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AAIB Special Bulletins / Interim Reports

AAIB Special Bulletins and Interim Reports

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

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 787-8, ET-AOP
No & Type of Engines:	2 General Electric GEnx-1B turbofan engines
Year of Manufacture:	2012 (MSN 34744)
Location	London Heathrow Airport
Date & Time (UTC):	12 July 2013, 1534 hrs UTC
Type of Flight:	Not applicable
Persons on Board:	None
Injuries:	Not applicable
Nature of Damage:	Extensive heat damage in upper portion of rear fuselage
Commander's Licence:	Not applicable
Commander's Age:	Not applicable
Commander's Flying Experience:	Not applicable
Information Source:	AAIB Field Investigation

Synopsis

A fire event occurred on a parked, unoccupied and electrically un-powered Boeing 787 aircraft at London Heathrow Airport. Subsequent examination of the fire-affected area has focussed on the Emergency Locator Transmitter (ELT). Two Safety Recommendations have been made.

Notification

On the afternoon of Friday 12 July 2013 the Air Accidents Investigation Branch (AAIB) was notified of an occurrence to a parked and unoccupied Boeing 787-8 on Stand 592 at London Heathrow Airport. The circumstances surrounding the occurrence did not fall within the definitions of an accident or serious incident as defined in ICAO Annex 13, however, the Chief Inspector, in exercise of his powers under the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, initiated an investigation and deemed it appropriate to treat the occurrence as a serious incident and to invoke the protocols of ICAO Annex 13 with regard to the participation of other interested States. An investigation was commenced immediately and a team of AAIB Inspectors was deployed. Accredited Representatives from the National Transportation Safety Board (NTSB) (representing the State of Design and Manufacture), the Civil Aviation Authority of Ethiopia (representing the State of Registry and the Operator) and the

Transportation Safety Board of Canada (representing a component manufacturer) were invited to participate in the investigation along with technical advisors from the Federal Aviation Administration (FAA) and aircraft and component manufacturers. The AAIB has also been assisted by the European Aviation Safety Agency (EASA) and the UK Civil Aviation Authority (CAA).

History of the event

The Boeing 787-8 aircraft landed at London Heathrow Airport at 0527 hrs on 12 July 2013 after an uneventful flight from Addis Ababa and arrived on Stand 326 at about 0540 hrs. The flight crew did not report or record any technical defects. After passenger and crew disembarkation, the aircraft was towed to Stand 592 to await its next service later that day. Before leaving the aircraft the engineer, on the flight deck, instructed the ground handling agent to remove ground electrical power. The ground handling agent accordingly turned off ground power at the stand's control box but left the power umbilical cables attached. The engineer visually confirmed on the flight deck that ground power was no longer available. He then secured and left the aircraft.

At approximately 1534 hrs an employee in the air traffic control tower noticed smoke emanating from the aircraft and activated the crash alarm. The Airport Fire Service arrived on scene at 1535 hrs and discharged water and foam onto the aircraft. One fire fighter removed the power umbilical cables from the aircraft as a precaution.

Fire fighters equipped with breathing apparatus entered the aircraft at the L2 door and encountered thick smoke. As they moved to the rear of the aircraft the smoke became denser so they opened further cabin doors to clear the smoke. At the rear of the passenger cabin they observed indications of fire above the ceiling panels. They attempted to tackle the fire with a handheld 'Halon' extinguisher but this was not effective, so they forcibly moved a ceiling panel and tackled the fire with water from hoses. This was effective and the fire was extinguished.

Aircraft examination

The initial technical investigation confirmed extensive heat damage in the upper portion of the rear fuselage, with significant thermal effects on aircraft insulation and structure. Surveying and detailed examinations of damaged areas revealed that the greatest heat damage and highest temperatures were centred on the rear fuselage close to the crown and displaced to the left of the aircraft centre line. This corresponds to the most damaged external areas, with blackened and peeling paint and damage to the composite structure. It also coincides with the location of the aircraft's Emergency Locator Transmitter (ELT) and its associated system wiring which is mounted internally on structure close to the aircraft skin. There are no other aircraft systems in this vicinity which, with the aircraft unpowered, contain stored energy capable of initiating a fire in the area of heat damage.

Emergency Locator Transmitter (ELT)

The ELT model installed in the aircraft contains a set of chemical batteries using a Lithium-Manganese Dioxide ($LiMnO_2$) composition. These allow the ELT, as required by regulation, to operate in an emergency situation entirely independent of the aircraft's electrical power system.

Detailed examination of the ELT has shown some indications of disruption to the battery cells. It is not clear however, whether the combustion in the area of the ELT was initiated by a release of energy within the batteries or by an external mechanism such as an electrical short. In the case of an electrical short, the same batteries could provide the energy for an ignition and suffer damage in the subsequent fire.

The ELT manufacturer has produced some 6,000 units of this design which are fitted to a wide range of aircraft and, to date, the incident on 12 July 2013 has been the only significant thermal event.

Safety Recommendations

The history of this ELT product line indicates that a thermal event is extremely rare and this incident occurred on the ground while the aircraft was unoccupied. However, large transport aircraft do not typically carry the means of fire detection or suppression in the space above the cabin ceilings and had this event occurred in flight it could pose a significant safety concern and raise challenges for the cabin crew in tackling the resulting fire.

The AAIB therefore makes the following two Safety Recommendations:

Safety Recommendation 2013-016

It is recommended that the Federal Aviation Administration initiate action for making inert the Honeywell International RESCU406AFN fixed Emergency Locator Transmitter system in Boeing 787 aircraft until appropriate airworthiness actions can be completed.

Safety Recommendation 2013-017

It is recommended that the Federal Aviation Administration, in association with other regulatory authorities, conduct a safety review of installations of Lithium-powered Emergency Locator Transmitter systems in other aircraft types and, where appropriate, initiate airworthiness action.

Detailed examination of the ELT and the possible mechanisms for the initiation and sustaining of the fire in this aircraft continues. Further updates on progress will be published as appropriate.

Published 18 July 2013

AAIB Field Investigation reports

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A321-231, G-EUXM
No & Type of Engines:	2 International Aero Engine V2533-A5 turbofan engines
Year of Manufacture:	2007 (Serial no: 3290)
Date & Time (UTC):	20 April 2012 at 1230 hrs
Location:	Lambourne Hold, near London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 182
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	13,735 hours (of which 1,500 were on type) Last 90 days - 100 hours Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

Synopsis

On two separate flights air speed indications became temporarily unreliable. On both occasions the flight crews retained control of the aircraft flight path and managed the situation while remaining in compliance with their ATC clearance. On one of the flights a simultaneous TCAS RA was caused by unreliable vertical speed data. In both cases the aircraft diverted to an airfield clear of adverse weather where it landed without further incident. During the investigation of the first incident the CVR was found to have been deleted by maintenance actions.

History of the flight

The aircraft was operating a passenger service from Stockholm Arlanda to London Heathrow. The flight had been unremarkable, although thunderstorms were forecast for the London area. At around 1230 hrs the aircraft joined the Lambourne hold with the co-pilot as Pilot Flying (PF). The aircraft was descending in light turbulence to FL140, the indicated Total Air Temperature (TAT) was +3°C and the pilots did not see any indication of airframe icing. St Elmo's fire was visible, however, and shortly after the aircraft entered cloud tops there was a white flash of lightning, without any associated noise.

Both pilot's recalled that about one second after the flash the air speed indications on their Primary Flying Displays (PFDs) fluctuated, with both the high and the low speed ends of the scale alternately visible. The standby air speed indicator was also fluctuating, and although neither pilot could recall the extent of its fluctuations, they thought it was not by as much as the primary instruments. The commander remembered that at one stage his PFD speed indication briefly appeared to be blank. The pilots estimated that the instrument disruption lasted for between 10 seconds and 2 minutes. Neither recalled seeing fluctuation of vertical speed or altitude indications.

The pilots recalled that coincident with the ASI fluctuations the master warning sounded repeatedly, an Electronic Centralised Aircraft Monitor (ECAM) message appeared, the autopilot disconnected without its associated audio caution, and the flight controls changed to Alternate Law. The pilots commenced the procedure for '*Unreliable Speed Indication*' and turned off the Flight Directors. PF checked the thrust setting and decided to leave the autothrottle engaged while monitoring the engine N_1 indications for any significant variation. A TCAS Resolution Advisory (RA) appeared on the PFDs though the crew did not hear its associated audio. This RA was depicted on the VSIs as green below 500 ft/min rate of climb, and red above 500 ft/min, indicating that a climb at less than 500 ft/min or a descent was appropriate. The lack of audio resulted in neither pilot being certain they had seen the RA immediately. The navigation display showed conflicting traffic 2,500 ft above and flying level. G-EUXM was in a gentle descent and thus already in compliance with the RA. The commander informed ATC which, based on radar, was unable to identify any conflicting traffic.

