB believed that sufficient distance would remain between an aircraft and vehicle in such circumstances that, again, any hazard would be deemed acceptable.

TOI 028 was adopted as Supplementary Instruction (SI) 021 with effect from 1 December 2018 with the intention of adding it as additional information to Chapter 10 in MATS[4] Part 2 when the latter was next revised.

Declared runway capacity[5]

London Gatwick Airport had a declared runway capacity on its single runway of 55 movements per hour with plans to increase this further.

Foreign Objects Debris recovered

Runway inspections between 1 January 2018 and the time of the incident had resulted in the following items being recovered:

- A metal retaining clip from a vehicle towing pin
- Two spanners
- A small piece of rubber seal
- An aircraft fuselage panel

A panel from a PAPI runway light was also recovered from the runway after having been seen and reported by a landing aircraft.

Previous occurrences

In the twelve months prior to the incident, there had been three other runway incursion events involving vehicles, one on 12 November 2017 involving a runway lighting inspection. This resulted in an operations vehicle occupying the far end of the runway as an aircraft touched down.

An internal report conducted by the airport's operations department into the incident on 12 November highlighted a number of issues. These included checks being done at excessive speed (in excess of 70 mph), poor communications between the airport operations staff and ATC, and ATC clearances including phrases such as 'as fast as possible' and 'as quick as you can'. The investigation determined the immediate cause of the incident to be the inspection being performed '*with the next arrival in mind rather than the task at hand*.'

The internal report also identified that the risk assessment for runway inspections on 08R/26L, carried out on 18 April 2012, should have been reviewed by the Airside Standards Department every three years but that this had not been done.

Footnote

4 Manual of Air Traffic Services.
5 The maximum traffic flow an airport declares it is able to accept.

The report recommended a number of actions, including a review of the way runway lighting inspections were performed and a review of the risk assessments for all runway inspections and operations. Neither review had been completed at the time of the incident on 3 February 2018.

Airside management and safety oversight

Airside operations are conducted by several departments, details of which are included in the Aerodrome Manual which is openly published on the internet. The heads of these departments reported to the Head of Airside Operations and included the Airside Operations Lead, who managed the airside operations teams responsible for conducting runway inspections. It also included the Head of Airside Compliance who was responsible for ensuring compliance, standards and procedures were effectively managed in accordance with the Aerodrome Certification requirements. The Head of Airside Operations had about four years operational experience of airports, all at a senior management level. The Airside Operations Lead had been in post for about eight months at the time of the incident and had an airport security background. The Head of Airside Compliance had 28 years of operational airport experience.

An organogram in the Aerodrome Manual of the senior management of airside operations at the airport included an Airside Improvements Lead and an Airside Standards Lead. The functions and responsibilities of these roles are not described in the Aerodrome Manual.

The airport operates several safety committees at various levels within the management structure, details of which are listed in Part B of the Aerodrome Manual. These include the Flight Operations Performance and Safety Committee (FLOPSC) and Local Runway Safety Group (LRSG).

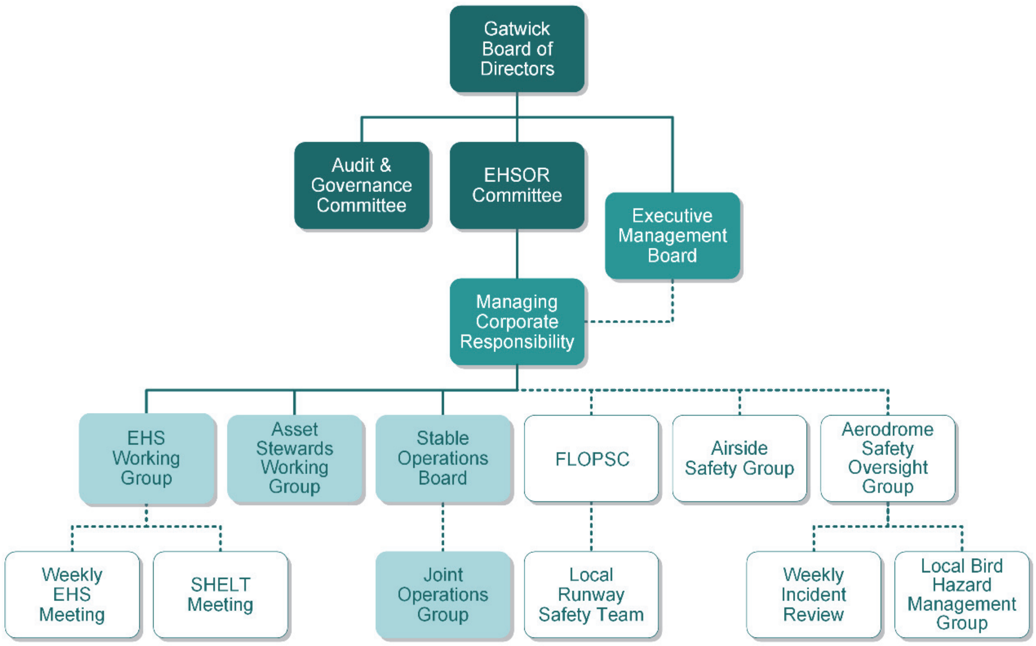

Figure 2

Gatwick Airport Safety Groups

The FLOPSC is chaired by the Head of Airside Operations and meets every two months with the purpose of discussing, reviewing and monitoring airline operational and safety performance at Gatwick Airport, adherence to noise and track-keeping rules, and to share best practice. Its membership includes various airport operational departments and other representatives, including those from airlines based at Gatwick Airport, ATC and the CAA. Among its stated safety duties is the review and monitoring of runway incursions and to track all agreed actions to completion. It is not apparent what, if any, role the FLOPSC played in the runway inspection review although much of its membership also sits on the LRSG which had some involvement.

The LRSG is jointly chaired by the Head of Airside Compliance and the Head of Safety, Security and Quality (ATC) and meets six times a year. Its membership again includes various airport operational departments and other representatives, including those from airlines, ATC and the CAA. Its listed safety duties are:

- To review and monitor runway safety;
- To agree and prioritise any required runway safety management actions;
- To track all agreed actions and audit recommendations to completion.

Minutes for the LRSG meeting held on 31 January 2018 included discussion of the incursion incident on 12 November 2017 and it was agreed to '*consider reviewing how airside operations plan the daily runway inspections*'. The same minutes included a comment that a review was now being undertaken of the runway lighting inspection procedure, with a recommendation from the group that the use of a runway slot for the inspection should be considered.

Section 2.2.8 of the Aerodrome Manual covers safety reporting and states:

> ***'2.2.8 Safety Reporting***
>
> *Airside incidents and near misses are recorded on the PRIME database. They are then reviewed at a weekly incident meeting, chaired by the Airside Standards Improvement Lead. All incidents are investigated and closed out, with any learning points shared with relevant parties. In some cases a Safety Alert will be issued to raise awareness of specific safety related issues.'*

Incidents requiring the filing of a Mandatory Occurrence Report (MOR) were handled by the Head of Airside Compliance who would allocate incidents to the most appropriate staff member for investigation and follow-up action. This was recorded on a spreadsheet, which included the status of the MOR. Minutes of various airside operational meetings were also recorded in a number of different formats.

Gatwick based airline operators

The crew involved in the incident was not based at Gatwick Airport and comments made in the ATC internal report suggested they were therefore not aware of the *'standard runway inspection procedures at the unit'.*

Senior pilot managers of two airlines based at Gatwick both confirmed to the AAIB that their pilots would also not be aware of runway inspection procedures at the airport as the information was not published in any normally available official documents. They also confirmed that they would not consider it acceptable for vehicles to enter a runway ahead of an aircraft until the aircraft was physically vacating the runway. They pointed out that although a crew may have nominated the exit they would be using, and may appear to be turning off the runway, they may choose to continue past the exit at any time due to a technical failure or operational issue.

The managers commented on the issue of receiving ATC instructions to expedite arrivals and departures, with such instructions often given at the critical phases of preparing to take off or land. This included transmissions to crews after touchdown enquiring which exits they would use; such transmissions being considered both distracting and applying unnecessary pressure. The situation was not helped by the relatively high number of new pilots these operators were training and the extra demands these training flights imposed on crews. This matter had been raised at LRSG meetings in the past by one of the airlines spoken to.

Neither manager had been invited to participate in the runway inspection review. Gatwick Airport Management commented that any revised procedure would be presented at the LRSG, where there was pilot attendance.

European Action Plan for the Prevention of Runway Incursions

The European Action Plan for the Prevention of Runway Incursions was released in 2003 as a product of the European Runway Safety Initiative and was updated in both 2011 and 2017. The ATC provider for Gatwick Airport was an active participant in its production. The plan is intended to help reduce the incidence of runway incursions, which the latest version stated occur within the European region '*at least twice every day*'.

The plan covers a range of airport operations including information on the conduct of runway inspections.

CAA oversight

The UK CAA provided oversight of operations at Gatwick Airport to ensure effective safety regulation. This was achieved by four inspectors, two responsible for overseeing different elements of the airport's operation and two for air traffic control.

The inspector responsible for overseeing the airport's safety management system and operational matters, such as runway inspection, also had responsibility for overseeing a further 20 airports, including two other major airports. The focus on oversight of Gatwick Airport since 2014 had centred on ensuring compliance with EASA aerodrome regulations. These had superseded the previous UK regulations and were more complex, including additional elements previously not covered.

Because of the limited time available, the inspector had only managed to attend one FLOPSC meeting in 2018. The inspector had been aware of the runway inspection issues and had been invited to attend the review meetings but had not had the opportunity to do so. The inspector did however hold regular compliance meetings with the Head of Airside Compliance, which gave an opportunity for specific issues to be raised.

There was a further observation about a runway inspection included as part of the audit in which the inspection team had to vacate and re-enter the runway three times and were cleared to enter the runway whilst an aircraft was still rolling out after landing. As a result, the CAA suggested that the airport reviewed the process to ensure that the possibility for a degradation in safety was reduced as far as reasonably practicable.

The CAA received feedback for Gatwick Airport on 30 September 2018, resulting from the findings relating to runway inspections in their audit of 8-10 May 2018. This stated that standard phraseology had been introduced by ATC. It also stated that liaison was now in place between the ATC watch manager and airport duty manager to plan times for the inspections to occur and for ATC to create suitable gaps in the air traffic arriving and departing the airport for the inspections to be carried out. On this basis the finding was closed.

A meeting between the CAA and Gatwick Airport on 20 December 2017 raised concerns about the high ATC workload created by the complex and consistent intensity of the air traffic schedule, exacerbated by staffing problems within the ATC provider.

Analysis

The importance of effective runway inspection is borne out by the number of foreign objects found over a relatively short period at Gatwick Airport and the potential safety risk these pose to aircraft. Whilst this problem is not unique to Gatwick Airport, in its drive to maximise the use of its single runway, the airport has created an intensity of operations that makes the task of runway inspection more difficult to achieve.

It is apparent from the investigation that both ATC and the airside operations teams were striving to carry out runway inspections under the prevailing working environment. There was, however, evidence of a lack of understanding of how each discipline's work impacted on others operating at the airport and had potentially normalised procedures that would otherwise have been considered undesirable, or at worst unacceptable. The ATC and airport investigations were triggered by the pilot declaring his intention to file a safety report. The ATC report, subsequently adopted by the airport operations department, saw nothing wrong in what happened. This was reinforced by subsequent interviews with ATC staff and was in direct contrast to the opinion of the airline operator involved and of other airline operators, when asked.

The ATC report justified the actions of the controller and operations staff as it considered the aircraft was committed to vacating at RET Foxtrot Romeo. This was based on the radio transmissions during the landing roll and ground radar recordings showing the aircraft moving off the centreline towards the exit as the operations vehicle entered the runway. The report, however, gave no consideration to the fact the aircraft appeared to be still on the centreline at the time the instructions were issued to the operations vehicle, the speed of the aircraft, the wet state of the runway and the implications had the aircraft, for whatever reason, needed to continue on the runway past RET Foxtrot Romeo. There was also no apparent understanding of the potential distraction caused by asking the crew questions at a time of high workload.

These conclusions were inconsistent with the comments of the ATC manager who justified the actions based on the aircraft having been re-cleared, after it touched down, to vacate at RET Foxtrot Romeo: in effect an instruction during the landing to stop short of a particular position on the runway. It is not clear that this is in accordance with any recognised ATC procedure.

In confirming the procedure to be adopted, SI 021 made no reference to re-clearing aircraft, but specified the need to ensure an aircraft '*must clearly be established in the turn off the runway-centreline into the runway exit'* before a vehicle can be cleared onto the runway ahead of it. This statement leaves the risk, as already outlined, of an aircraft subsequently turning again to continue along the runway past the exit. In addition, SI 021 contains no information on the direction runway inspections should be performed.

The guidance available to the controllers both in SI 021 and MATS Part 2 lacks relevant information published in the airport's runway inspection SOP, such as communication procedures and actions in the event of a vehicle breakdown on the runway. There was also a lack of consistency between the existing guidance in MATS Part 2 and SI 021 on the desirability of conducting the runway inspection in one run.

Safety Recommendation 2019-003

It is recommended that Air Navigation Solutions Ltd amend the wording of the Gatwick Airport Manual of Air Traffic Services Part 2, Chapter 10 and Supplementary Instruction 021 to specify how an aircraft is determined to have fully committed to vacating the runway, and ensure a vehicle cannot be cleared onto the runway ahead of an aircraft until the aircraft has done so.

From the airport operator's perspective, the Aerodrome Manual lists a comprehensive safety management structure; information that has been made widely available, not least by publishing it openly on the internet. Some of the descriptions of the relevant management positions are however incomplete, making it difficult to determine the division of responsibility for certain tasks related to this incident. The published reporting chain for the various airside safety groups also appeared to lack a focal point with groups reporting in parallel, creating the potential for safety issues to be treated in isolation.

Although the airport operated a safety database, the incident reporting system did not appear to provide a means of properly managing and recording the progress and outcomes of investigations of airside incidents and any subsequent actions determined necessary. Consequently, it remains unclear how the allocation of the review of runway inspection procedures was achieved. Whilst the duty manager was deemed by the Head of Airside Operations to be sufficiently senior to carry out the review it was conceded that the task more properly fell to the Airside Operations Lead. As it was, the incumbent had difficulty in organising meetings, not helped by the review having been given no scope or formal list of participants. The review would have benefitted from the input of an operator, none of whom were invited to participate. It might also be necessary to seek clarification on some operational aspects from the relevant CAA Inspectors. Finally, the outcome from each meeting was hard to determine in the absence of a proper means of recording progress from each meeting.