The audio voice callout "clear of conflict" sounded and the crew levelled the aircraft at FL140, in compliance with the earlier clearance. With ATC agreement the aircraft was turned away from a storm cell, towards better conditions in the Bovingdon hold. The flight instruments had now stopped fluctuating. The pilots crosschecked the pitch versus power tables in the Quick Reference Handbook (QRH) and confirmed the speed indications now appeared to be correct at 240 KIAS. PF re-engaged the autopilot.

The pilots noted the ECAM message NAV-ADR DISAGREE and carried out the associated actions. They agreed to follow the optional IF NO SPD DISAGREE branch of the procedure, as all indications were now normal. This directed the crew to land with FLAP 3 (the operator's normal landing setting) use V_{REF} +10 kt (5 kt faster than normal) and noted that the flight controls would enter Direct Law when the landing gear was selected DOWN. The ECAM then displayed AOA DISCREPANCY, suggesting the problem had been caused by a mismatch between the aircraft's three Angle Of Attack (AOA) probes. No further procedures were presented or required.

The commander checked the aircraft electronic maintenance pages for the status of the AOA probes and noted that all three AOA outputs were within 0.5° of each other.

The pilots established the aircraft in the hold at Bovingdon in VMC. The commander referred to the company Abnormal Procedures manual (PRO–ABN) and noted that an AOA fault might cause spurious stall warnings. The crew discussed the implications of the failures and considered various scenarios, utilising the company's decision making tool T-DODAR[1], and decided to divert to London Stansted airport, which was clear of adverse weather. A PAN was declared and on ATC request 7700 was set on the transponder.

Footnote

[1] T-DODAR, Time- Diagnose Options Decide Assign Review; a method of adding structure to decision making.

Direct Law landings are rare and the commander sought supplemental information from the company manuals to confirm his understanding of it. However, with additional storm cells developing near London Stansted he decided to prioritise the landing. The flight controls remained in Alternate Law until the autopilot was disengaged, after which an uneventful landing was accomplished in Direct Law, using autothrust.

Operating information

The pilots commented that company training in unreliable airspeed indications had made the incident straightforward. They noted, however, that the '*Unreliable Speed Indication/ADR Check Proc*' QRH procedure spanned four pages of the QRH. Pitch and power settings for a 'clean' aircraft, at minimum speed, were shown in a table on the fourth page, which had delayed them in finding the appropriate settings. They noted that as aircraft may spend considerable time operating at minimum clean airspeed in holding patterns, earlier presentation of these figures would be helpful. The operator informed the AAIB that it will discuss this with the manufacturer, and the manufacturer commented that the procedure referred to memory items that could be actioned immediately.

Subsequent incident

A second unreliable airspeed event occurred to G-EUXM on 16 June 2012. The aircraft was operating from Edinburgh to London Heathrow Airport when, while climbing through FL265 having been in VMC, the aircraft flew through the top of a "dome" of cloud. The commander's airspeed indication reduced towards zero, returned to normal, then reduced again. The co-pilot's indications were similarly affected, with a red 'SPD' caption visible. The autopilot disconnected and the pilots commenced the actions for unreliable airspeed, disconnecting the autothrust and turning off the flight directors. When the initial actions had been completed the airspeed indications appeared to have returned to normal. As in the first event the aircraft was now in Alternate Law and the pilots were aware that it would revert to Direct Law for the landing. Considering the destination weather, including wind from 230° at 24 kt gusting to 39 kt, they decided to divert to London Stansted where the wind of 210° at 22 kt was more favourable.

Neither pilot saw any St Elmo's fire or airframe icing during the second incident. Disruption to the ASIs ceased on or shortly after the aircraft left cloud.

Meteorological information – Incident 1

The UK Met Office provided an aftercast of the weather situation in the London TMA at the time of the first incident. They noted that the general situation was consistent with forecasts. The aftercast showed that the conditions were conducive to the formation of thunderstorms and that there was electrical activity and lightning strikes to the ground in the region of the Lambourne hold. London Heathrow, in common with the other London aerodromes, reported thunderstorms including hail and strong wind gusts at various times throughout the day.

Meteorological information – Incident 2

The UK Met Office provided considerable satellite cloud temperature data for the location of the second incident. Cloud top temperatures were approximately -50°C.

Other Aircraft

No other aircraft in the LAM hold at the time of incident 1 reported any unusual occurrences or TCAS RAs. Several aircraft had been struck by lightning during descent and approach to airports in the London area that day without any reported adverse effects.

System information

Electronic Instrument System

The Electronic Instrument System (EIS) includes the Primary Flying Display (PFD) and Navigation Display (ND), and the Electronic Centralized Aircraft Monitoring (ECAM) functions.

The ECAM uses aircraft system data which has been processed by the System Data Acquisition Concentrators (SDAC), Flight Warning Computers (FWC) and Display Management Computers (DMC). This data is then presented to the flight crew on the Engine/Warning Display (E/WD) and System Display (SD). The E/WD displays the engine and fuel parameters, the checklist and warning messages, and some information relevant to system operation. The SD displays synoptic diagrams giving the configuration and status of various aircraft systems.

Centralised Fault Display System

The Centralised Fault Display System (CFDS) provides a central maintenance aid which allows maintenance information to be extracted, and system and sub-system BITE tests to be initiated from the cockpit. It comprises a Centralized Fault Display Interface Unit (CFDIU), which receives data from other aircraft systems BITE. The CFDIU is accessed from two Multipurpose Control and Display Units (MCDU) located in the cockpit, which can be used initiate tests and to call up other reports such as the Post-Flight Report (PFR).

Air Data and Inertial Reference System

The Air Data and Inertial Reference System (ADIRS) supplies temperature, anemometric, barometric and inertial parameters to the PFD and ND as well as various other systems. The ADIRS includes three identical Air Data and Inertial Reference Units (ADIRU) each of which has two parts: the Air Data Reference (ADR) and the Inertial Reference (IR). The ADR supplies barometric altitude, airspeed, mach, angle of attack, temperature and overspeed warnings. An ADIRS panel, located in the cockpit, allows the crew to select the mode for each ADIRU and provides information on the status of the IR and ADR systems. The normal procedure is for all three ADIRU to be selected ON during flight with ADIRU 1 providing information to the left side (Capt) instruments, ADIRU 2 providing information to the right side (F/O) instruments. In the event of a failure of ADIRU 1 or 2, ADIRU 3 can be selected to provide information to either the Capt or the F/O instruments. In normal operation, all three ADIRU constantly provide air data to a number of systems including flight guidance, autoflight and autothrust.

The air data is provided to the ADIRU from three pitot probes, six static pressure probes, three Angle of Attack (AOA) sensors and two Total Air Temperature (TAT) probes (Figure 1). The data from the AOA and TAT probes is provided directly to the ADIRU as an electrical signal, whereas air pressure from the pitot and static probes is first converted at an Air Data Module (ADM) into an electrical signal. Air pressure is provided directly to the standby airspeed indicator and altimeter from static and pitot probes that are also linked by two ADMs to ADIRU 3. The pitot head probes, static ports, AOA probes and TAT probes are electrically heated by three independent Probe Heat Computers (PHC) that automatically control and monitor the electrical power to the Capt, F/O and standby probes.