Gatwick Airport is now seeking a new system which will track incidents, audits and actions with the intention of introducing it during the 2019/2020 financial year. In addition, the review will continue to be managed by the same airside duty manager, but with oversight from the Airside Operations Lead.

Despite the issues highlighted, the output from the working group has been positive in providing better coordination between the operations teams and ATC in conducting the inspections. By providing notice before carrying out a runway inspection, ATC has a better opportunity to build a sufficient gap in air traffic to accommodate it. This remains a complex task when operating at high flow rates and often means inspections still cannot be done in one run.

A new runway inspection SOP became operational in January 2019. The SOP is detailed and now incorporates runway inspections on both the main and standby runways, although it still does not include details on the direction the runway inspections are to be performed. It also requires lighting inspections to be done with the driver looking forward and the additional vehicle occupant having to look behind the vehicle. This is currently being reviewed with the intention of carrying out lighting inspections in both directions, however proposed trials due to take place over the winter of 2018 have been delayed.

The SOP also now incorporates the instruction that vehicles should not enter the runway ahead of a landing aircraft until the aircraft has '*fully committed to the exit*', although the verbal instruction that this is irrespective of any ATC clearance has not been included. The document does not define *'fully committed to the exit.'*

The scope for the issues affecting runway inspections to be picked up and addressed as part of the general oversight of the airport was affected by the workloads of those whose task it was. The Head of Airside Compliance was the most experienced member of the airside management team and this experience was often called upon for tasks not under his immediate area of responsibility. Since 2014, CAA oversight had had to incorporate the additional elements brought about by the introduction of EASA regulations. This had created more demands on inspector workloads which had led to a reduction in time available to pick up on more routine operational issues. This is reflected in the non-attendance at routine meetings where the CAA inspector might otherwise have hoped to be able to attend. Doing so was considered an important means of identifying areas requiring further review or needing inclusion in future audits. Whilst inspectors were able to receive and review copies of the relevant meeting minutes, the standard of the minutes did not always allow a proper understanding of the items discussed or the outcomes agreed.

Whilst the CAA's annual audit did identify and address relevant issues relating to ATC and runway inspections, the latter were identified only after this incident had occurred. It remains important to ensure individual airport inspector workload is commensurate with providing adequate oversight of a major complex airport.

Conclusion

Gatwick Airport operates at high intensity to maximise the use of its single runway. This demands that airport operations, ATC and aircraft all operate as efficiently as possible if the declared runway capacity is to be attained. This capacity is not imposed but is set by the airport itself.

In setting the capacity it is important to balance maximising the number of aircraft operating to the airport with the safety of the operation itself. This investigation indicates that the pressure of meeting the operating targets has had a direct effect on undertaking runway inspections both safely and effectively.

Many of the measures taken to redress the issues outlined in this report have yet to be completed and continued oversight and regular reviews in this area at all levels should be maintained.

Published 22 August 2019.

SERIOUS INCIDENT

Aircraft Type and Registration:	Agusta Westland AW189, G-MCGR
No & Type of Engines:	2 General Electric Co CT7-2E1 turboshaft engines
Year of Manufacture:	2014 (Serial no: 92004)
Date & Time (UTC):	17 February 2018 at 1200 hrs
Location:	Beinn Narnain, Scotland
Type of Flight:	Public Transport with easements
Persons on Board:	Crew - 4 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43
Commander's Flying Experience:	3,800 hours (of which 350 were on type) Last 90 days - 56 hours Last 28 days - 24 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter was tasked to rescue three climbers in the area of the Beinn Narnain mountain. The flight was at night and the crew made several attempts to reach them from different directions but due to low cloud were unable to do so. On the fourth attempt, from another direction, the visual references seen through each pilot's Night Vision Imaging System (NVIS) were lost and a turn back down the re-entrant was attempted. Due to the proximity of the ground, the pilot climbed the helicopter but lost airspeed after which the helicopter yawed to the right. The Pilot Flying (PF) attempted to use the Automatic Flight Control System (AFCS) upper modes to assist him but decoupled them because they caused the collective control lever to lower. The helicopter spot-turned through some 370° before regaining VMC on top. Control was regained and the aircraft subsequently landed. The crew liaised with the Mountain Rescue Team (MRT) who recovered the climbers on foot.

History of the flight

Search and Rescue (SAR) operations in the UK are conducted as Public Transport (PT) flights under the Air Navigation Order (ANO). The CAA, as the national regulator, grants operators 'easements' from specific provisions of the ANO to enable them to operate effectively. In particular, easements are granted with respect to PT weather operating minima, which would otherwise be too restrictive.

G-MCGR, an SAR AW189 helicopter, was based at Prestwick Airport and the crew of two pilots and two crewmen had reported for duty at 1300 hrs. They carried out their normal aircraft and equipment inspections as well as detailed briefings including the weather to be expected during the shift.

At 1919 hrs, the Maritime and Coastguard Agency (MCA) tasked the aircraft to rescue three climbers in difficulties in the area of the Beinn Narnain feature, a 3,050 ft mountain in the Arrochar range some 40 nm north of Prestwick Airport and just to the west of Loch Lomond in Scotland (Figure 1).

The weather conditions were forecast to be poor with thick cloud and snow blizzards passing through the area, rapidly changing the wind direction and strength. The commander in the right seat was the Pilot Flying (PF) with the Pilot Monitoring (PM) in the left seat. Both were equipped with helmet-mounted Night Vision Imaging Systems (NVIS) which they were using to see the ground and weather in the dark. In the cabin, the winch operator was also using his NVIS to look out of the bubble window on the right side of the aircraft whilst the winchman was using the Forward Looking Infra-Red (FLIR) system to monitor the terrain and search for the climbers.

On arrival at the scene the conditions were "around freezing" and NVIS performance was acceptable given the absence of any cultural lighting and the overcast cloud cover. The pilots could still identify enough terrain features to fly and navigate, despite a dusting of snow on the higher ground. The helicopter was being flown by the PF handling the controls in attitude (ATT) mode[1] to control the flightpath, with the conventional white lights selected ON. Their first attempts to locate the climbers were made from the south-west, but during two attempts to enter a re-entrant the cloud was too thick, so a valley turn was made to exit the area on both occasions. The conditions were described as "very challenging", but a third attempt was made from the north-east during which the lights of the climber's torches were seen through the NVIS. Due to the cloud base, the commander decided not to continue to attempt a rescue from that direction as he felt it was unsafe, so another valley turn was carried out.

The crew reviewed their options and decided to attempt to locate the climbers by entering a third re-entrant from the southeast. This had the additional problem that the helicopter would have to cross a saddle feature at the far end of the re-entrant, but if the weather was better, and this could be continuously assessed, then it might have been possible to reach the climbers from that direction. This would have allowed a safe rescue with only a small left turn to come to the hover into the wind.

As they entered the re-entrant, which with the saddle at the end the PF described as a bowl, he elected to keep the high ground on his right. With the wind from his left the helicopter would be in the up-drafting air and, should a valley turn be required to the left, it would be into wind, reducing the ground track in the 180° turn onto the escape track towards the lower ground and re-entrant entrance. The ground tracks of the previous attempts and the entry into the third re-entrant are shown in black at Figure 1.

Footnote

[1] See later sections for a description of flight control modes.

Figure 1

Ground tracks of the rescue attempts

The crew cautiously entered the re-entrant at low speed but with the PF in visual contact with the terrain on the right and the PM able to see the line feature of the stream in the bottom of the re-entrant. The PM engaged the Hover (HOV) speed mode of the Automatic Flight Control System (AFCS) which also engaged the Radio Altimeter Height (RHT) mode. This was subsequently changed to Altitude (ALT) mode and the PF “trickled” the helicopter forward at slow speed. He recalled that he used the collective control lever to adjust the height by depressing the trim release trigger, rather than by operating it against the trim actuators. As they progressed towards the saddle at the re-entrant head, differentiating between cloud, terrain, and snow-covered terrain became increasingly difficult. Realising that they were near high ground ahead which they could not see, the PF asked the PM to clear the area to the left of the helicopter in order to make a valley turn in that direction. Using his NVIS, the PM confirmed the area was clear and the PF disengaged the HOV mode and commenced a low speed moderately banked turn to the left whilst gently increasing the airspeed but also climbing. About half way around the turn, the PM stated that he had lost visual references and the PF looked across the cockpit to the left to try and pick up some visual cues but was unable to see any. The winch operator noted that at about this time the view out of his window went completely white from the helicopter external lights reflecting in the cloud.

The PF stated subsequently that in looking for visual references he became “distracted” from monitoring the helicopter heading and it passed through the intended escape track. He believed they were heading towards the rock face of the eastern side of the re-entrant, the tops of which were above his altitude. He turned the helicopter to the right with a moderate angle of bank using both cyclic and pedal controls, during which the nose pitched up and the airspeed reduced rapidly. Concerned about the high ground, he raised the collective lever to climb and attempted to engage the Go Around (GA) mode of the AFCS, which brought the collective lever under the control of the AFCS. Almost immediately, the AFCS commanded the collective lever to lower, which he did not want, and so he believed he deselected the GA mode. The GA mode had already decoupled, however, as the airspeed dropped below the disengagement threshold of 38 KIAS, and the AFCS reverted to ATT on both longitudinal and lateral axes and RHT on the collective axis. With airspeed at zero and the helicopter yawing rapidly to the right, the PF concentrated on climbing and maintaining the helicopter pitch attitude on the horizon, as indicated on the Attitude Indicator (AI). He then engaged the Transition Up (TU) mode, but again the collective lever lowered, and so he decoupled it. Apart from his concerns about the proximity of the high ground, he was concerned that, with the low airspeed, had a high rate of descent developed, raising the collective lever could have caused the helicopter to enter a vortex ring state[2].

The helicopter climbed vertically whilst continuing to yaw to the right. The winch operator could feel the yawing motion and looked across at the co-pilot's Primary Flight Display (PFD) where he saw from the Synthetic Vision System (SVS) display that the helicopter was yawing rapidly to the right. The PF was trying to maintain wings level and pitch control when the PM called that they were "above the highest terrain", the height of which they had briefed before entering the area. They had previously inhibited the Terrain Alerting and Warning System (TAWS) to prevent nuisance warnings when operating close to terrain, but this had also removed the terrain display from the PFD.

The PF pressed the trim release on his cyclic control to reset the pitch and roll trims and then trimmed the cyclic control forward to increase the airspeed. Having achieved 80 KIAS he engaged GA and the helicopter climbed wings level. At some point during this, they became VMC on top of the cloud, and saw that the helicopter had yawed through some 370°.

With the aircraft back under control, the crew flew to a landing site at Ardgartan close to where the Mountain Rescue Team (MRT) were assembled and briefed them on the conditions that had prevented the rescue. The MRT then walked onto the mountain and recovered the three climbers.

Recorded information

The operator provided the AAIB with a copy of the recorded data for the flight. No CVR recording for the flight was available as the recordings had been overwritten with more recent flights in the time between the incident and when the AAIB were notified of the event.

Footnote

[2] Vortex Ring state where the helicopter downwash created by the main rotor, at low airspeed and with a significant rate of descent with power applied, will recirculate the downwash through the main rotor and cause the helicopter to descend rapidly in the downwash. Recovery is difficult and can result in significant height loss.

Figure 2 shows a plot of the salient data for the event and starts with the helicopter already within the re-entrant, which it had entered one minute earlier on a heading of 295°M at about 2,180 ft amsl and with 4 kt groundspeed (11 KIAS) before climbing to about 2,400 ft amsl and accelerating to 14 kt groundspeed. Both autopilots were on with HOV and ALT modes selected on the AFCS.

With reference to Figure 2, the following points in the flight are highlighted:

- UTC 20:08:10 – The helicopter commenced a turn to the left at the head of the re-entrant. Altitude was 2,400 ft amsl, airspeed was 11 KIAS and groundspeed 14 kt. The AFCS HOV and ALT modes were deselected 5 seconds later, and the AFCS reverted to the ATT mode.
- UTC 20:08:30 – During the left turn, the airspeed was just over 50 KIAS. The roll angle peaked at 30°, with the groundspeed reaching 57 kt a few seconds later as the helicopter started to roll out of the turn on a heading of 098°M at a height of 840 ft agl.
- UTC 20:08:38-40 – The helicopter pitched to 18° nose-up with the wings level at 2,750 ft amsl (1,070 ft agl) and on a heading of 123°M. At an airspeed of 47 KIAS the GA mode was selected for two seconds before decoupling due to the drop in airspeed to below 38 KIAS. The AFCS reverted to ATT mode on the longitudinal and lateral axes and RHT on the collective axis. With the RHT mode engaged the collective lever lowered to maintain the radio height. The airspeed had reduced rapidly to 11 KIAS.
- UTC 20:08:50 – After 10 seconds the RHT mode dropped out with the airspeed still at 11 KIAS. The helicopter was at 2,880 ft amsl rotating through the vertical axis to the right through a heading of 140°M.
- UTC 20:09:00 – The TU mode and its associated RHT mode were engaged as the helicopter climbed through 2,975 ft amsl with a climb rate of about 1,000 fpm. Airspeed was still 11 KIAS and the helicopter was yawing through a heading of 250°M as it continued to rotate.
- UTC 20:09:10 – The helicopter climbed above the height of highest ground (Beinn Narnain at 3,050 ft amsl). Radio altitude was 1,100 ft agl, airspeed 11 KIAS and the heading was 345°M. TU and RHT modes were decoupled with the AFCS defaulting to the ATT mode.
- UTC 20:09:23 – The maximum altitude of 3,250 ft amsl was reached and the helicopter then descended and accelerated on a heading of 130°M.

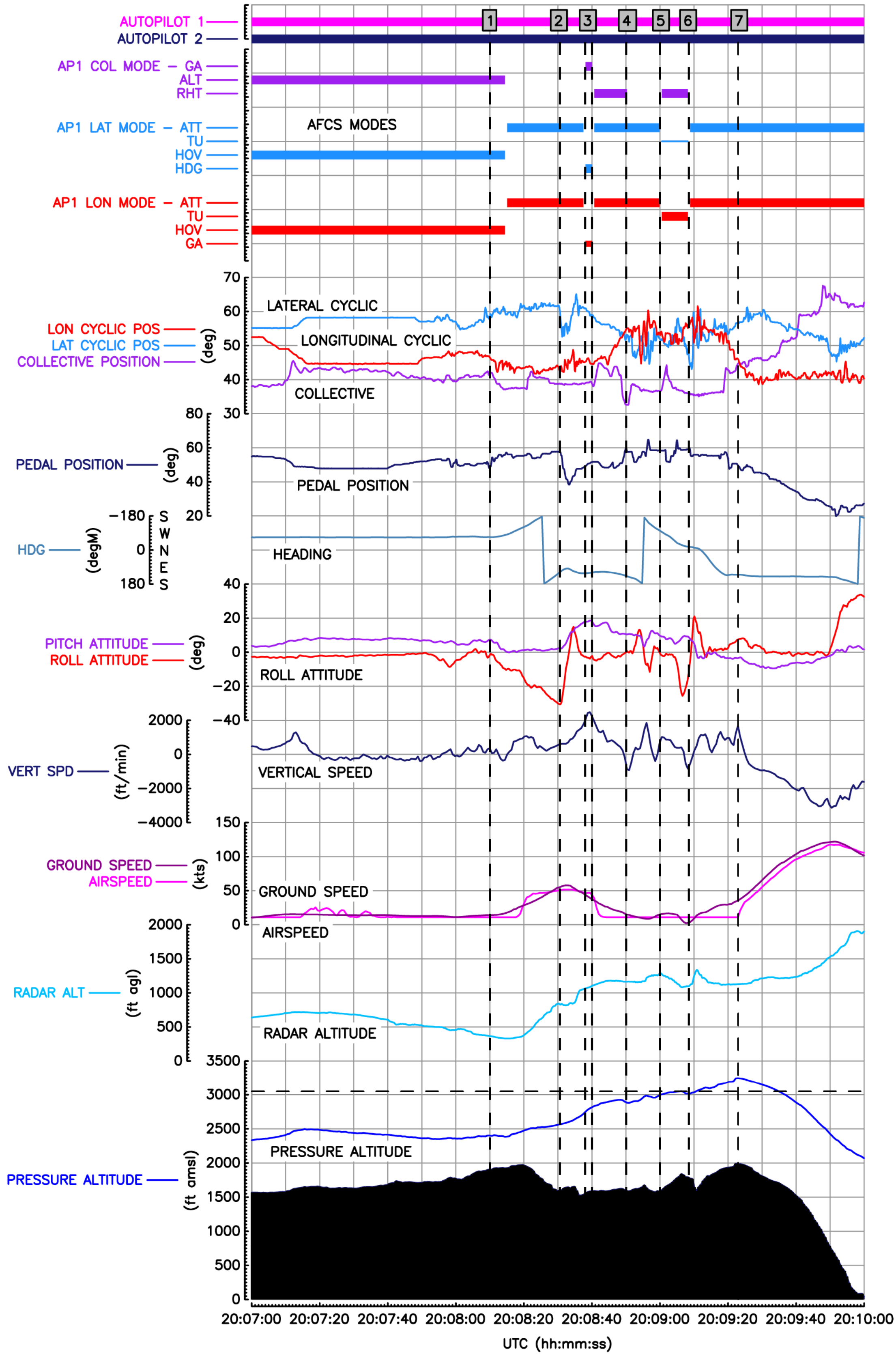

Figure 2

Salient parameters from recorded with the terrain elevation immediately below the helicopter in black

Aircraft information

General description

The SAR AW189 helicopter is a derivative of the commercial Air Transport version with specialist role equipment and an enhanced AFCS. The incident helicopter is shown at Figure 3.

Figure 3

G-MCGR in the SAR equipped role

The helicopter has EASA certification to be flown by two pilots and carry up to 19 passengers on VFR or IFR flights. Two General Electric CT7-2E1 turboshaft engines equipped with Full Authority Digital Engine Control (FADEC) power the five-bladed main, and four-bladed tail rotors. Flight in icing conditions is permitted using the ice protection system. The helicopter is equipped with retractable main and nose landing gear with flotation equipment for overwater flight. It has a maximum permitted all up weight of 8,600 kg, a Velocity Never Exceed (V_{NE}) of 169 KIAS and a maximum cruise speed of 155 KIAS.

Automatic Flight Control System (AFCS)

The AFCS is a dual-duplex redundant, predominantly electromechanical system, that provides varying degrees of automatic control of flight. The operating modes of the AFCS are split into attitude stabilisation and upper modes.

In attitude stabilisation modes, the controls operate in three axes (pitch, roll and yaw), and Attitude Hold (ATT) is the default operating mode of the system. Stability Augmentation System (SAS) is the degraded mode of operation when ATT is not available. SAS provides short term corrections in response to turbulence.

Upper modes, which consist of Primary and Flight Director (FD) upper modes, control the helicopter in four axes (pitch, roll, yaw and collective). Primary upper modes control basic helicopter parameters and performance such as heading (HDG), altitude (ALT), airspeed (IAS), vertical speed (VS), Wings Level (WLVL) and Go Around (GA). FD upper modes control the flight path of the helicopter; for example, the navigation mode allows the helicopter to be flown automatically to the active flight plan or tactical steering patterns from the Flight Management System (FMS), and Approach (APP) modes allow automatic control of a precision approach. Additional SAR modes relevant to the incident are Transition Up (TU), Radio Height (RHT) and Hover (HOV).

The pilot can override the AFCS at any time by manually moving the controls. When the pilot takes command of the helicopter, AFCS operation is suspended. When the pilot relinquishes control, AFCS operation resumes.

The AFCS has a Flight Control Computer (FCC) which has two independent but connected channels (Channel 1 and 2). AFCS actuation (that is movement of the control surfaces, main and tail rotor blade pitch) is carried out using linear (series) and trim (parallel) actuators.

AFCS Control Panel (AFCS CP)

The AFCS CP provides controls for mode arming/engagement and mode status display. It is also used for pre-flight testing. The AFCS CP is in the centre of the inter seat console between the pilots (Figure 4).

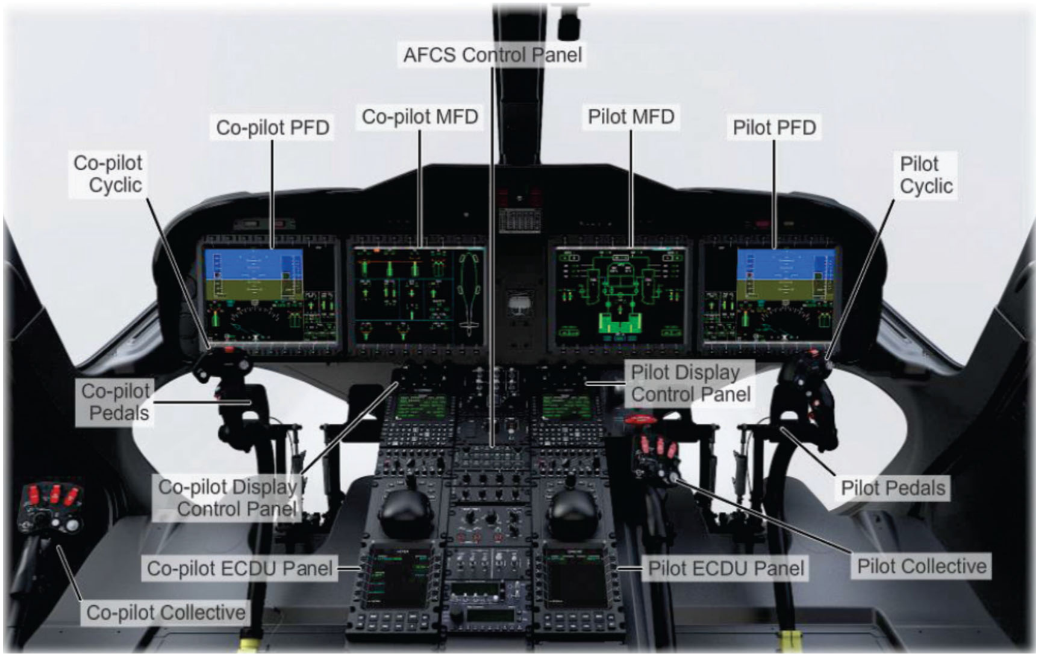

Figure 4

AFCS Control Panel location

It has 16 push buttons and two rotary/push knobs. Each button and rotary knob has its function annotated above it (Figure 5).

Figure 5
AFCS Control Panel

The mode selected is displayed on the PFD Annunciator Area (AA) which shows whether the mode is active or armed as well as any values for the available mode (Figure 6). A triangular green pointer in the centre of the AA indicates which pilot has command of the AFCS. The AA displays from left to right the armed/captured collective modes, the armed/captured pitch modes, captured roll/yaw modes and armed roll/yaw modes. Captured modes are in green and armed modes in white. Modes are selected and deselected using the AFCS CP.

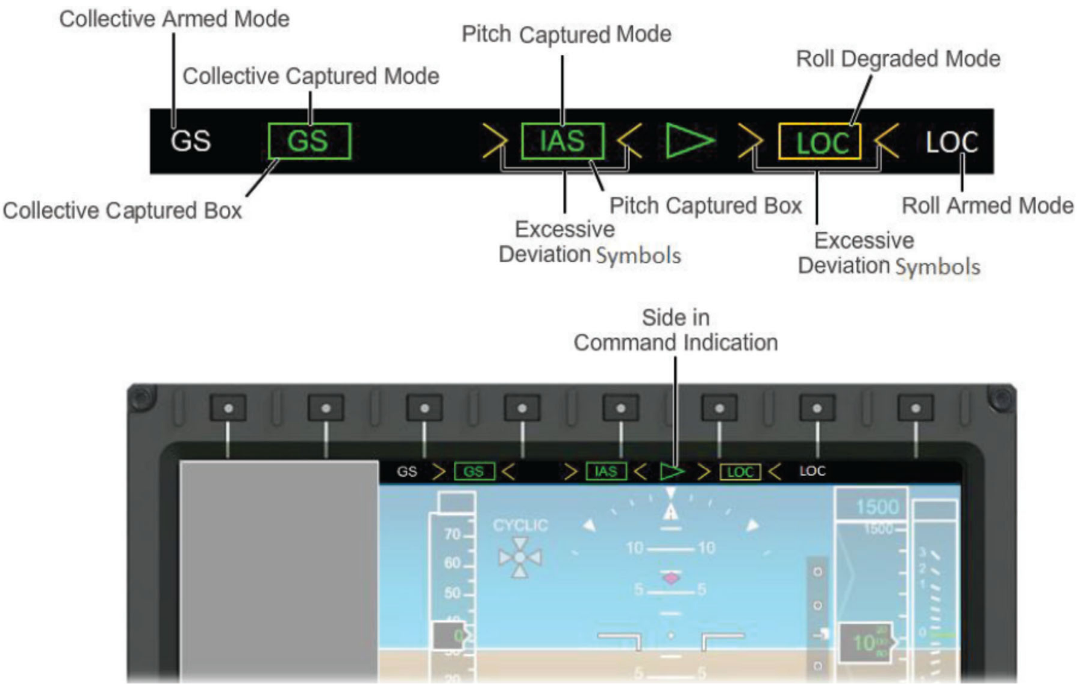

Figure 6
Pilot's Flight Display Annunciator Panel

AW189 SAR Limitations and Airworthiness Approval

Limitations

The SAR modes of the AFCS were approved under EASA Certification Standard CS 29, '*Certification Specifications and Acceptable Means of Compliance for Large Rotorcraft*', Appendix B, and Special Condition CRI B-03. This permits flight in Instrument Meteorological Conditions (IMC) below the Instrument Flight minimum speed (V_{MINI}) of 50 KIAS but only with the AFCS coupled in the four-axis SAR mode. The use of the SAR and associated RHT modes in IMC is authorised only over flat surfaces which are clear of obstructions with a minimum Flight Crew for SAR operations of two pilots.

Airworthiness Approval

Applicable criteria for airworthiness approval of SAR modes are established under the Special Condition CRI B-03. The CRI B-03 is intended to provide adequate safety standards for the rotorcraft when flown below V_{MINI} in IMC using the SAR modes. CRI B-03 applies:

1. To the SAR system and dedicated higher modes of the AFCS;
2. To single/dual pilot operations over water during automatic approach to the hover, departure from the hover and in the hover;
3. Under IMC in an area which is clear of obstructions.

There are neither Airworthiness Criteria nor adequate safety standards established/agreed with EASA to certify a rotorcraft that is intended to fly in IMC below V_{MINI} in an area that is not clear of obstructions eg mountains, cliffs.

Operational capability

The SAR mode that permits manoeuvring vertically and horizontally whilst in the hover is the Hover (HOV) mode. Automatic transition from the hover into climb and acceleration of the helicopter is the TU mode, and both modes are relevant to the incident flight. GA is a mode which is included in the normal AFCS system and is not a dedicated SAR mode, but it is also relevant to the incident flight. Those modes and others available for the situation encountered are:

Go around (GA) mode

GA mode is mainly used when carrying out a missed approach; it is operative above 40 KIAS and disengages automatically if the airspeed reduces below 38 KIAS. It controls the aircraft in a climb profile at a fixed, non-adjustable climb rate, and HDG mode is engaged simultaneously. GA is engaged by pressing the GA/TU button on the collective grip. Once the helicopter reaches 200 ft radio height, 1,000 fpm and 80 KIAS, the GA mode disengages and VS, IAS and HDG modes are then engaged. The GA/TU button and displays are shown at Figure 7.

Figure 7

Go around push-button location on the collective lever and PFD presentation

Hover (HOV) mode

The HOV mode performs two functions:

- Acquire and hold the current longitudinal and lateral groundspeed (Hover Speed Hold)
- Acquire and hold zero kt longitudinal and lateral groundspeed (Hover Position Hold)

Hover Speed mode is engaged by pressing the HOV button on the AFCS CP which automatically changes the Horizontal Situation Indication (HSI) display to the hover mode symbology format (Figure 8). At Hover Speed mode engagement, RHT and HDG modes are simultaneously engaged; the AFCS maintains the current radio height and heading, but both can be adjusted using the collective beep trim switch. The cyclic beep trim switch can be used to control groundspeed.