Pitot heating

The pitot probes, as well as the other sensors, are heated to counter icing. This heating can only provide a finite amount of energy in a given time. Conditions can be encountered in which the heat removed from the probe due to environmental conditions exceeds the ability of

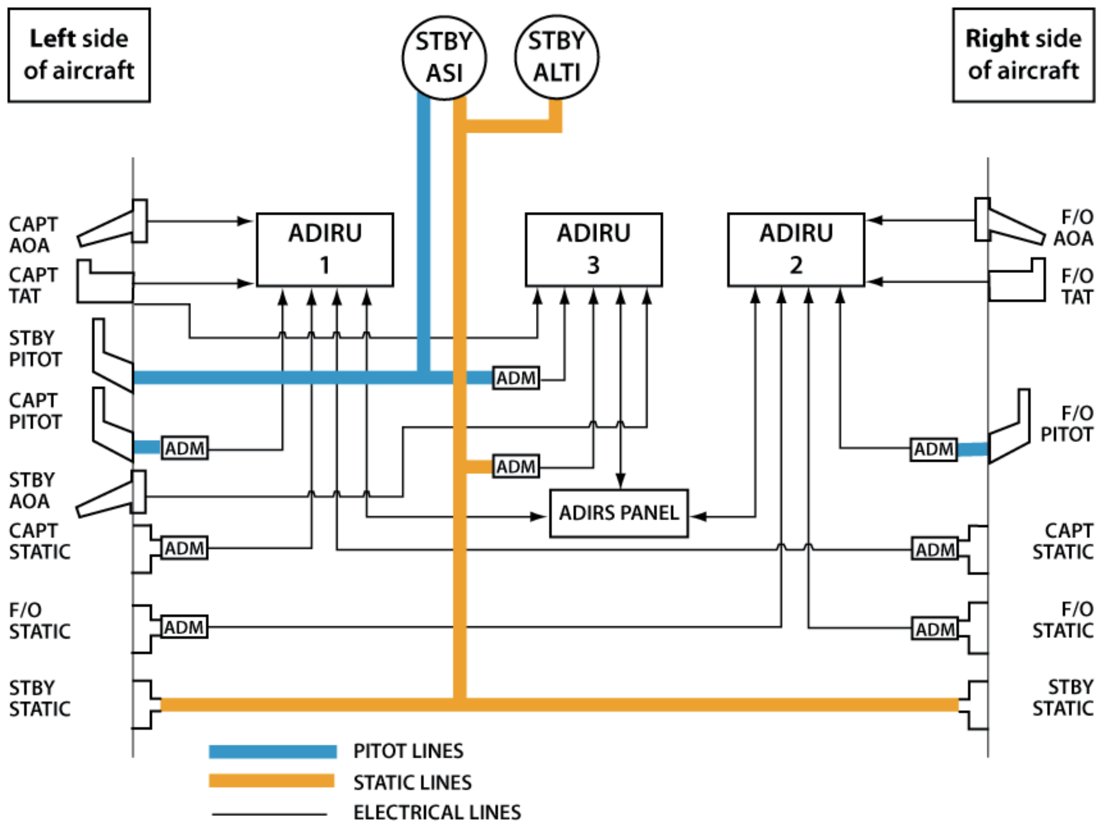

Figure 1

Air data system

the heating system. Ice may then accumulate on the probe. Probe icing can lead to blocking of the pitot probe orifices which results in erroneous airspeed and altitude indications. This will continue until the aircraft enters less severe environmental conditions in which the probe heating system can melt the ice.

The three Probe Heat Computers (PHC) monitor and control the electrical power to the heating elements in the probes, ports and AOA sensors. If the electrical current consumption is outside limits, ECAM warnings are generated by the FWS, using discrete signals sent by the PHC through the ADIRU (Figure 2). BITE messages are generated directly by the PHC and recorded in non-volatile memory (NVM) as well as being sent to the CFDIU on two ARINC channels (data buses). In the event that the data communication between the PHC and CFDIU is lost, ECAM warnings will still be displayed providing the discrete outputs from the PHC are still available, but the associated BITE fault message will not be recorded by the CFDIU.

The NVM in the PHC, in which the BITE messages are stored, is cleared during each ground/flight transition as computed by the Landing Gear Control and Interface Unit (LGCIU). Opening the Circuit Breaker (CB) on the power supply to at least one of the two LGCIU will also clear the PHC BITE messages even if the aircraft has not flown.

Flight control laws

The fly-by-wire flying control system can operate in Normal Law, Alternate Law or Direct Law. In Normal Law the system automatically protects the aircraft

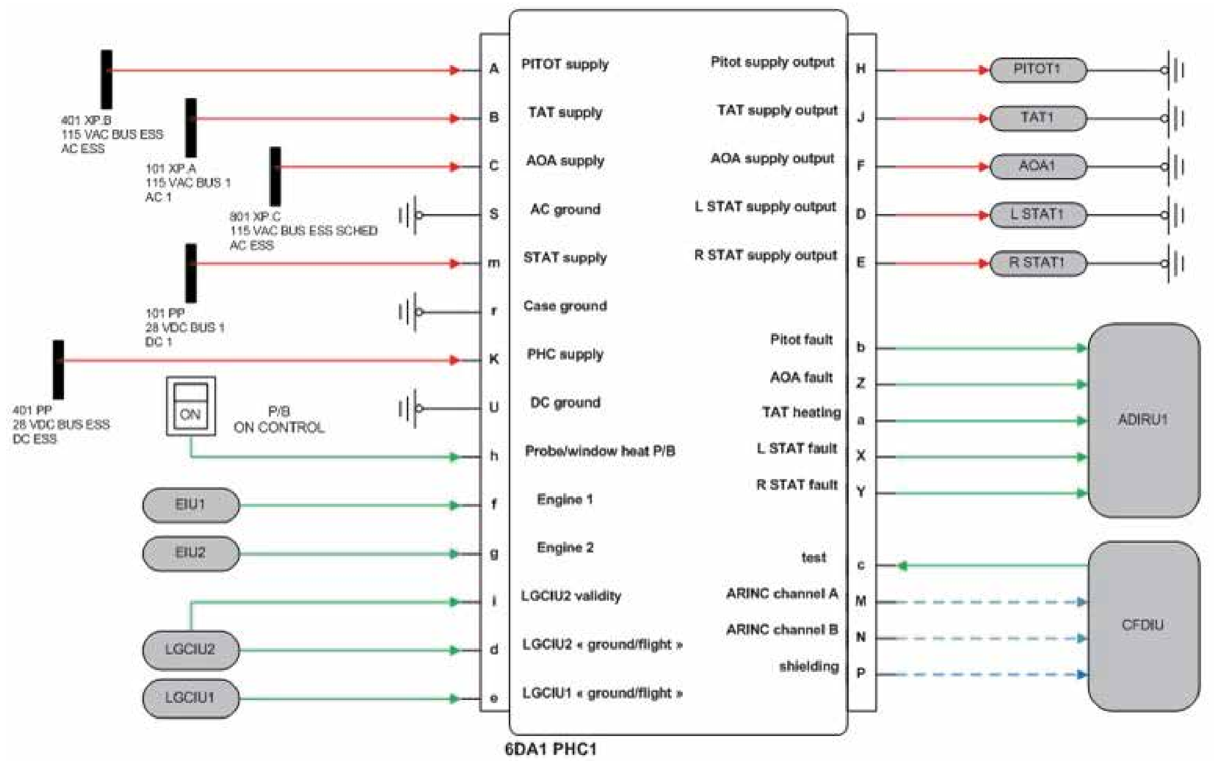

Figure 2

PHC, input and output signals

throughout the flight envelope for load factor limitation, pitch attitude, high AOA, high speed and bank angle protection. In the event of a loss of inputs, such as air data, the system will degrade into Alternate Law where some of the protection is either lost or altered. When the landing gear is selected DOWN in Alternate Law, the system degrades further to Direct Law, in which all protections are lost.

Recorded data

Recorded data was recovered relating to two separate events on G-EUXM and a subsequent event on G-EUXC.

First erroneous air data event

Recordings were recovered from the Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR), a Digital AIDS Recorder (DAR) and Traffic Collision Avoidance System (TCAS) after the first event, on 20 April 2012. Radar recordings of the track and Mode S downlinked parameters of both the aircraft under investigation and the other aircraft involved in the TCAS RA were also obtained.

The recorded data showed problems associated with the air data of all three related systems on the aircraft, and a TCAS event. Pertinent parameters are shown in Figure 3.

The problems occurred whilst descending to a selected altitude of 14,000 ft within a hold north of London. Soon after passing 14,800 ft there was a period of approximately 27 seconds during which all three sources of altitude and airspeed data intermittently and independently jumped to either unreasonable but valid values or values indicating invalid data. This was associated with jumps in recorded air temperature and Mach number.

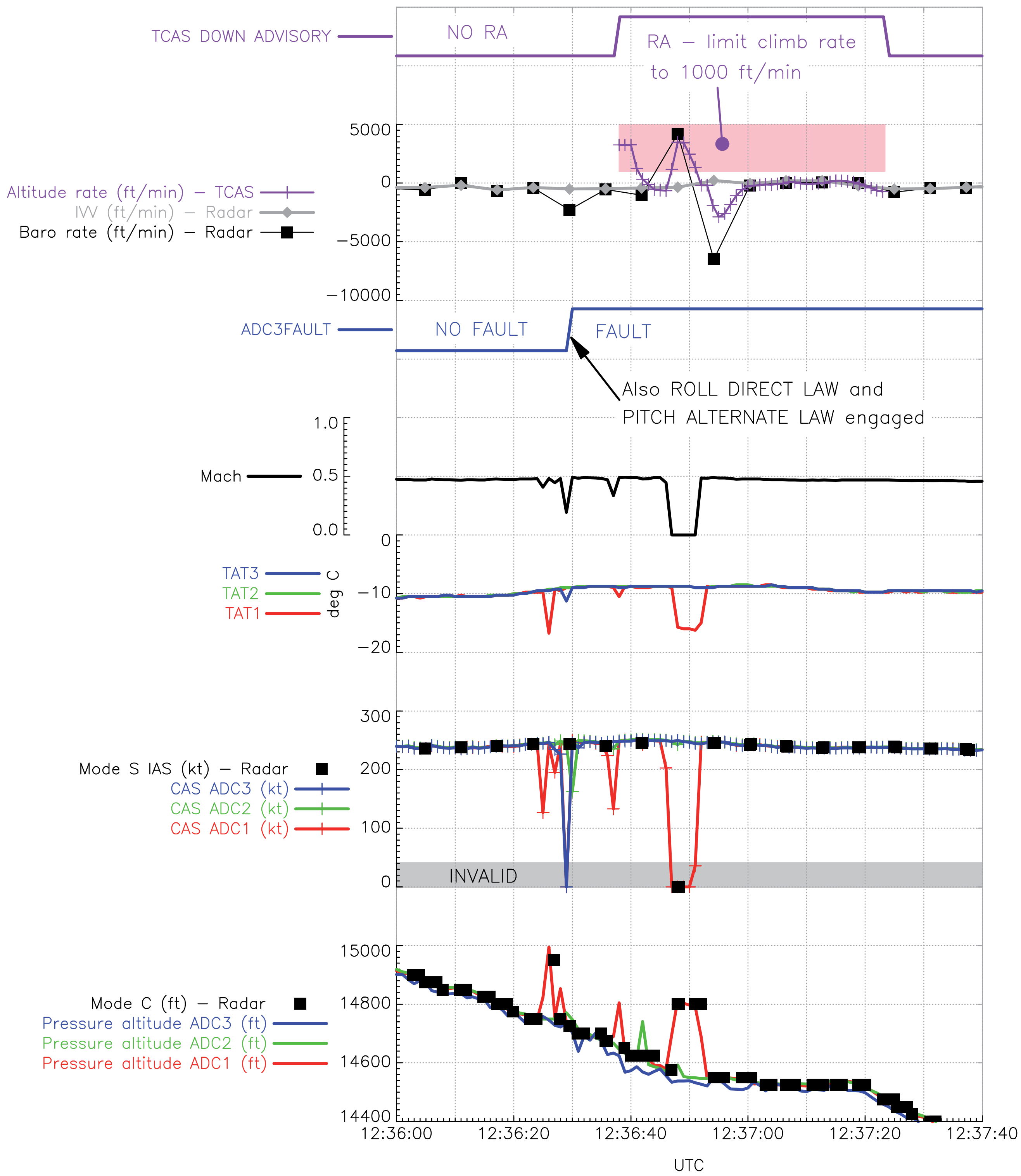

Figure 3

Pertinent parameters from the FDR, ACMS, TCAS and radar recordings

During this 27 second period, Air Data Computer (ADC) number 3 indicated a fault that was latched for the rest of the flight but the other two ADCs did not indicate any faults and no other system problems were apparent in the FDR data. Afterwards, and for the rest of the flight, all three sources of temperature, altitude and airspeed remained reasonable.

Barometric rate was not recorded by the FDR or DAR but was recorded as a Mode S downlink parameter along with Inertial Vertical Velocity (IVV). The IVV showed that the aircraft was in a stable descent but the barometric rate parameter was reacting to the erroneous altitude readings, initially indicating a climb.

During this period another aircraft joined the hold at FL170. The TCAS recording showed an RA advising not to climb at more than 1,000 ft/min. At the same time TCAS recorded the aircraft climbing at 3,250 ft/min and another aircraft at a relative altitude corresponding to FL170. The altitude rate varied as the erroneous ADC 1 altitude parameter varied. The RA cleared 30 seconds after the erroneous air data behaviour ceased.

The TCAS of the other aircraft did not issue an RA. This was in accordance with the TCAS manufacturer's expectations given the separation and relative motion.

The control laws switched from Normal to Alternate law (ROLL DIRECT LAW and PITCH ALTERNATE LAW) when the ADC 3 FAULT became active, closely followed by autopilot 2 disengaging. Autopilot 2 was re-engaged 80 seconds later and remained engaged until passing through 1,000 ft agl on the final approach to Stansted airport, at which point the PITCH DIRECT LAW engaged.

The DAR recorded Static Air Temperature (SAT) of -21°C leading up to the period of erroneous air data.

Second event

A second event occurred on the same aircraft on 16 June 2012, this time during the climb. The relevant data from the DAR and FDR are given in Figure 4. There was a similar period of disrupted air data during which no ADC faults were recorded; later in the flight faults with ADCs 2 and 3 were recorded as the result of crew actions.

The DAR recorded a Static Air Temperature of -41°C leading up to the second event.

CVR recording problem

During both G-EUXM events the CVR Cockpit Area Microphone (CAM) channel recorded a number of periods during which large audio pulses were recorded, often resulting in a recorded waveform using the full amplitude capability of the recording. The time between pulses varied during the affected periods. The air data problems on both flights occurred during a part of one such period during each flight.

The pulses and their effect on the automatic gain control of the CAM channel amplifier resulted in the loss of the cockpit area ambient audio from the recording during intense periods of pulsing and significant degradation during the less intense periods.

The recordings of the crew audio channels did not record any such sounds or indicate that the crew could hear such sounds at the time. Also, there was no adverse effect on the VHF channels being used by the crew during these pulsing periods.

An Airbus A319, registration G-EUPO, experienced an unreliable airspeed indication event in December 2010 (AAIB Bulletin 4/2012). The G-EUPO event differs from the G-EUXM events in relation to the air data