Hover Position mode is selected by pressing the cyclic beep trim switch (Figure 9) which causes the HSI to display the hover mode format. At Hover Position mode engagement, RHT and HDG modes are simultaneously engaged; as the helicopter reduces its groundspeed to 0 kt and the AFCS maintains the current radio height and heading (Low speed heading hold). Radio height and heading are controlled by the collective beep trim switch, and groundspeed can be controlled by the cyclic beep trim switch.

Figure 8

Horizontal Situation Indication (HSI) Hover Speed mode symbology

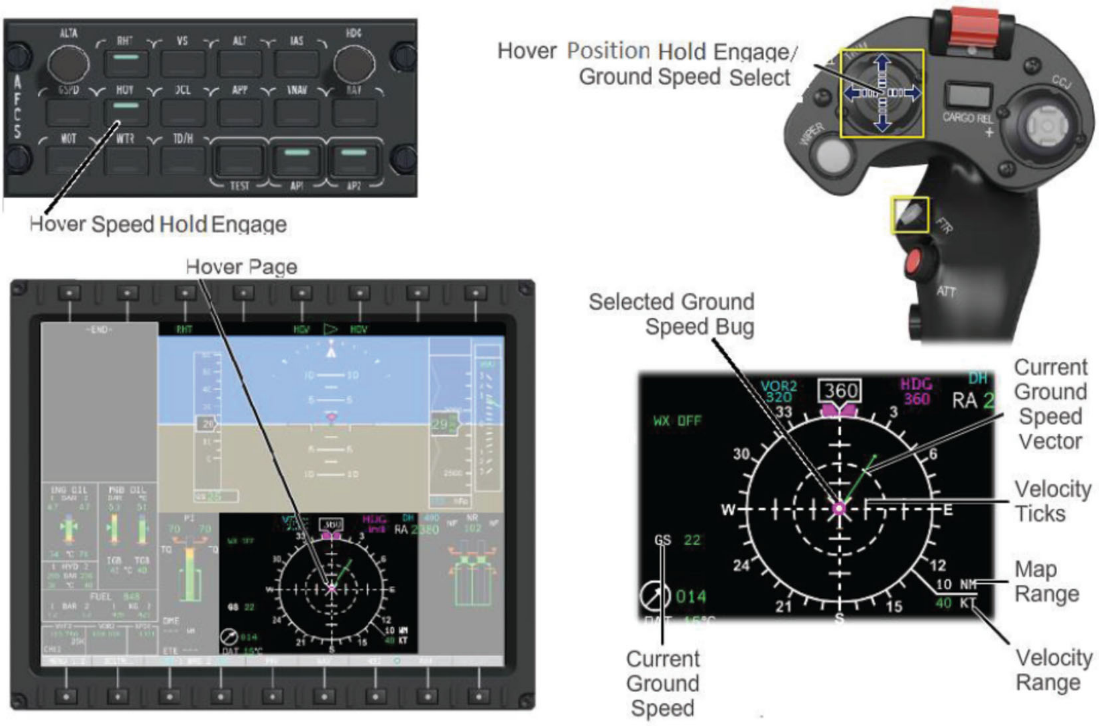

Figure 9

Hover Position Hold mode selection display and operation

Radio Height (RHT) mode

Pressing the RHT button on the AFCS CP engages the RHT mode and the current radio height is captured and held by the AFCS. RHT operates on the collective axis only. When the RHT mode is engaged, radio height can be controlled using the collective beep trim switch.

Manual control of the collective lever is achieved by pressing the Force Trim Release (FTR) ‘trigger’ under the collective hand grip. The collective lever can then be moved up and down with the pitch and roll modes being maintained by the AFCS. Radio height is maintained by the AFCS where the FTR was released.

Manual control of the collective without pressing the collective FTR causes the RHT bug to remain at its previously set value as the helicopter’s height increases or decreases. When the pilot releases the input on the collective the AFCS resumes control and returns to the original radio height. The controls and displays are shown at Figure 10.

Figure 10

Radio Height (RHT) mode selection, display and operation

Altitude (ALT) mode

Altitude (ALT) mode provides the capability to maintain a selected barometric altitude and operates on the collective axis. Pressing the ALT button on the AFCS CP engages the ALT mode. A magenta bug is displayed on the barometric altitude scale positioned at the current value. The barometric altitude is captured and held by the AFCS. When ALT mode is engaged, the position of the ALT bug can be changed using the collective trim switch.

Transition up (TU) mode

This mode is used during the climb-out phase from the HOV mode or to abandon a Transition Down (TD) to HOV during SAR operations. TU mode provides a fully automated ascent combining rate of climb to 200 ft pre-set radio height and acceleration to 80 KIAS. Roll angle is controlled throughout the ascent profile to maintain the heading on selection of the mode.

Attitude (ATT) mode

On both cyclic control grips there is an Attitude Hold (ATT) push button that allows the pilot to acquire and hold attitude. When the ATT mode is engaged pitch, roll and (low speed) heading reference bugs are displayed on the PFD. ATT will annunciate both aurally and on the PFD. If the button is pressed, other modes are disengaged, and pitch, roll and yaw attitude hold modes are activated.

Wings Level (WLVL) mode

The Wings Level (WLVL) mode (Figure 11) is a safety feature which allows the pilot to return to near straight and level flight with one key press. This mode has high priority and momentarily pressing it will disengage all other AFCS modes and place the helicopter in a wings level, 6° nose-up pitch attitude. The key is on the left side of both cyclic controls and WLVL mode can be disengaged by pressing the ATT button on either cyclic control or engaging any other AFCS mode.

Figure 11

Wings Level (WLVL) mode

Heading Hold (HDG) mode

The Heading Hold (HDG) mode provides the capability to acquire and hold a magnetic reference heading. The cyan heading bug on the HSI can be selected to a required heading using either the rotary heading selector knob on the AFCS CP or the cyclic beep trim switch.

When IAS is greater than 40 KIAS, selecting a new heading will cause the AFCS to carry out a balanced, rate one turn onto the new heading. Below 40 KIAS, the heading can be adjusted in the same manner as when HOV or ATT mode is active.

For the HDG mode to function normally, pilots must keep their feet clear of the tail rotor control pedals. The pedals are fitted with micro switches which, if pressed with the feet, prevent the yaw actuator from changing tail rotor pitch and maintaining HDG.

Synthetic Vision System (SVS)

The helicopter was equipped with SVS, which assists a crew by improving situational awareness in relation to terrain and helicopter flight path by displaying a visual picture on the PFD. SVS provides the pilots with displays of the helicopter position relative to the surrounding terrain and known obstacles. The system components are a navigation database and obstacle database stored in each PFD/MFD, and a complete terrain database stored in a Data Transfer Device (DTD).

The Flight Path Vector (FPV) symbol represents the current trajectory of the helicopter and is removed from the display below 20 kt groundspeed.

The PFD with SVS presentation and the Field of View (FOV) in the horizontal and vertical planes are shown at Figure 12.

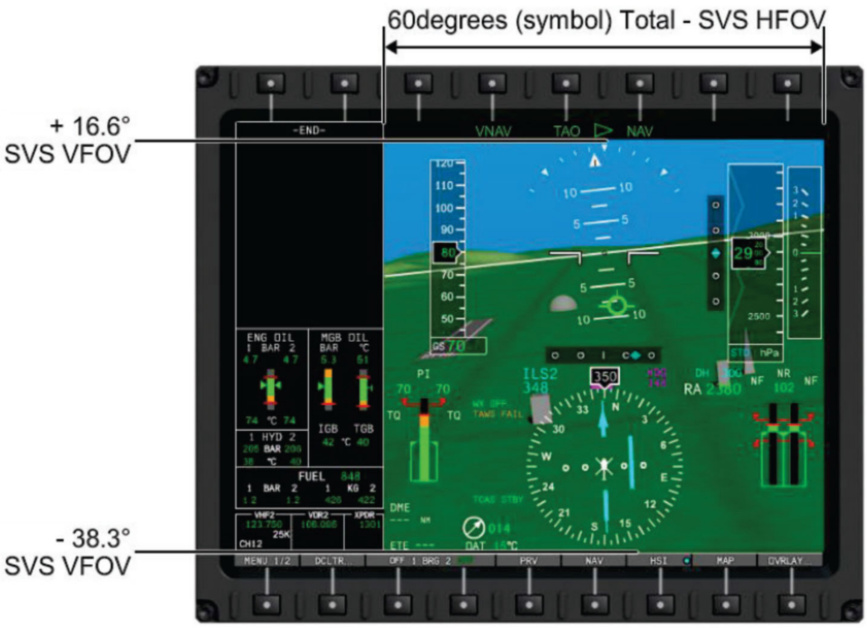

Figure 12

PFD SVS presentation and FOV display

On the PFD (with SVS active), the horizon line is always represented as a white line as shown at Figure 13.

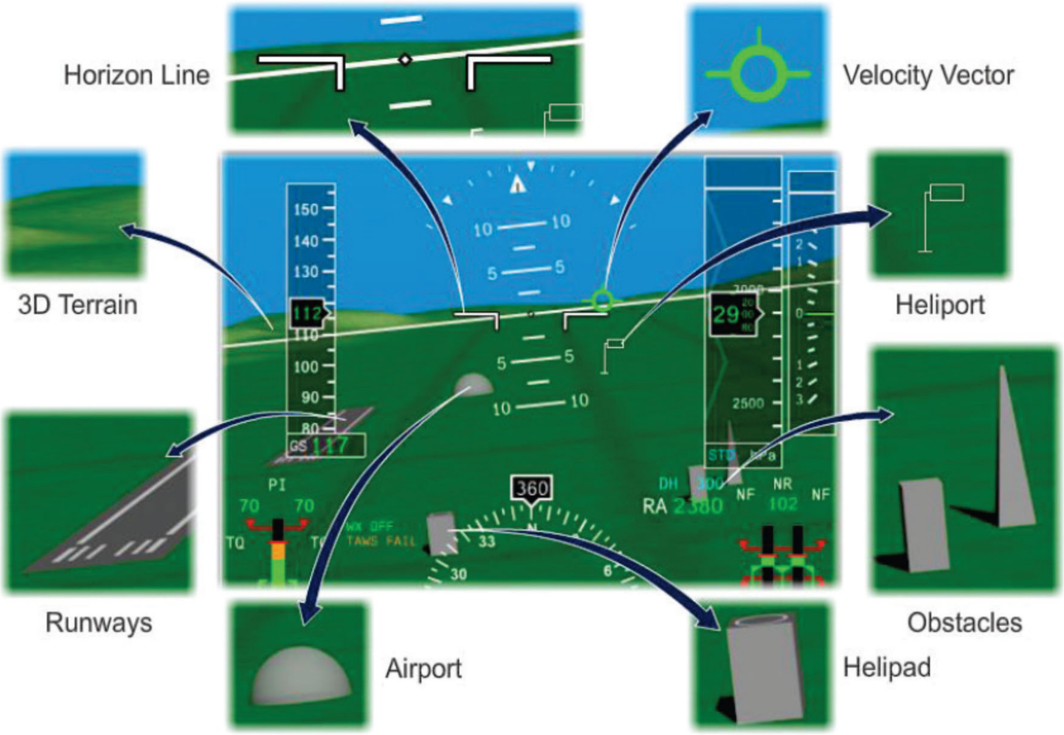

Figure 13

SVS Symbology displayed on the PFD

Terrain consists of the earth's natural surface. Terrain data is derived from a high-resolution database. The SVS image contains terrain consisting of 3D terrain and bodies of water such as oceans, and major lakes and rivers. By texturing the terrain surface, the SVS presentation provides useful cues to the pilot. Colour indicates the absolute elevation of the terrain features and distinguishes the land from the blue of the sky and dark blue of the water. Shading is used to create shadow components which help provide a 3D look and feel to the terrain surface. An example of the SVS terrain display is shown at Figure 14.

The operating manual contains the following statement:

> ***'CAUTION:** FPV is NOT a primary flight instrument. Always use FPV in combination with raw data, an altimeter and/or Visual Cues.'*

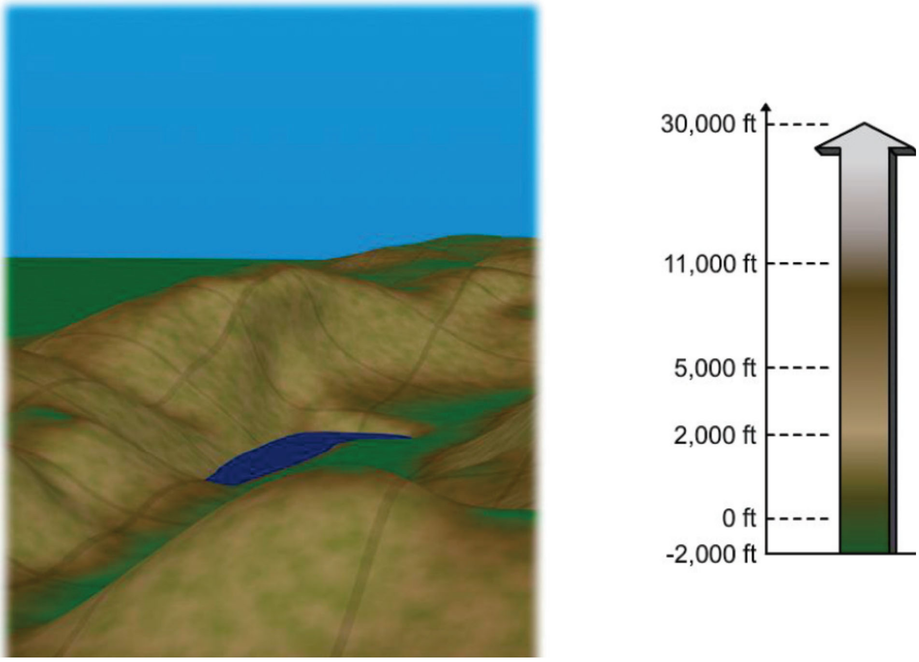

Figure 14
SVS Presentation of the terrain in 3D with texturing, shading and colour coding

Helicopter Terrain Awareness Warning System (HTAWS)

The helicopter was equipped with HTAWS which uses the same databases as SVS and provides the pilot with a display of the helicopter position relative to surrounding terrain. The outputs of the system include: terrain and obstacle display, visual cautions and warnings, voice alerts, warnings and callouts. The HTAWS has two alerting functions described below.

The Forward Looking Terrain and Obstacle Avoidance (FLTA) Alerting Area is an area mostly in front of and to both sides of the helicopter. Through lookahead algorithms, alerts are generated if terrain or an obstacle conflict with the flightpath of the helicopter.