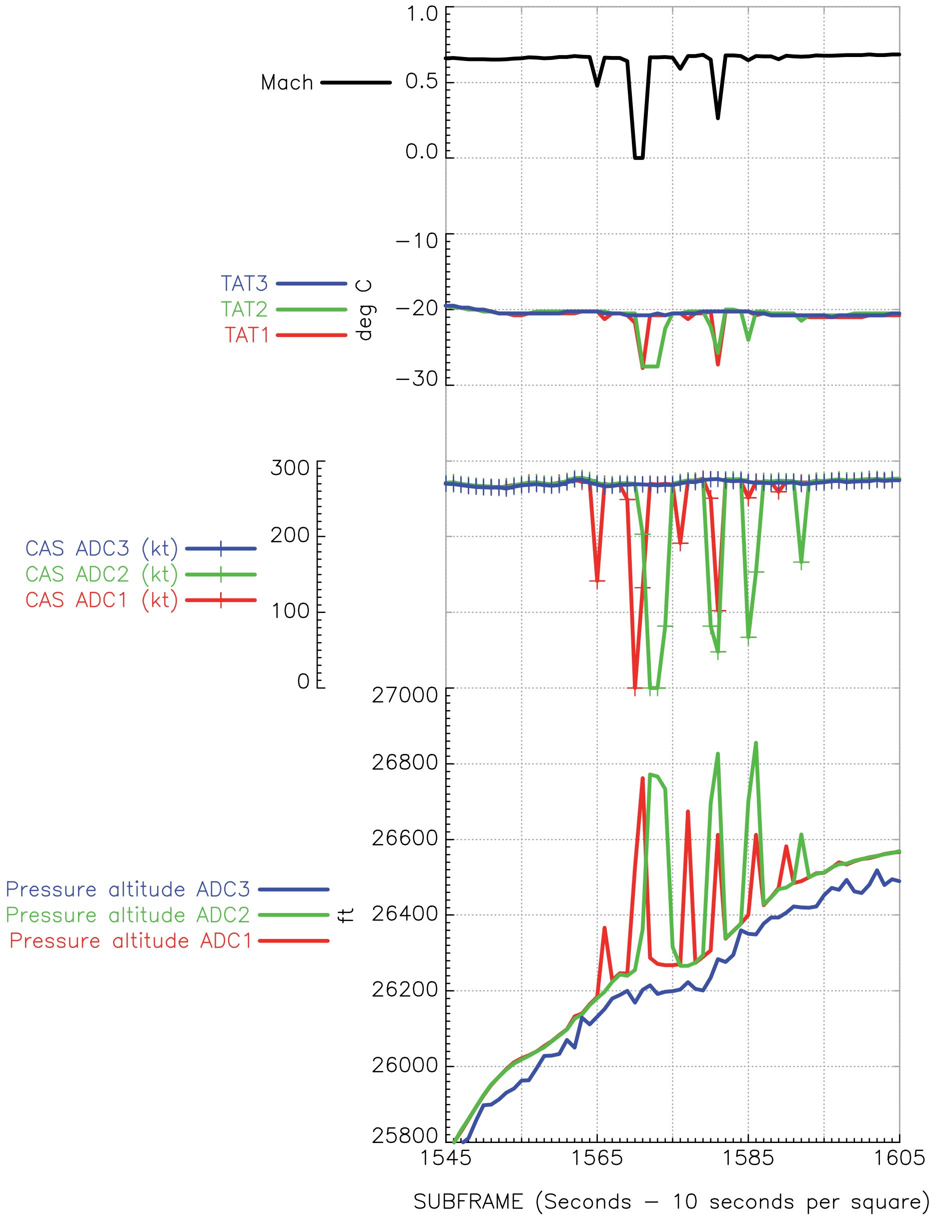

Figure 4

Pertinent parameters from the FDR, ACMS, TCAS and radar recordings

system warnings and parameter behaviour and so the air data problems are not likely to be common between the aircraft. However, the investigation did find similar pulsing on the CAM, not heard by the crew and not evident on the other CVR channels. The investigation found that the effect on the CAM could be replicated with an electrostatic discharge applied to the connector of the CAM control panel.

The airframe manufacturer and associated national investigation body have not observed this problem other than on aircraft subject to this investigation and the G-EUPO event.

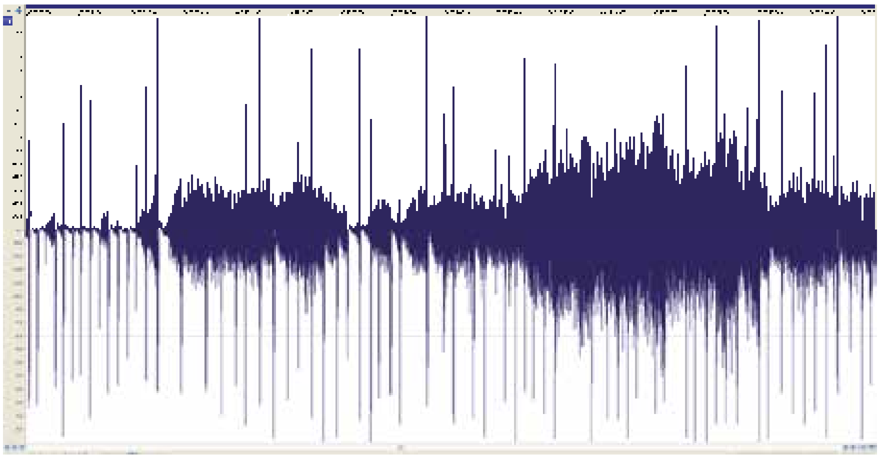

Figure 5

Sample period of the CAM recording showing recorded pulses that were not heard by the crew

Aircraft examination

First incident

An inspection of the aircraft was carried out by the operator in the presence of the AAIB on 21 April 2012. Several areas of damage were identified on the fuselage skin above and below the cockpit windows which were consistent with multiple lightning strikes. No other evidence of lightning strikes was found. Examination of the aircraft's Technical Log showed that the aircraft had been subjected to a lightning strike on 19 April and a number of 'strike points' had been identified above and below the cockpit windows. It was not possible to confirm that all the damage observed had been caused prior to the 20 April incident.

The post-flight report recorded faults with ADIRU 3, the two ADMs associated with ADIRU 3 and the Capt AOA sensor. After restoration of electrical power to the aircraft, interrogation of the CFDS identified the fault messages which had been associated with the systems failures reported by the flight crew and printed on the post-flight report. No additional fault reports were recorded. Further tests of the aircraft's flight control and air data systems confirmed that the previously reported faults were no longer displayed. As a result of the fault messages generated during the incident, ADIRU 3 and its two associated ADMs were replaced together with the Capt AOA sensor and the TCAS computer. A test of the aircraft's pitot-static system indicated that no faults were present.

Second incident

A physical inspection of the aircraft confirmed that there was no evidence of additional lightning strikes of damage to the aircraft. All the air data and flight control systems operated normally and a test of the pitot-static system confirmed that it was serviceable. As a precaution, all three of the aircraft's pitot probes were replaced and the removed units dispatched to the AAIB for further examination.

Component examination

The ADIRU removed after the first event was tested at the operator's approved test facility and no faults were identified with the unit.

The two ADMs and the AOA sensor were subjected testing at the manufacturer's facility. No faults were found.

The three pitot probes removed after the second incident on 16 June were Thales units, part number C16195BA. These probes had been introduced on the A320 family of aircraft to provide improved airspeed indication behaviour in heavy rain conditions when compared with an earlier Thales probe, part number C16195AA. A visual examination of the probes showed no evidence of corrosion or mechanical damage. The probe manufacturer conducted a series of tests which found no defects within the probe heating system.

Flight crew training

The operator had identified several possible events as having a high priority for training within its Advanced Training and Qualification Package (ATQP), based on a Task Analysis and Training Needs Analysis of its Airbus operation. Unreliable airspeed was among them, and was included in one of the Line Orientated Evaluation (LOE) scenarios conducted in 2009-10. Three different evaluation scenarios had been developed, so about 33% of the operator's Airbus pilots were evaluated on this item.

The number of crews required to re-fly the exercise was above the trigger level for a training intervention. Therefore, in the 2010 recurrent training sessions, a package covering unreliable airspeed, including presentations, group discussion and simulator time, was provided for all pilots. An unreliable airspeed event in December 2010 (G-EUPO, published in AAIB Bulletin 4/2012) helped to validate the package and a video was created, with the crew from that incident, providing tips about what they thought went well and what to look out for. This video was incorporated into the online version of the 2010 training package remained available to all company pilots remotely via the operator's training intranet. The commander during the first incident had had this training; the co-pilot was new to the company and had not.

The operator's training cycle envisaged revisiting an unreliable airspeed scenario towards the end of 2012. The re-fly rate on such exercises will be used to evaluate the effectiveness of the training package and close the feedback loop regarding further training.

Abnormal procedures manual (PRO-ABN)

The PRO-ABN-34 procedure '*NAV ADR disagree*' cross-refers to PRO-ABN-27 which describes the various flight control laws. This was the information the commander of incident 1 was intending to review when he decided instead to prioritise the landing. In his subsequent post-flight review, the commander commented that the only information in PRO-ABN-27 of which he was unaware was that manual thrust is advised during Direct Law landings.

CVR preservation

The operator put in place engineering instructions to preserve the FDR but not initially the CVR. In the time between the crew leaving the aircraft and the AAIB arriving, the CVR erase button had been pressed. The purpose of the CVR is to assist in accident investigation and the purpose of the CVR erase function is to protect staff from routine management monitoring; both serve their purpose and are not mutually exclusive. In accordance with CVR standards, erased audio can be recovered using special techniques, but this is a time-consuming and costly activity. Consequently, the recovery of CVR evidence took longer than usual, delaying the investigation. No systemic issues were found relating to the act of the CVR erasure that would constitute a risk to further investigations.

The operator's recorder preservation procedures are predicated on an engineering function. The rationale is that if there is a hazard, the crew should not be subjected to risk for the purpose of recorder preservation. In this case, like many others before, there was no hazard after landing and a procedural requirement for the crew to take an active part in the preservation of the recordings would have resulted in a more robust approach to flight recorder preservation requirements. The lack of crew action in an operator's recorder preservation process is not unique to this operator.

Similar events

The same operator reported a similar occurrence on G-EUXC, the same aircraft type, which occurred on 20 August 2012. The data shows similar air data behaviour, with a slightly longer period and without any faults recorded. The entry condition was pressure altitude of approximately 26,800 ft with a SAT of -23°C. The CVR was not removed (and not required to be).