The Ground Proximity Warning System (GPWS) has a downward looking alert capability which generally uses the radio altimeter as an alerting source. The GPWS alerting function operates in accordance with six GPWS Modes.

The HTAWS MFD display and controls are shown at Figure 15.

In relation to the incident, the FLTA offered the crew of G-MCGR an indication of terrain and its proximity to the helicopter. Where a helicopter is operating in close proximity to terrain or obstacles, it is normal to inhibit the audio or the complete HTAWS to prevent nuisance warnings. In the bottom right of the display are options for inhibiting the capabilities of the HTAWS. When INHIBIT is selected, a TAWS INHB caption is shown in the top left of the display, and the terrain image, obstacle symbols and alerts are removed from the display. In addition, all FLTA and GPWS audio alerts, except for GPWS Mode 6 (altitude callouts), are inhibited.

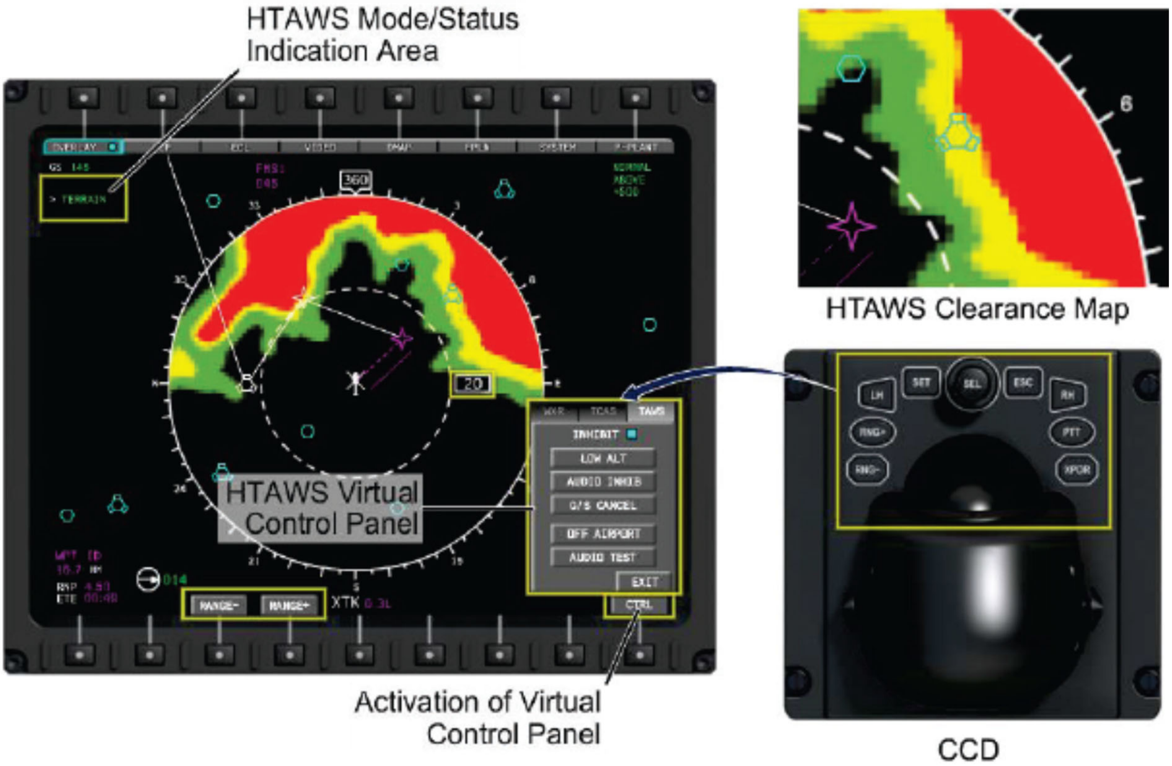

Figure 15

HTAWS MFD display and controls

If just the AUDIO INHIB is selected, only aural FLTA and GPWS cautions are muted. HTAWS aural warnings and altitude callouts cannot be muted. With AUDIO INHIB selected, a MUTE caption appears in the top left of the display. The audio reactivates automatically after five minutes.

The HTAWS terrain display is colour coded and is used to make potentially conflicting terrain appear distinctive. Different elevations will be coloured to give the pilot a cue of the relative elevation of any piece of surrounding terrain. The colour coding is shown at Figure 16.

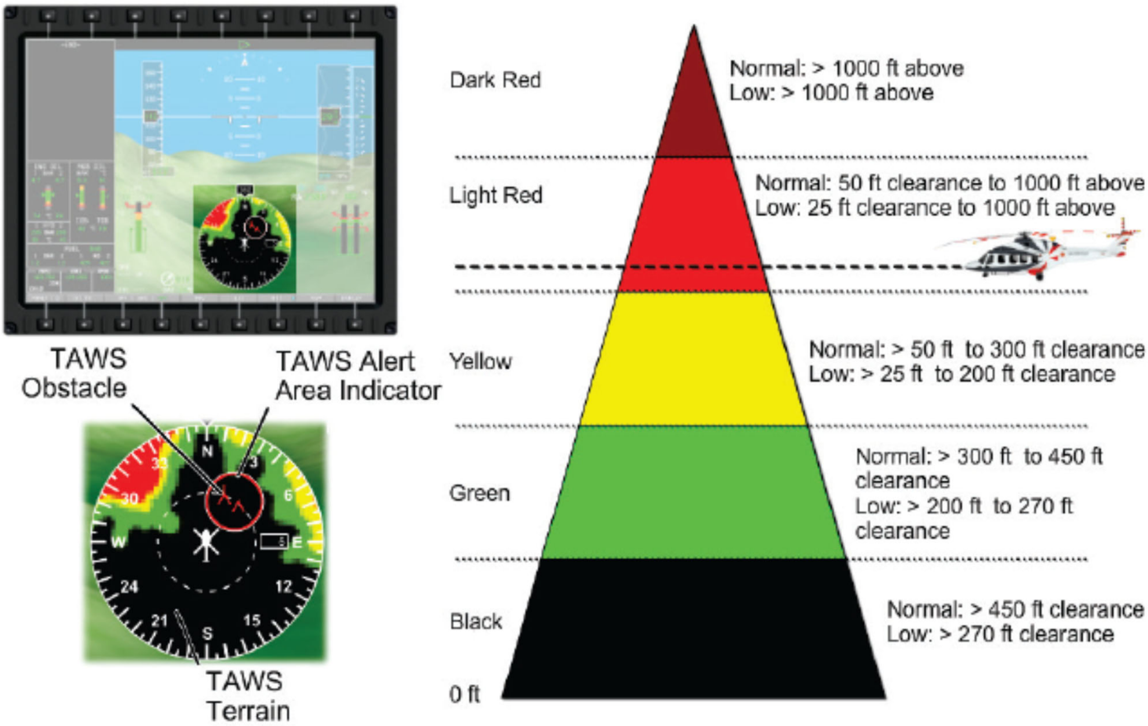

Figure 16

HTAWS Terrain colour coding showing relative elevation of surrounding terrain

Night Vision Imaging System

The crew were all using helmet mounted NVIS sometimes referred to as Night Vision Goggles (NVG). Two image intensifying tubes are mounted side by side on a frame attached to tracks on the front of the helmet. A battery pack, which also contains backup batteries, is mounted at the rear of the helmet and acts as a counterweight to the goggles. They can be in the lowered position when in use and the raised position when not required, as shown at Figure 17. An example of an image through NVIS is shown at Figure 18.

Figure 17

The helmet mounted NVIS in the lowered position on the left and raised position on the right

Figure 18
An example of an NVIS image illustrating the green monochrome picture[3]

Forward Looking Infra-Red (FLIR)

The helicopter is equipped with a Star Safire 380HD passive camera system that collects infra-red (IR) and visible light for detection, recognition and identification allowing pilots to see in total darkness, through smoke and in other low visibility, low contrast situations. It is installed under the nose of the helicopter, allowing 360° rotation and visibility. The images produced are displayed on 'fold-down' flat screens in the rear of the passenger cabin and an adjacent moveable hand controller panel is operated by one of the rear crewmen. The images can also be displayed on the pilots' MFDs. The camera turret is gyro stabilised and has a camera zoom, auto tracking and laser range finding capability. The IR image is displayed in monochrome which can be selected to black or white indicating hot or cold temperature differences.

Footnote

[3] This image is for illustration purposes and was not produced from the systems worn by the crew of the incident helicopter.

SAR Operations

The Operator's Flight Operations Manual (FOM) contains the two following statements relating to SAR operations that permitted the incident flight to be undertaken in the conditions experienced:

> *'SAR Operating Minima*
>
> *For the purposes of SAR operational flights, the Authority grants alleviations from standard operating minima. These alleviations are granted on the condition that crews have successfully completed the operator's approved SAR OCC and training course. When conducting SAR operational flights, it is beholden on the SAR Commander (utilising the best information available) to use his judgement as to whether the risk to the aircraft and crew, balanced against the perceived gain to the casualty, justifies the application of the full use of these alleviations.'*

And:

> *'Weather minima*
>
> *When piloted by a qualified SAR crew, company SAR helicopters that are equipped with a fully serviceable SAR auto-hover system with a 'transition down' function are cleared to* [Rotorcraft Flight Manual] *minima in IMC. For SAR operational flights there are no restrictions on weather minima.'*

Meteorology

At the time of the incident flight, there were a series of low-pressure systems to the north and north-west of the British Isles with frontal systems approaching south-west England. A moderate south-westerly airflow produced a wind at 2,000 ft amsl which was from 250° at 20 kt and at a temperature of -2°C. Cloud was generally a thin layer with a main cloud base of 2,000 ft amsl but with isolated showers of sleet and snow. Visibility outside the showers was generally good but reduced to 800 m in sleet or snow.

The crew reported that they experienced sleet and snow showers at their altitude which reduced visibility in the rescue area at times to less than 1,000 m.

Personnel

The flight crew comprised two pilots, the helicopter commander seated in the right seat who was the PF and the co-pilot in the left seat who was the PM.

The commander

The commander had served in the armed forces as a helicopter pilot flying large helicopters, three years of which were spent on SAR operations. He joined the company which operated G-MCGR in 2013, initially flying the Sikorsky S-92 in the 'oil and gas' support role before transitioning to the SAR role as a co-pilot later that year. He became a SAR commander on the type in 2014 moving from the northern operations to Prestwick SAR in late 2015 also operating the S-92. In February 2017 he converted onto the AW189 followed by SAR line training before returning to Prestwick in May 2017. He had 400 hours experience of flying using NVG.

The co-pilot

The co-pilot had flown fixed wing aircraft initially before moving onto helicopters in 2002. He had flown a mixture of oil and gas support operations and SAR on the Super Puma L2 and Sikorsky S61 before transitioning onto the AW189 SAR operation in 2014. He commenced NVG flying in 2017 and had accumulate 40 hours using them at the time of the incident.

Analysis

The helicopter was being operated in difficult flying conditions of low cloud, reduced visibility and darkness, over largely featureless terrain with no cultural lighting, which was compounded by a light covering of snow on the upper slopes. These conditions were still viable for visual contact flight using NVIS, given the high levels of crew training and helicopter equipment, and were within the weather minima for SAR. The nature of the task placed a strong desire on the part of the helicopter crew to try and recover the climbers as quickly but as safely as possible.

The crew had planned their approach to attempting the rescue and, when the weather prevented their progress, the pilot executed valley turns using the NVIS and AFCS in ATT mode to return to the lower ground. The upper SAR modes, which had reduced workload progressing up the re-entrant, allowed greater capacity for the pilot to manage the flight but were disengaged during the valley turns.

After the initial attempts at rescue in the first two re-entrants, the final entry into the 'bowl' was made in conditions of low cloud base and visibility much the same as those experienced earlier. During the low speed progress into the bowl, the weather deteriorated rapidly, resulting in the pilot abandoning further progress but also causing a loss of visual references at a critical time in the valley turn. His concentration in attempting to regain the external visual references distracted him from monitoring the heading on his HSI and he passed through the escape heading required for exiting the bowl to the lower ground. Believing that the left turn and the resulting helicopter ground track was taking them towards the high ground, he reversed the turn to the right, but the helicopter's airspeed reduced rapidly due to the nose pitching up 18°. His priority was to climb, so he raised the collective significantly to achieve a maximum rate of climb and the helicopter responded. It is probable that his feet were on the tail rotor control pedals but he did not have enough left pedal applied to prevent the helicopter yawing to the right. The airspeed reduced below 11 KIAS, and with the same tail rotor pedal position and maximum power applied the helicopter yawed to the right continuing through some 370°.

The crew had inhibited the HTAWS, which was normal when flying in the mountains visually and close to the terrain to prevent 'nuisance' warnings. This meant that as the helicopter manoeuvred the pilot had no information on the relative height and proximity of the terrain. The PF recalled that the SVS was selected off on his display and therefore the information from that presentation was not available.

The PF tried to use the AFCS to assist with correcting the difficult situation, initially using the GA mode. He expected it to establish the helicopter on a heading, adopting a wings level attitude with a climb and acceleration. Due to the existing high rate of climb of 1,800 fpm, however, the AFCS lowered the collective lever to achieve the 1,000 fpm and 80 KIAS targeted in the GA mode. This concerned the pilot as he wanted to climb quickly but at that moment, as the airspeed dropped below 38 KIAS, the GA mode de-coupled. The RHT mode engaged as it was designed to, until it was decoupled by the PF. He next tried engaging the TU mode, which also caused the collective lever to lower but this time the helicopter had no airspeed. This was also not what he wanted or expected, especially considering the possibility of entering vortex ring state, and so he decoupled the AFCS and 'hand flew' the recovery. He did not want to select the WLVL mode as this would have set a nose-up pitch attitude of 6° and he wanted to maintain a lower, accelerating pitch attitude. Despite the unintended yaw to the right, the pilot was able to maintain a relatively wings level attitude with the nose on, or near the horizon using his basic instrument flying (IF) skills assisted by the PM stating that they were above the high ground. While the PF was correcting the yaw to the right, the helicopter became clear of the cloud and he saw visual references through his NVIS. He was then able to use the GA mode to transition the helicopter into safe and stable flight.