Other national accident investigation bodies have reported erroneous air data events with recommendations for further action. These include:

> Australian Transport Safety Bureau (ATSB) report AO-2009-065 "*Unreliable airspeed indication 710 kn south of Guam, 28 October 2009, VH-EBA, Airbus A330-202*". This report also refers to three unreliable airspeed events on A320 aircraft which occurred in Australian airspace between 2008 and 2010;
>
> Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) report into the loss of Airbus A330-203 registration F-GZCP (AF447) on 1 June 2009.

Icing certification standards

Current icing certification standards, detailed under EASA Certification Specifications for Large Aeroplanes CS-25, Appendix C, define altitude and temperature envelopes for continuous and intermittent maximum icing conditions for supercooled liquid droplets. Ice crystals, not considered to be as hazardous as liquid, are not covered.

Airbus has its own standards relating to ice crystal icing and supercooled droplet icing that extend beyond the EASA CS-25 requirements. Both G-EUXM events involved combinations of altitude and SAT that fall outside their current requirements. Airbus testing has shown that the probe designs meet all current requirements.

Figure 6 shows the EASA CS-25 requirement envelopes and Airbus requirements; the two events are plotted on SAT v Altitude graph.

Airbus has conducted studies including investigating reported airspeed indication problems, icing wind tunnel testing and instrumented flights tests. The results have been shared with the aviation community and Airbus is working in partnership with other organisations on better understanding of icing problems. As a result of their studies, Airbus considers that the current EASA and Airbus requirements need to be improved to better address pitot probe icing. Airbus is in the process of developing expanded envelopes for inclusion in the EASA requirements, which address ice crystal issues. When the revised standards are approved, work can begin with the pitot probe manufacturers to develop designs that reflect the new understanding of pitot probe icing issues. The proposed standards are also given in Figure 6.

There is also a new requirement, currently related to engines, that specifies the total water content associated with SAT and Altitude. Work is being done to apply these to other aircraft equipment, including air data probes.

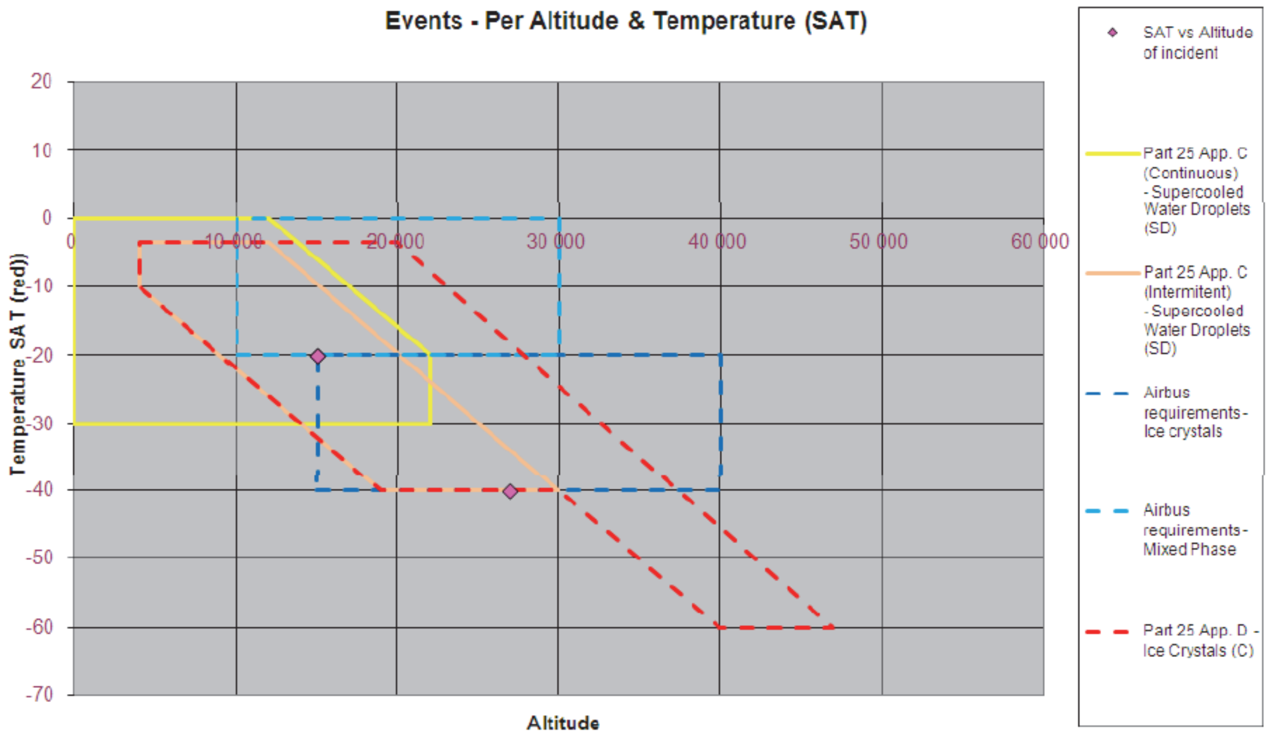

Figure 6

Altitude v SAT envelopes for the current and proposed requirements and the G-EUXM events. The diamonds are the G-EUXM events

Airbus considers that even though the two G-EUXM airspeed indication problem events occurred on the same aircraft, albeit months apart, and on only one other of the operator's fleet during the same period, the events are not associated with any fault on the aircraft. They consider that the problems were consistent with their studies linking these events to obstruction of at least two pitot probes by ice crystals, and not any airframe-specific problem.

Airbus reported that the failure of two or more probes to perform their function is certified as a "Major" event and as such should not occur more than once every 10^5 flight hours. Its statistics indicate that the actual occurrence rate is in the order of 100 times less frequent.

Weather

The Met Office supplied colour-coded and time-stamped images depicting the temperature of the tops of the clouds over the UK covering the periods of both flights where pulsing on the CAM channel was recorded. Comparing these to the recorded location of the aircraft during the periods of CAM interference showed an approximate correlation with localised colder patches of cloud tops, between -51°C and -62°C. This indicates higher altitude cloud, more likely to contain ice crystals.

Electrostatic discharge

The environment through which an aircraft flies provides a number of mechanisms for electrically charging it. Airbus identified the more common sources of charging as triboelectric charging (flying through snow, ice, hail, rain or sand), ionic engine exhaust charging (exhaust particles charged during combustion) and flying through intense electric fields (such as those required to generate lightning).

The main mechanisms for discharging are arcing, corona discharge and streamering.

Arcing involves an electrically isolated metal component on the aircraft developing a sufficient charge to cause a spark to jump the gap to the rest of the aircraft. Conductive parts are electrically bonded to the primary structure to prevent this, but a failure in the bonding mechanism can cause arcing. Arcing can create an electromagnetic interference that can induce a current in unshielded wiring.

Corona discharge is a luminous and audible discharge, usually from parts of the aircraft such as the antennas, wing tips and windshields to the atmosphere. The windshield discharge is the St Elmo's fire seen by pilots. Static dischargers are installed to control the location and effect of this.

Streamering, also a luminous effect, often involves the charge jumping from one part of the airframe to another due to a change in properties of the surface creating a difference in charge. This is mitigated using conductive coatings, under the thin painted surfaces, bonded to the structure to drain any build-up.

The CVR manufacturer has recreated a pulsing effect, similar to that recorded by the CVR, by applying electrostatic discharges to the CAM system components, suitably interconnected, in a workshop environment. This supports the theory that the source of the problem is outside of the CVR CAM components.

Airframe manufacturer experience with problems associated with static build-up and discharge does not include any previous effect on the CVR and is most commonly associated with an effect on the VHF antenna closest to the problem area. They have committed to working with the equipment manufacturer and the operator to resolve this problem.

TCAS

The Traffic Collision Avoidance System (TCAS) works in association with a Mode S transponder to detect aircraft in the vicinity and assess whether their closure rate constitutes a hazard. TCAS can only assess relative altitudes by comparing the altitude of the onboard air data system with the altitude data which the other aircraft transmits via Mode S. Jumps in altitude translate to increases in calculated altitude rates; TCAS projects this forward in time to assess whether an aircraft conflict is likely. If necessary, TCAS will issue an appropriate instruction to the pilots, known as a Resolution Advisory (RA), to improve the separation between conflicting aircraft.

Two sources of air data are supplied to the Mode S transponders, but only one source is used at a time and they are not compared. TCAS derives its own aircraft altitude from the Mode S transponder. Problems can occur when erroneous data reaches the Mode S transponder due to sensing or data transmission problems.

Analysis

The April 2012 incident began shortly after a bright flash of light, generally associated with lightning. There was no noise that is often associated with lightning strikes and identifiable damage was not found on the airframe. Existing aircraft skin damage may have masked any new lightning damage. Coincidence with the bright flash does not prove causation and it was impossible to be certain that a lightning strike occurred as there are other explanations for unreliable air data indication.

The vertical speed fluctuations shown on the DAR data were not noticed by the pilots. Either this was not displayed on the PFDs or the focus of the crew's attention was elsewhere. The rapid, though spurious, changes in vertical speed triggered a TCAS RA against the aircraft 2,500 ft above. The rapidity of the vertical speed change, without a change in actual altitude, masked the reason for the RA from the air traffic controller. The controller saw G-EUXM as being in compliance with its clearance and clear of other traffic. The pilots verbally acknowledged the TCAS RA within eight seconds of the audio commencing, slightly outside the target for TCAS RA response, but the aircraft remained compliant with the RA at all times.

A TCAS RA is presented both aurally and visually to the crew to give a high probability that they will detect it. This RA did not require the pilots to take any different action and as such the visual aspect may have been less obvious than an RA which required a change of the aircraft's flight path. The RA occurred at a time of high workload and neither pilot detected the digitised "MONITOR VERTICAL SPEED" aural alert. This 'inattentional' deafness is within normal human performance and is why critical alerts should be provided via more than one sense.

In this incident the crew reacted appropriately to a transient unreliable airspeed situation. They maintained the aircraft within known, safe datums which allowed its systems to recover from the initiating event. The crew then made a series of decisions which reduced consequential risk: they selected a hold in VMC, diverted to an aerodrome with better weather than the planned destination and, as the weather changed, prioritised the landing task over supplemental information gathering.

The manufacturer and operator's existing procedures and training worked and the aircraft remained in compliance with its ATC clearance at all times.

The June incident occurred as the aircraft transited the top of developing cloud at a temperature of approximately -50°C. An ice crystal encounter in those conditions seems likely and would have been outside the certification standards for the pitot system, as referred to by the ATSB in 2009. The aircraft remained in a safe condition throughout and the pilots mitigated risk associated with high winds at their planned destination.

Erroneous air data

The data showed periods during which the air data parameters of the three separate systems suffered intermittent errors, but not at precisely the same time. When a system became erroneous, all its main parameters were affected. This indicates errors due to the environment, each system being affected slightly differently.

Problems with the pitot or static probes would affect system Mach calculations, which are used to calculate corrections to other parameters. However, given the altitude errors were small compared to the speed errors, it is likely that the problems were associated with the pitot probes.

The location and time of the problems correspond to weather likely to be associated with ice-crystals, so it is probable that air data errors were due to the affect of ice crystals on the pitot probes temporarily defeating the pitot heat system.

Airbus analysis indicated that for the whole A320 family the current rate of occurrence of two or more pitot probes providing erroneous data is better than that required by the "Major" classification of this failure condition. However, the occurrence rate depends on the period chosen. The operator experienced three temporary erroneous airspeed indication events within a four month period, two on the same aircraft. The previous such event was significantly before this.

Current icing standards are associated with supercooled water droplets and not ice crystals. Airbus testing has shown that the pitot probe designs meet current requirements.

Airbus believed the events were due to ice-crystals and so not covered by the EASA CS-25 icing standards targeted at supercooled water droplets. The only current and relevant requirements that were applicable were the Airbus ice crystal icing requirements.

Ongoing Airbus research, including analysis of other documented events reported by operators, icing wind tunnel testing and flight testing, has highlighted the inadequacies of current icing requirements. When revised standards are agreed, they can inform design discussions with the pitot probe manufacturers.

The first G-EUXM event occurred outside the SAT/Altitude boundary of the Airbus requirement but within the proposed new envelope. The second G-EUXM event occurred at a temperature just outside the proposed revised boundaries for CS-25 and also the total water content boundaries, and so is not addressed by the proposed changes. The fact that there were two occurrences on the same aircraft indicates there may be another unidentified environment, system design or specific aircraft factor.

Testing of the aircraft air data and pitot heat systems found no problems. Airbus did not provide checks other than the AMM tasks for the air data and pitot heat systems, because it associated the two events on this aircraft with the ice crystal issue, not the coincident CVR CAM audio pulsing. At the time of writing, the aircraft has been flying without a recurrence. It is feasible that component removals associated with this investigation resolved an undetected problem, such as component bonding.

The G-EUXC event occurred within the current Airbus requirements relating to ice crystals but also within the boundary of the proposed new requirements relating to both ice-crystals and total water content.

TCAS event

TCAS reacted to the erroneous air data by issuing an RA that was not contrary to the intended flight path and did not create a conflict with another aircraft. The other aircraft did not generate a TCAS RA. However, with different aircraft relative flight paths, a similar error could result in RAs that could induce a genuine traffic conflict.

This consequence of TCAS receiving erroneous altitude data highlights a hazard associated with closely stacked airspace. However, the effect on the altitude data is only temporary, reducing exposure to the hazard.

CVR CAM pulsing

In both events involving G-EUXM, the periods of the CVR CAM pulsing corresponded to weather conducive to electrical charging of an aircraft. In the first event, during the first indication of airspeed upset, the crew observed St Elmo's fire which is a phenomenon caused by build-up of static charge. The crew also observed a nearby lightning flash. These indicate an abundance of electrical charging sources.

Though the aircraft was not reported to have been directly struck by lightning during the reported events, a direct lightning strike had occurred on G-EUXM a few days prior to the first event. However, maintenance action did not reveal any associated problems.

The CVR CAM pulsing effect is not commonly observed, but the circumstances under which it could be observed require that a CVR is removed for replay and that the aircraft has flown through an area of high electrical charge within the recording period (30 minutes or two hours depending on CVR model). This is an uncommon combination.

In this case it is feasible that lightning activity degraded a bonding mechanism resulting in arcing under circumstances of electrical charge build-up, resulting in the CVR CAM pulsing recorded. No evidence of this, or a wider systematic issue, was found.

The airframe manufacturer has undertaken to work with the equipment manufacturer and the operator to resolve this problem, which affects the ability of the CVR to fulfil its intended function.

CVR erasure

CVR erasure is not a common problem associated with accident investigation. No systemic issues were found that required further action to prevent recurrence of CVR erasure.

The most common cause of loss of CVR evidence is over-writing of the recording. In this case the recovery of the CVR recording was significantly delayed but it was not lost or over-written. However, both cases demonstrate that robust CVR preservation procedures are necessary, involving crew when there is no hazard requiring evacuation. The delay to the evidence did not have an airworthiness impact, and these events do not support a further related Safety Recommendation. However, this information has been passed to the CAA for consideration, along with previous AAIB recommendations, when approving operator procedures to meet requirements associated with the preservation of flight recorder recordings.

Conclusion

On two occasions the aircraft encountered atmospheric conditions that resulted temporarily in unreliable air data.

The first event occurred within the boundary of current icing certification standards, which only consider supercooled water droplets. The second occurred outside the proposed revised boundaries and may have involved an encounter with ice crystals. Icing certification standards are being reviewed by the manufacturer and EASA.

The hazard of such events persists. However, the safe outcome of these incidents indicates that training to deal with unreliable air data can be effective.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A330-343, G-VKSS
No & Type of Engines:	2 Rolls-Royce RB211 Trent 772B-60 turbofan engines
Year of Manufacture:	2011 (Serial no: 1201)
Date & Time (UTC):	19 January 2013 at 2333 hrs
Location:	On departure from Orlando International Airport, USA
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 311
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to both engines, leading edges and radome
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	13,850 hours (of which 128 were on type) Last 90 days - 135 hours Last 28 days - 75 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was in the initial climb, passing 530 ft agl after takeoff from Runway 35L, when it was struck by birds which impacted the fan blades of the left and right engines as well as the nose of the aircraft. Both engines were damaged and the left engine was shut down by the crew because the engine oil pressure indicated zero. The aircraft returned to Runway 36R and carried out an uneventful single-engine landing. One Safety Recommendation related to the indication of engine oil pressure has been made.

History of the flight

The aircraft was on a scheduled flight from Orlando Airport, USA to Manchester International Airport, UK. The flight crew comprised three pilots: the aircraft commander and two Senior First Officers. All three pilots were present on the flight deck for the departure.