Conclusion

The incident happened when visual references were lost as the helicopter made an inadvertent entry into cloud during the valley turn. The escape heading required to exit the re-entrant was missed due to the pilot attempting to locate visual references which, due to being IMC, were not available. Use of the AFCS modes, which operated correctly, did not improve the situation but created concern at the unwanted lowering of the collective control lever, and this resulted in the AFCS modes being disengaged. The situation was being resolved, by the PF using his basic IF skills and with the assistance of the PM announcing that they were above the high ground, when the helicopter regained VMC on top of the cloud.

Safety action

> Shortly after the incident, the operator introduced a scenario-based training exercise for all pilots that reproduced the incident during six-monthly recurrent training and testing. The training was continued with an emphasis on unusual attitude recovery.

Published 15 August 2019.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZGR
No & Type of Engines:	1 x CFM56-5B5/3 and 1 x CRM56-5B5/P turbofan engines
Year of Manufacture:	2011 (Serial no: 4837)
Date & Time (UTC):	30 September 2018 at 1830 hrs
Location:	Glasgow International Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 148
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	13,855 hours (of which 7,762 were on type) Last 90 days - 120 hours Last 28 days - 6 hours
Co-pilot's Flying Experience:	686 hours (of which 512 were on type) Last 90 days - 186 hours Last 28 days - 68 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The co-pilot experienced anxiety which developed into an anxiety attack during the approach to Glasgow. He could not continue to operate the aircraft and left the flight deck. The anxiety was triggered by a go-around the day before and built up over the course of his duty the next day.

The commander, ATC and cabin crew worked together to achieve a safe single pilot landing and to get medical help for the co-pilot.

Pilot peer support programmes and employee assistance programmes are now widely offered by operators. They provide the opportunity to talk about any issue in confidence to a trained person. This can have a benefit to emotional wellbeing and can provide a route to accessing further assistance if needed.

History of the flight

On 29 September 2018, the day before the incident flight, the commander and co-pilot had flown together from Glasgow to Palma de Mallorca and back. The co-pilot was pilot flying for the Glasgow to Palma de Mallorca sector. During the approach to Palma de Mallorca, at approximately 30 ft, a change in the wind displaced the aircraft towards the runway edge. The commander took control during the flare and executed a go-around.

On 30 September 2018, the same commander and co-pilot flew together from Glasgow to Stansted with the commander as pilot flying. The return flight to Glasgow proceeded normally with the co-pilot as pilot flying. Over the course of this flight the co-pilot began to suffer from anxiety. During the approach, the commander mentioned windshear. Immediately after this, the co-pilot felt unable to continue to operate the aircraft and left the cockpit.

The commander took control, checked the flight instruments and decided to continue the approach. He instructed the Senior Cabin Crew Member (SCCM) to assist the co-pilot.

The commander declared a PAN[1] to Glasgow RADAR, advising that the aircraft was being operated by only one pilot. The ATCOs assisted the commander by minimising the frequency changes required and arranging medical assistance to meet the aircraft. The commander completed the landing successfully.

The ambulance crew concluded that the co-pilot had suffered an anxiety attack[2].

Peer support and employee assistance programmes

The operator provided a peer support programme intended to support flight crew with "any issue". To access the service, pilots would use a website to request a call from one of the trained volunteer pilots. There was an opportunity to indicate a level of urgency, with the most urgent option requesting a call back within 12 hours.

The operator launched the peer support programme for its UK-based pilots in December 2017. Pilots were informed of this "soft launch" via an "Administration Notice". A full launch occurred in October 2018, after the occurrence involving G-EZGR.

The operator also offers an employee assistance programme which includes a 24-hour phone service to discuss situations and feelings confidentially. Details of this programme are given to all new employees as part of their induction training.

Commander's comments

The commander considered that the co-pilot seemed "fine" during the debrief after the go-around and nothing that the co-pilot said alerted the commander that there could be an issue. Later, on the return flight to Glasgow, the commander recalled that the co-pilot seemed "subdued" and "annoyed with himself" but the commander did not feel that there

Footnote

1 Urgency call.
2 An anxiety or panic attack is "a feeling of sudden and intense anxiety" where a person "experiences a rush of intense mental and physical symptoms". These can include: racing heartbeat, feeling faint, shortness of breath, nausea and needing to go to the toilet. https://www.nhs.uk/conditions/panic-disorder/ and https://www.nhs.uk/conditions/stress-anxiety-depression/coping-with-panic-attacks/ [Accessed on 15 February 2019].

was cause for concern. The commander stated that on the morning of the incident flight he enquired about the co-pilot's wellbeing, intending to reassure him but to keep the conversation light. At this point and during the flights on the day of the incident the commander did not observe any signs that the co-pilot was becoming distressed.

The commander did not recall what prompted him to mention windshear during the approach to Glasgow. He stated it was probably turbulence, which is often encountered at Glasgow in that position and at that altitude.

The commander praised the ATC at Glasgow and the cabin crew for helping to minimise his workload during the single pilot approach and landing.

Co-pilot comments

The co-pilot reported that the wind change and go-around at Palma de Mallorca was the first time he had experienced this in the aircraft and he found it frightening. He did not feel able to make control inputs towards the centre of the runway while floating in the flare and was afraid the aircraft would touch down at the edge of the runway.

There were several conversations with the commander about the go-around before they flew again. The co-pilot said that he told the commander he had felt frightened and attempted to discuss the event with him. He also informed the commander he had not slept well. He did not feel able to discuss it further with him. The co-pilot felt that some of the commander's comments reinforced his impression that the go-around was a frightening and serious event.

On the night before the incident the co-pilot was thinking about the go-around and slept for approximately four hours. He was aware of the procedures for reporting sick or fatigued but as his report time was not early in the morning, he felt well enough to fly.

The co-pilot reported that he felt increasingly nervous during the flights to and from Stansted and was "over-thinking" the need to do a good approach. He felt it was critical to get his confidence back for a task that he knew he was capable of. Eventually, his emotions and associated physical symptoms overwhelmed him.

At the time of the incident, the co-pilot was not aware of the peer support or employee assistance programme offered by his employer.

Analysis

The co-pilot was experiencing anxiety caused by the wind change and go-around event at Palma de Mallorca the previous day. This is a normal event and manoeuvre that is practised regularly in the simulator, but the co-pilot had not experienced it in the aircraft before. He reported that he was frightened by the event and it triggered self-criticism and performance pressure.

The commander made a comment about windshear during the approach which suggests the aircraft encountered turbulence during the approach to Glasgow. This may have caused the co-pilot's anxiety to develop into panic. His ability to cope effectively with his emotions would have been reduced by his lack of sleep the night before.

The commander and the co-pilot had different recollections of the interactions between them prior to the co-pilot's incapacitation. The difference between the two pilots' impressions of their conversations suggests they did not communicate effectively regarding the emotional issues the co-pilot was experiencing.

It was the co-pilot's responsibility not to fly if he was unfit and to advise the commander if he felt he was becoming unfit at any point during the flights. In practice this can be a difficult judgement for pilots to make. At the reporting time, the co-pilot felt well enough to report for duty and had informed the commander that he had not slept well. The co-pilot also hoped that if he could perform a good approach and landing his confidence would be restored, so he was motivated to continue as usual.

The co-pilot was not aware of the programmes offered by the operator that he could have used to discuss the go-around event anonymously and confidentially. The peer support programme would have enabled him to talk to another pilot who may have understood the issues well. However, this programme was new and had not yet been fully publicised by the operator. The co-pilot also had the option to discuss his concerns with someone in the management of his employer, or a trusted peer.

Experiencing a panic attack does not necessarily preclude someone from holding an aviation medical but, once known, the condition must be declared and adequately controlled. After support from the operator, his AME and other medical professionals, the co-pilot was assessed as fit to return to flying.

When the co-pilot became incapacitated, the commander, ATC and cabin crew worked together effectively to minimise the risk from the single pilot landing and to give the emergency services access to the co-pilot without delay.

Conclusion

The co-pilot experienced anxiety which developed into an anxiety attack during the approach to Glasgow. The commander, ATC and cabin crew worked together effectively to achieve a safe single pilot landing and to get medical help for the co-pilot. The opportunity for the incident to occur might have been reduced by the co-pilot reporting unfit for duty, more effective communication between the co-pilot and the commander, and use of support available from peers or one of the official assistance programmes.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A320-214, G-EZOI
No & Type of Engines:	2 CFM56-5B4/3 turbofan engines
Year of Manufacture:	2015 (Serial no: 6562)
Date & Time (UTC):	25 February 2019 at 1700 hrs
Location:	En route from Edinburgh Airport to Bristol Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 178
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:	4,200 hours (of which 4,050 were on type) Last 90 days - 149 hours Last 28 days - 32 hours
Information Source:	Operator's internal report and Aircraft Accident Report Form submitted by the pilot

Synopsis

A louder than usual noise was observed from an avionics vent fan before flight. During flight the noise increased and vibration became apparent. The crew then noticed a strong burning smell so they donned their oxygen masks and diverted the flight. An ECAM[1] message, associated with an avionics ventilation system fault, was generated and the crew performed the associated actions.

A subsequent investigation revealed the cause of the event to be worn bearings in the avionics extract fan. The fan manufacturer and the aircraft manufacturer both took safety action to prevent similar incidents in future.

History of the flight

On the ground at Edinburgh the flight crew were advised by the cabin manager of a louder than usual fan noise in the aircraft cabin. The commander identified the noise as being from an Avionics Vent Fan. There were no other indications and, following a discussion with the co-pilot and the cabin manager, the commander, who considered that the noise was not so unusual, decided to continue the flight and to monitor for any change in the noise.

Footnote

[1] Electronic Centralised Aircraft Monitoring.

Later, while in cruise flight, the noise increased and vibration became apparent. The commander sent a message to the company Maintenance Operations Control (MOC) requesting engineering assistance on arrival at Bristol. The flight crew also reviewed their required actions in the event of a fan overheat or fire/smoke indication.

Shortly after starting the initial descent, with the aircraft in the vicinity of Birmingham, "a very strong burning smell" filled the flight deck. The flight crew donned their oxygen masks and initiated a diversion to Birmingham Airport. The commander alerted the cabin crew to the situation and gave the cabin manger a NITS[2] brief. The fan noise was then heard to wind down and, soon after, the Electronic Centralised Aircraft Monitoring (ECAM) message VENT EXTRACT FAULT was displayed. The ECAM actions were carried out, after which the smell of smoke appeared to lessen.

The crew declared a PAN to ATC and an uneventful approach and landing was made at Birmingham Airport.

Aircraft information

The first steps of the procedure when a crew suspects that smoke is coming from the avionics and/or the air conditioning systems is to don an oxygen mask and establish communication between themselves. Switch selections are then made to ensure that avionics ventilation air is directed overboard and further smoke is prevented from entering the cockpit and cabin.

The avionics blower and extract fans form part of the avionics ventilation system. The system is fully automatic and a VENT EXTRACT FAULT alert triggers on the ECAM when the extract pressure is low. The associated crew action is to select the EXTRACT fan switch, located on the overhead panel, to OVRD (override).

Aircraft examination

The avionics blower and extract fans were removed from the aircraft and sent to the workshop for examination. The extract fan was found to be seized with the rear flange worn. Its rotor was damaged and the front bearing worn. No significant anomalies were found with the blower fan which was fully functional.

The avionics blower and extract fans were replaced and the aircraft was returned to service.

Footnote

[2] NITS emergency briefing protocol; Nature, Intention, Time, Special instructions

Other information

Previous similar event

The AAIB reported on a similar in-flight fumes event which occurred in July 2015.[3] The report advised on safety action taken by the aircraft manufacturer:

> *'In March 2005 the fan manufacturer issued a Vendor Service Bulletin, 3454-21-108, to replace the original steel ball bearings with an improved ceramic bearing. The aircraft manufacturer issued a corresponding Service Information Letter, SIL 21-141, to notify operators. SIL 21-141 was replaced by In Service Information (ISI) 21.26.00027, published in November 2013. The introduction of ceramic bearings has reduced the in-service arising rate, but the aircraft manufacturer reported that fan failure still causes between five and 10 aircraft diversions per year.*
>
> *In August 2013 the fan manufacturer issued a Service Information Letter, 3454HC-21-250, to inform operators that a new overhaul task had been added to the fan Component Maintenance Manual. The task periodically replaces the bearings and other components subject to wear, with a recommended periodicity of 10,000 Flying Hours. However, the fan manufacturer acknowledged that operators may wish to set their own avionics blower fan maintenance plan and recommended that operators avoid exceeding 12,000 flying hours between fan overhauls.'*

Additional information was included:

> *'The aircraft manufacturer advised that, in the longer term, fan vibration monitoring will be the subject of an in-service evaluation aimed at reducing similar events in the future.'*

The fan manufacturer subsequently developed an optional modification to introduce a ball bearing health monitoring function on the avionics fan. This would stop the fan before a failure occurred and fumes were released.

Analysis

The flight crew were aware of a possibly noisy fan before departure from Edinburgh but in the absence of any other indication decided to continue the flight. The problem worsened in flight and the commander advised the company MOC that assistance would be required at their destination. The next indication to the crew was a strong burning smell and they donned their oxygen masks at once and initiated a diversion. Subsequently, an ECAM VENT EXTRACT FAULT alert was triggered and the crew performed the associated actions.

Footnote

3 AAIB investigation to Airbus A320-232, G-EUYE, In-flight fumes event, 90 nm south-east of London Heathrow Airport, 27 July 2015. Available at:https://www.gov.uk/aaib-reports/aaib-investigation-to-airbus-a320-232-g-euye [Accessed 14 May 2019].

The source of the smoke was traced to the avionics extract fan. The aircraft manufacturer had previously acted to reduce the number of avionics fan related smoke events. Subsequently, additional action was taken to introduce an optional modification which would stop a fan before smoke was released.

Conclusion

The avionics extract fan failed during flight and released smoke/fumes into the flight deck. The flight crew, already alerted to a possible problem by an unusual noise and vibration, initiated a diversion. Similar events have occurred in the past and the aircraft manufacturer, fan manufacturer and operator took action to reduce the number of occurrences.

Safety action

Fan manufacturer

The fan manufacturer issued service bulletin 3454HC-21-101 on 18 April 2018, which provided details of an optional modification which introduced a ball bearing health monitoring (BBHM) function to continuously monitor the condition of the ball bearings and preventively stop the fan before its failure.

Operator

Following the fan manufacturer's original service bulletin and information letters between 2005 and 2013, the operator introduced a soft-life campaign to incorporate the recommendations to reduce the inflight failure rate of these fans. This commenced in 2016.

In November 2018 the operator commenced a soft-life campaign to install the BBHM function and at the date of this report 23 modified fans had been installed.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A330-243, G-TCCF
No & Type of Engines:	2 Rolls-Royce Trent 772B-60 turbofan engines
Year of Manufacture:	1998 (Serial no: 248)
Date & Time (UTC):	6 February 2019 at 1720 hrs
Location:	In flight over North Atlantic Ocean, west of the Republic of Ireland
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 11 Passengers - 326
Injuries:	Crew - None Passengers - None
Nature of Damage:	VHF radio unit damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	13,135 hours (of which 1,050 were on type) Last 90 days - 98 hours Last 28 days - 45 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and operator investigation

Synopsis

Coffee was spilled onto the commander's audio control panel (ACP). This resulted in failure of his ACP and later, the ACP on the co-pilot's side. During the failures, the ACPs became very hot and produced an electrical burning smell and smoke. The commander decided to divert to Shannon, Republic of Ireland. The failure of two ACPs caused significant communication difficulty for the flight crew. The operator has taken safety action to reduce the chance of spillage.

History of flight

The flight departed from Frankfurt airport in Germany and was scheduled to fly to Cancun in Mexico. Approaching position N5500.0 W02000.0 the flight crew were served coffee in cups without lids (Figure 1). This was normal for this operator and route.

The commander was pilot monitoring. He put the coffee on his tray table while he completed tasks required due to approaching a waypoint. At approximately 1620 hrs, the cup was knocked over. Most of the liquid fell onto the commander's lap and a small amount spilled onto the commander's ACP (ACP1, see Figure 2).

Figure 1
Example of cup used in the aircraft cup holder

Figure 2
Location of the ACP1 and ACP2 boxes

The coffee on the centre console was dried quickly but resulted in immediate malfunction of ACP1 that affected VHF transmissions and public address announcements from this unit. The crew attempted to isolate ACP1 but it was not possible to do this from the flight deck. Subsequently, at approximately 1700, the ACP1 unit became very hot and failed and there was an electrical burning smell in the cockpit.

At approximately 1720 hrs, approaching N5600.0 W03000.0, the audio control panel on the co-pilot's side (ACP2) became hot enough to start melting one of its buttons, and failed. A small amount of smoke was observed coming from the ACP1. The commander decided to divert to Shannon, Republic of Ireland. During the diversion, the flight crew alternately used supplementary oxygen, with one pilot on oxygen at all times.

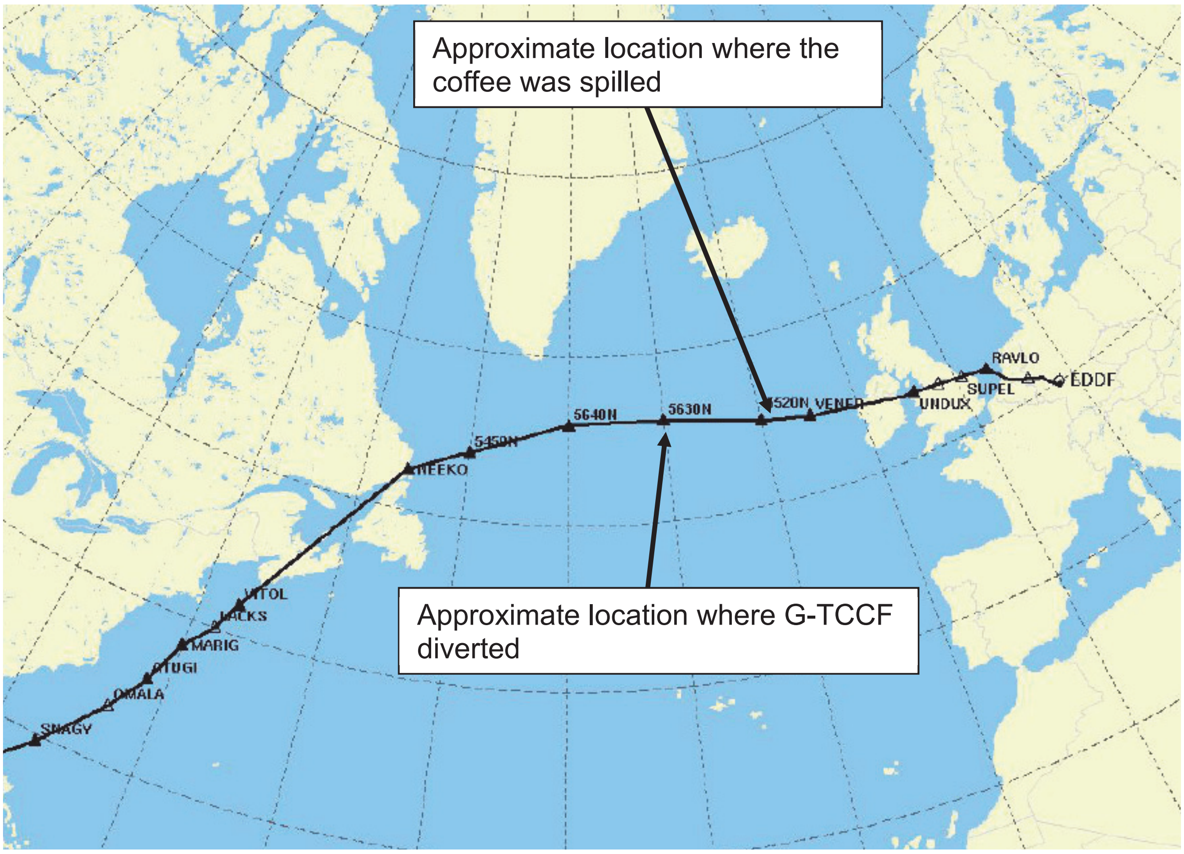

Figure 3

Planned route and approximate location where the commander decided to divert

The various ACP failures resulted in communication difficulties. The commander was not able to receive or transmit and could only hear transmissions through the co-pilot's speaker. There was no interphone between the pilots.

The aircraft diverted to Shannon without further incident. The smoke stopped and though there was a residual burning smell, the fumes did not result in injuries to anyone on board.

Airbus flight crew techniques manual

The A330 flight crew techniques manual states:

> *'Airbus highly recommends that the flight crews put and store all objects in their dedicated area in the cockpit: Cups in the cup holders.'*

Engineering action

ACPs 1 and 2 were removed and stripped by the vendor. The strip report for ACP1 confirmed component failures attributed to liquid contamination. The strip report for ACP2 listed the failed components but did not offer potential causes these failures. The area below the centre console was inspected and no further areas were found that had been affected by liquid contamination.

Analysis

The strip report indicated that the failure of ACP1 and the smoke and fumes were the result of electrical shorting caused by liquid contamination. The reason for the failure of ACP2 was unclear from the strip report.

The aircraft manufacturer recommends using the cup holder. The size of cups used by this operator on this route made it more difficult to take cups in and out of the cup holder than larger cups that have a bigger area at the top of the cup holder to grasp. This incompatibility generally discouraged use of the cup holder, despite the policy. In the A330, flight crew were provided with a table in front of them, and it was a natural place to put a drink momentarily. However, objects here are vulnerable to being knocked over because it is a fold out table in a small space. It is also a convenient place to put other things that are likely to be moved during flight, such as the pilot's log. A lid properly secured on the top of the cup may have reduced the amount of liquid spilled on the centre console.

Conclusion

A spillage of coffee on to the centre console led to the failure of ACP 1 and 2 resulting in communication difficulties for the flight crew. The resulting electrical burning smell and smoke in the cockpit necessitated a diversion to Shannon Airport.

Safety actions

> The operator changed their procedure to ensure that cup lids are provided for flights on all routes and reminded cabin crew of the requirement to use them. The operator also issued a flight crew notice reminding pilots to be careful with liquids. The operator raised an action to source and supply appropriately sized cups for the aircraft's cup holders.

ACCIDENT

Aircraft Type and Registration:	EC120 B Colbri, G-RCNB
No & Type of Engines:	1 Turbomeca ARRIUS 2F turboshaft engine
Year of Manufacture:	2002 (Serial no: 1333)
Date & Time (UTC):	25 June 2019 at 1120 hrs
Location:	Enniskillen Airport, County Fermanagh
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to rotor blades, head, tailboom, horizontal stabliser, fenestron and skid gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	395 hours (of which 13 were on type) Last 90 days - 19 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had planned a flight from Enniskillen, St Angelo Airport, to a private site at Frosses in Donegal, Ireland. The helicopter was parked on the apron adjacent to the fuel installation where it had just been refuelled to full tanks. Having completed all the pre-start checks from the checklist and carried out a normal start, the pilot performed the pre-takeoff checks and raised the collective pitch lever. He led with right yaw pedal but, as the helicopter became light on the skids, it started to yaw to the left. Due to the close proximity of the fuel storage tanks, he applied left cyclic control to move the helicopter to the left away from them, but the helicopter continued to yaw to the left. After yawing through 360°, the helicopter lost height with the left skid contacting the apron. The helicopter rolled about the left skid and the main rotor contacted the ground and debris was scattered over a wide area. The helicopter continued to yaw through another 90° about the tail before rolling onto its right side. The pilot shut off the fuel before applying the rotor brake and was able to leave the helicopter unassisted through the left door. The airport Rescue and Fire Fighting Service attended the scene immediately and applied a foam blanket to the wreckage.

Over the preceding weekend the pilot had been flying a Robinson R44 helicopter on which the main rotor blades turn anticlockwise when viewed from above. The EC120 main rotor blades turn in the opposite direction ie clockwise when viewed from above. The pilot was aware of this difference and the way it affects the use of the yaw pedals: raising the collective pitch lever in the Robinson requires increasing amount of left pedal to counter the rotor torque, but in the EC120 increasing amounts of right pedal are required. The pilot believed that during the initial phase of applying collective lever, he had used insufficient right yaw pedal, allowing the helicopter to yaw left, and the application of additional right pedal did not then reduce the yaw rate.

ACCIDENT

Aircraft Type and Registration:	Replica Fokker DR1, G-DREI	
No & Type of Engines:	1 Superior XP-IO-360-B1AC2 piston engine	
Year of Manufacture:	2017 (Serial no: LAA 238-14848)	
Date & Time (UTC):	19 April 2019 at 1410 hrs	
Location:	Old Buckenham Airfield, Norfolk	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Damage to the upper wing, cowling, rudder, engine and propeller	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	56 years	
Commander's Flying Experience:	390 hours (of which 41 were on type) Last 90 days - 3 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and a report submitted by the airfield operator	

Synopsis

The replica Fokker tri-plane collided with an edge marker whilst taking off from Runway 02 at Old Buckenham. The collision caused the aircraft to rotate forward and invert. The limited forward visibility from the tri-plane meant the pilot could not see the edge marker.

History of the flight

On the day of the accident the pilot flew the replica Fokker tri-plane from Felthorpe Airfield to Old Buckenham Airfield, both near Norwich. It was the first time he had operated to Old Buckenham. Whilst on the ground he spoke to the airfield radio operator to determine the taxi route and departure procedure in preparation for his flight back to Felthorpe. He then returned to the aircraft and taxied to the grass area at the start of Runway 02 and 07 (Figure 1).

The pilot had observed from the windsock that the wind was from the north-east so thought he could takeoff from either Runway 02 or 07. He positioned the aircraft in the centre of what he believed to be Runway 07. After the accident he discovered he had actually been aligned with Runway 02 and had been unable to see Runway 07 to his right as it was obscured by the wing. He reported that the tri-plane had very poor forward visibility when on the ground making it difficult to see directly forward.

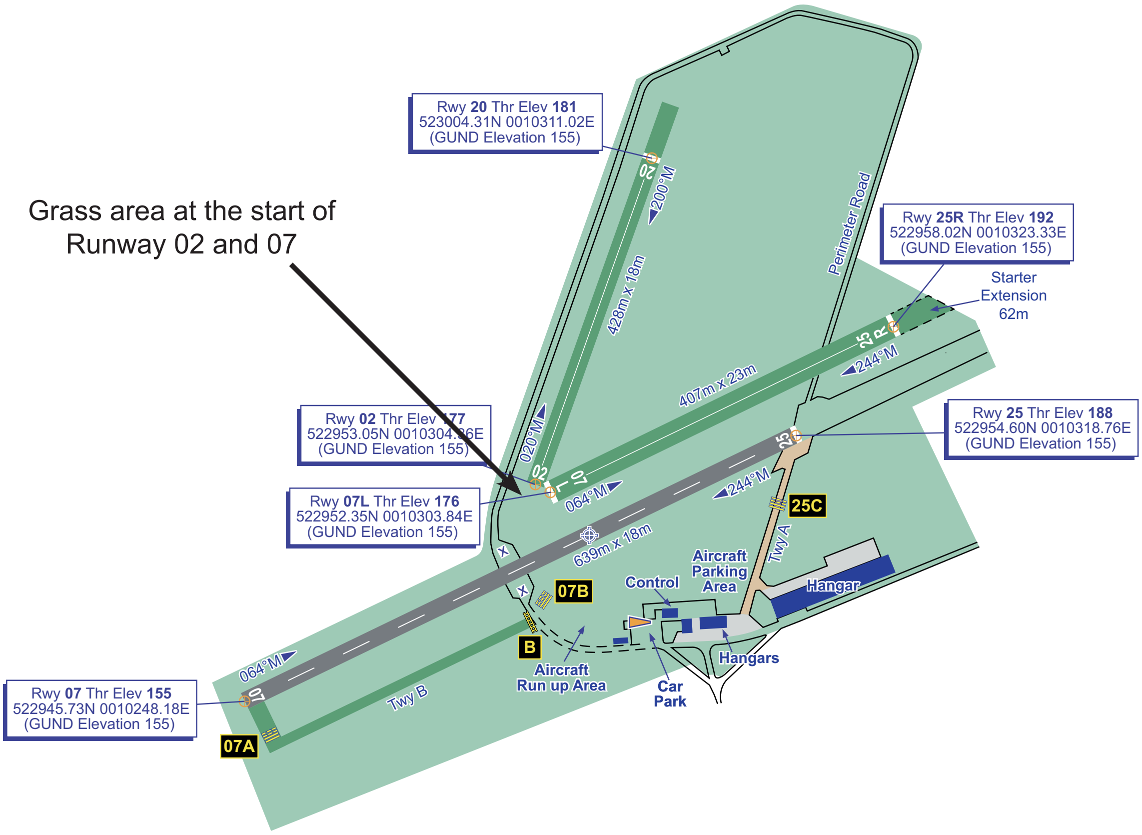

Figure 1

Old Buckenham Aerodrome Chart (from UK AIP)

The airfield air/ground radio operator expected the aircraft to takeoff from Runway 07 as the surface wind was indicating 070° at 11 kt favouring Runway 07. The radio operator observed that the aircraft was aligned with Runway 02 rather than 07 and advised the aircraft to move to the right. However, the pilot interpreted the message as an instruction to move to the right side of the runway. The pilot, therefore, moved the aircraft to the right but maintained alignment with Runway 02.

As the pilot started the takeoff roll, he reported that the right wheel collided with a runway edge marker causing the aircraft to rotate forward and invert (Figure 2).

Analysis

The accident occurred because the aircraft started its takeoff roll on the right side of Runway 02 and collided with an edge marker. The limited forward visibility from the tri-plane meant that the pilot could not see the edge markers.

The air/ground operator had tried to assist the pilot in aligning with Runway 07 but this advice had been misinterpreted by the pilot. He thought he was advised to move to the right side of the runway. This confusion resulted in the pilot aligning with the edge of the runway.

Figure 2
G-DREI inverted on Runway 02

ACCIDENT

Aircraft Type and Registration:	Sky Arrow 650T, G-BYCY
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	1999 (Serial no: PFA 298-13332)
Date & Time (UTC):	1 June 2019 at 1445 hrs
Location:	Near Newport City Aerodrome, Newport, Gwent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	597 hours (of which 374 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and inquiries made by the AAIB

Synopsis

The aircraft was downwind to land after a short cross-country flight, when the pilot became aware of a "rumble" from the engine followed by a stoppage. The pilot turned the aircraft into wind and carried out a forced landing in an uneven field. During the landing the aircraft sustained severe damage and the pilot suffered minor injuries. The engine stoppage was caused by the failure of the No 3 big end bearing. This may have been the result of lubrication failure, but it could not be positively determined whether there was a No 3 bearing problem that led to lubrication failure or a lubrication problem that led to the bearing failure.

History of the flight

The pilot reported that he had flown a short uneventful flight along the Welsh coast and had returned to Newport City Aerodrome (formerly Upfield Farm). Whilst on the downwind leg, he "heard and felt a rumble" from the rear[1] of the aircraft. The pilot tried to "add power" but the engine stopped. He was unable to make the airfield so turned into wind to land in what appeared to be a suitable field. However, the field was "full of ditches" that were indiscernible from the air and the aircraft was severely damaged during the landing. The pilot sustained minor injuries.

Footnote

[1] The Sky Arrow 650T is a microlight aircraft with a high wing. The engine is mounted behind the trailing edge of the wing above the rear fuselage and drives a pusher propeller. The pilot sits forward of the engine.

Engineering investigation

The engine was examined and found to have suffered a catastrophic mechanical failure of one of its connecting rods which had broken and was protruding from the crankcase. A more detailed assessment was carried out with the assistance of the Light Aircraft Association (LAA). The damage was centred around the No 3 connecting rod big end bearing and journal. There was also significant secondary damage to the No 3 piston. The evidence on the bearing fragments suggested lubricating oil starvation leading to premature and accelerated wear. The other journals and big end bearings were normal and well lubricated. However, it could not be positively determined whether there was a No 3 bearing problem that led to lubrication failure or a lubrication problem that led to the bearing failure.

ACCIDENT

Aircraft Type and Registration:	Ace Aviation As-tec 13, G-CKUL
No & Type of Engines:	1 Simonini Mini 3 piston engine
Year of Manufacture:	2017 (Serial no: AA13264)
Date & Time (UTC):	15 May 2019 at 0935 hrs
Location:	Shotteswell Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller detached from aircraft
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	700 hours (of which 540 were on type) Last 90 days - 6 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

After an uneventful local flight the pilot was returning to Shotteswell Airfield at an altitude of 2,100 ft when he noticed the engine speed suddenly increase. He observed that the pusher propeller had detached from the aircraft and so he shut the engine down and commenced a glide descent back to Shotteswell Airfield, which was approximately 1 nm to the north. A successful power-off landing was made.

The flex-wing aircraft's single-cylinder engine rotates a pusher propeller using a reduction drive belt, driven by a pulley on the engine crankshaft. Drive belt tension may be adjusted using an eccentrically-mounted bearing on the propeller driveshaft. Inspection of the engine revealed that the eccentric bearing assembly and propeller had detached at the support bracket due to a fatigue failure of the bearing support, Figure 1. The propeller was not located following the event.

Following this event the engine manufacturer issued a safety notice[1] to all owners and operators of the Mini 3 engine, requiring the eccentric bearing support to be replaced before the next flight.

Footnote

1 Simonini Racing SRL Security Campaign No. 1, 31 May 2019.

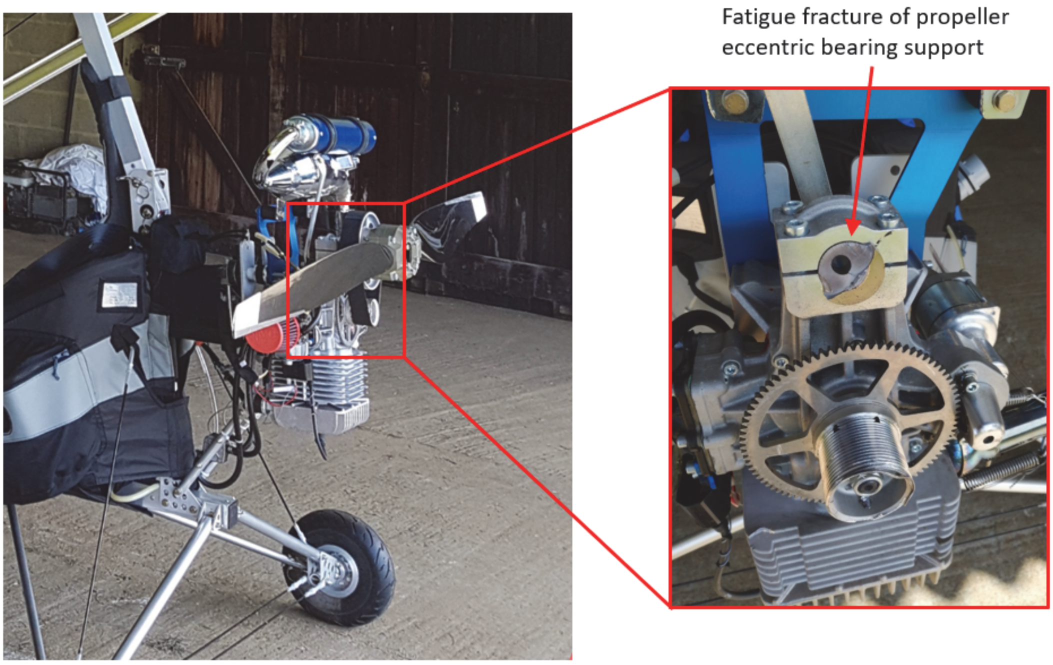

Figure 1
Fatigue fracture of eccentric bearing support

ACCIDENT

Aircraft Type and Registration:	Team Minimax 91, G-BZOR
No & Type of Engines:	1 Rotax 447 piston engine
Year of Manufacture:	2001 (Serial no: PFA 186-13312)
Date & Time (UTC):	19 May 2019 at 1006 hrs
Location:	Godshill, New Forest
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Dented cowling, broken brake cable
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	182 hours (of which 22 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the cruise at 2,000 ft, G-BZOR's engine began running roughly and lost power. Unable to maintain height, the pilot positioned the aircraft for a forced landing on open heathland. Just as the aircraft came to rest it tipped forward onto its nose causing minor damage to the airframe and a brake cable. The cause of the engine failure was traced to a faulty stator in the ignition system.

History of the flight

While cruising at 2,000 ft and 80 kt G-BZOR's engine suddenly began misfiring and lost power. An increase in vibration and reduction in throttle response led the pilot to believe that one engine cylinder had failed. Unable to maintain height, he positioned the aircraft for a forced landing. The pilot was not receiving an air traffic control service at the time and decided to concentrate on flying the aircraft rather than transmitting a MAYDAY call.

Initially over a copse of trees, the pilot selected a suitable landing site south of the woods, on an uphill slope in open heathland (Figure 1). Aware that he would have to execute a tight turn into wind on finals, he increased his airspeed from 55 to 75 mph to give a higher stall margin in the turn.

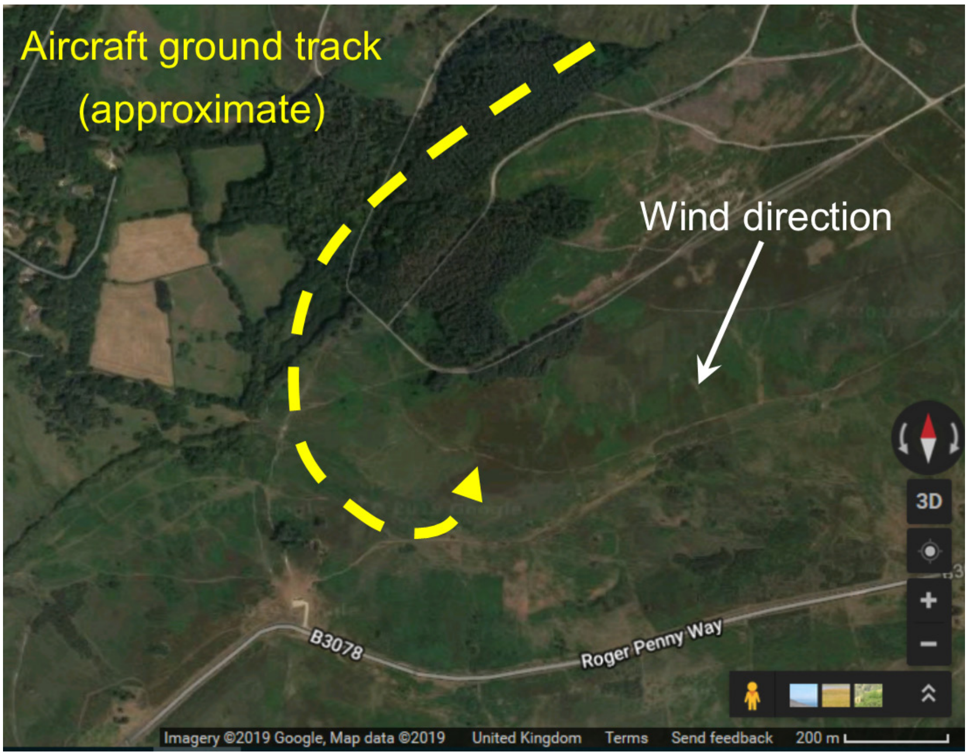

Figure 1

Approximate ground track of G-BZOR during the forced landing

Having rolled out into the light north-north-easterly breeze the pilot reduced speed and achieved a gentle touchdown. As G-BZOR came to a halt its front axle fouled in heather and the aircraft tipped forwards, resulting in minor damage to the airframe (Figure 2) and a brake cable.

Figure 2

G-BZOR after the forced landing with minor damage evident on the engine cowling

Aircraft information

The pilot described the aircraft as being "carefully maintained". Within the previous 30 flying hours the engine had been rebored and rebuilt with new bearings, and fitted with a new main ignition module. The crankshaft had recently been clearance checked, the spark plugs were less than five hours old and the propeller was brand new. The fuel (MOGAS) had been drawn earlier that day from a "busy source". It was "correctly diluted" with oil and filtered into the aircraft's tank.

While the Rotax 447 is not a certificated aircraft engine it is the recommended engine in the Pilots' Operating Handbook (POH). It is also accepted as the normal engine fit by the Light Aircraft Association (LAA) in their Type Acceptance Datasheet (TADS186[1]) for the Team Minimax 91. The Rotax 447 POH[2] contains the following warnings and safety information for users of the engine:

> *'This engine, by design, is subject to sudden stoppage…This is not a certificated aircraft engine…and conforms to no aircraft standards…User assumes all risks…Be informed and prepared for any situation or hazard associated with flying.'*

On this aircraft, carburettor heating is not pilot-selectable. Fixed ducts circulate warm air from the engine bay past the carburation system.

Aircraft examination

The pilot reported that, on inspection after the accident, the carburettor float bowl contained a "suitable" amount of uncontaminated fuel. When he later removed the spark plugs, the pilot noted that they were "clean", the "correct colour" and sparked normally when tested. Subsequent diagnostic testing found that "the ignition stator was breaking down under load and causing the engine to misfire". The engine ran normally after a new stator had been fitted.

Personnel

The pilot credited good training and regular practice of abnormal situations as significant contributors to a successful outcome in this challenging event. He opined:

> *'Two stroke engines can fail without warning - Be Prepared! The success of the* [forced] *landing considering the adverse nature of the terrain is entirely due to good tuition and well-rehearsed "what if' drills. Practice* [forced landing] *procedures regularly, and when things go wrong: Fly the aircraft.'*

Analysis

The Rotax 447 is not a certificated aircraft engine, but it is approved for use under the LAA type acceptance process. The user guide is explicit in its guidance regarding the risks associated with using the engine in an aircraft. Pilots are left in no doubt that they should be prepared for sudden engine failures at any stage of flight. The accident pilot was aware of the risk and mitigated it by regularly practising emergency drills.

Footnote

1 http://www.lightaircraftassociation.co.uk/engineering/TADs/186%20TEAM%20MINIMAX%2091.pdf [Accessed 11 June 2019].

2 https://rotax-docs.secure.force.com/DocumentsSearch/sfc/servlet.shepherd/version/download/200681H000002wI8PQAU?asPdf=false [Accessed 11 June 2019].

Faced with a forced landing on rough terrain, the pilot prioritised flying the aircraft and planning for the landing ahead of transmitting a MAYDAY call. Landing uphill and into wind required a tight turn on late finals. Aware of the attendant risk, the pilot increased his gliding speed to generate a higher stall margin in the turn. The forced landing was successful.

The cause of the engine failure was a faulty ignition stator.

Conclusion

This was a successful forced landing. Key factors in this outcome were the pilot's knowledge and his preparedness for such an emergency. By prioritising flying the aircraft over communicating, the pilot was able to anticipate problems and focus his thoughts on achieving a safe and controlled touchdown.

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).

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

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

Published June 2014.

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

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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.

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