The commander was seated in the left seat and the co-pilot in the right with the remaining pilot seated in the 'jump seat' located behind and between the operating pilots. For the departure, the co-pilot was the Pilot Flying (PF) with the commander as the Pilot Monitoring (PM).

The flight crew carried out the normal pre-flight inspection of the aircraft and the cockpit checks. The departure was to be at night, from Runway 35L in benign weather conditions; visibility was reported as being 10 km with a few clouds at 3,600 ft. The crew briefed the actions to be taken in the event of an abandoned or continued takeoff as well as the procedure to be followed for an overweight landing. With all the required checks and briefings completed, the aircraft lined up on the runway and commenced the takeoff roll using a flexible takeoff thrust temperature of +46°C.

After takeoff, the landing gear was retracted and the aircraft commenced its climb. At a height of 530 ft, the aircraft suffered multiple bird strikes. There was a loud bang as a bird struck the nose of the aircraft which caused the crew some alarm and this was followed almost immediately by an Electronic Centralized Aircraft Monitoring (ECAM)[1] message indicating a malfunction of the left engine. The crew engaged the autopilots in heading mode and, in line with their departure clearance, selected a heading of 060°.

In accordance with established Crew Resource Management principles, the co-pilot continued to fly the aircraft and the commander analysed the problem with the assistance of the third pilot. There was a significant vibration which was felt through the airframe; indications showed that this was from the left engine. The ENG 1 OIL LO PR (engine one low oil pressure) caption was displayed on the ECAM and the pressure was indicating zero. Following standard operating procedures, this indication required the crew to select idle thrust on the left engine and, because the warning persisted, then select the engine master control to the OFF position and carry out the 'ENGINE SHUT DOWN PROCEDURE'. This was performed by the commander and monitored by the other pilots. The commander informed the tower of the situation with a radio call of "PAN STANDBY CLIMBING RUNWAY HEADING." Tower acknowledged and instructed him to contact the Radar controller on a different frequency.

On initial contact with Radar, the commander prefixed their callsign with "MAYDAY" and he requested a return to the airport. There was already a high volume of RT on the frequency and ATC attempted to assist the crew by keeping the aircraft close to the airport and minimising any manoeuvring. The aircraft levelled at 3,000 ft.

The crew reviewed the situation and, having confirmed that all the ECAM actions had been completed, the Flight Service Manager (FSM) was called to the flight deck and given a NITS[2] briefing. Having briefed the FSM, the commander used the public address system to inform and reassure the passengers. He then downgraded the Mayday to a "PAN" and took control as PF. The crew calculated the landing distance required for an overweight, single-engine landing and ATC offered radar vectors for an ILS approach to Runway 36R but a single orbit was required to allow the crew additional time to complete the pre-landing checks.

The commander confirmed with the other two pilots that all actions had been completed and the aircraft then made the approach to land. Following the uneventful landing the aircraft taxied clear of the runway where the airport Rescue and Fire Fighting Service (RFFS) inspected the aircraft. The crew had intended to taxi to the parking stand but, as the brakes were hot, a tug was used instead. The passengers and cabin crew were kept informed of the situation throughout and, once on stand, the aircraft was shut down and the passengers disembarked normally. The total flight time was 30 minutes.

Orlando International Airport

The area is ecologically diverse and home to many unique and iconic species of reptiles, mammals and birds. It is particularly rich with respect to diversity and

Footnote

[1] The ECAM indicates to the flight crew abnormal conditions with the aircraft engines or systems.

Footnote

[2] Nature, Intentions, Timings and Special Instructions.

abundance of both resident and migratory birds. Many species traverse the airspace frequented by aircraft but only a fraction is hazardous to aviation.

The Greater Orlando Aviation Authority has a comprehensive wildlife management plan which includes reptiles and mammals as well as birds. A detailed report is produced annually and covers the Air Operations Area (AOA) which is essentially the area within the boundaries of the airport perimeter. It is 1,604 hectares (3,963 acres), and includes four parallel runways with the associated taxiways, parking areas, terminal buildings and maintenance areas. The predominant habitat is artificial prairie composed of dry, sandy soils sporadically covered with various grasses, sedges and asters. Approximately 5% of the AOA habitat comprises retention ponds, lakes and drainage canals.

The goal and responsibility of wildlife personnel and airfield operations is to reduce the probability of wildlife aviation conflicts. Their primary objectives are:

- Continual identification of species most hazardous to aviation operations.
- Identifying, eliminating or reducing attractants and activities that entice birds and wildlife to areas where they may cause a strike or interfere with aircraft operations.
- Create and maintain a hostile environment for birds and wildlife on the Air Operations Area.

In order to fulfil the task, the wildlife personnel consist of a Biologist and two Wildlife Specialists who patrol the airfield daily and implement the airport's Wildlife Management Plan. In addition, Airfield Operations have personnel on duty 24 hours a day, 7 days a week, trained to respond to, and alleviate most wildlife/aviation conflicts.

However, as the annual report notes:

> *'There are no products, procedures, or technologies proven to eliminate bird strikes. Concentrating efforts on those hazards with the highest probability of impacting aviation was and continues to be the most effective strategy. Identification and characterization of the most significant wildlife hazards was determined by evaluating and comparing historic data, (strike and wildlife report) which depicted hazards by species, time of year, time of day, and location on the airfield. This provided a basis for practical allocation of personnel and resources'.*

During 2011 there were 317,020 aircraft movements. 115 aircraft were struck by birds of which arriving aircraft accounted for 72% of the strikes. The majority of strikes (44%) occurred on Runway 17L/35R, 22% on Runway 17R/35L, 22% on Runway 18L/36R and 12% on 18R/36L. Approximately 66% occurred on the eastern airport complex which is considerably less developed than the western complex (Figure 1).

Flight recorders

The aircraft was equipped with a 25-hour duration Flight Data Recorder (FDR), a 120-minute Cockpit Voice Recorder (CVR) and a Digital ACMS Recorder (DAR). A record of the entire incident flight was available from the recorders. Salient parameters from the FDR and DAR included the engine low oil pressure warning[3] from the Flight Warning Computer (FWC), engine

Footnote

[3] The FWC is provided with three low oil pressure signals per engine. The EEC unit from each engine provides two signals which are derived from the raw outputs from the engines two oil pressure sensors. The third signal is provided by a "hard-wired" low oil pressure switch. If the FWC determines that two or more of the inputs indicate low oil pressure, the LO OIL PR message will be displayed on ECAM and the low oil pressure parameter on the FDR will be set for the respective engine.

Figure 1

Orlando International Airport

untrim[4] oil pressure from the Engine Interface and Vibration Monitoring Unit (EIVMU) and engine N_1 shaft vibration for each engine. Figure 2 illustrates salient parameters during the period between takeoff and engine shutdown.

The aircraft took off from Orlando International Airport Runway 35L at 2333 hrs (1833 hrs local). The takeoff roll was uneventful, but at a height of approximately 530 ft during the climb out, there was a loud bang, which was almost immediately followed by the activation of the master warning and ENG 1 FAIL and ENG 1 LO PR captions being displayed on the ECAM. The left engine N_1 shaft vibration increased from 0.4 to 10 units[5], which is the maximum range of the parameter, EGT increased by 10°C to 771°C and all three engine shaft speeds, N_1, N_2 and N_3, increased slightly and a series of rapid and erroneous fluctuations in the left engine untrim oil pressure were also recorded. The right engine N_1 shaft vibration also increased from 0.2 to 1.8 units at this time.

Almost immediately, the commander (PNF) confirmed the ECAM indications and the left engine thrust lever was retarded to the idle position. He declared a "PAN" to ATC which was then upgraded to a "MAYDAY". As the left engine speed reduced, the N_1 shaft vibration level also reduced to 0.1 units and the untrim oil pressure normalised. The PF increased the right engine thrust to the TOGA position, before the shutdown procedure for the left engine was completed. The total time from initial warning to shutdown was 1 minute 46 seconds.

Footnote

[4] Engine oil pressure displayed on the ECAM SD display is provided by the EEC as a validated signal. The validated signal is derived by first selecting the highest raw oil pressure value from each of the engines two pressure sensors. An average is then taken over 1.8 seconds before the value is then trimmed to "mapped" oil pressure data for N3 shaft speed ranges when the aircraft is on the ground and in the air. The FDR and DAR record the averaged oil pressure signal, prior to the trimming function being applied.

Footnote

[5] ECAM displays an advisory message if the N_1, N_2 or N_3 shaft vibrations increase above 3.3, 2.6 and 4.0 units respectively.

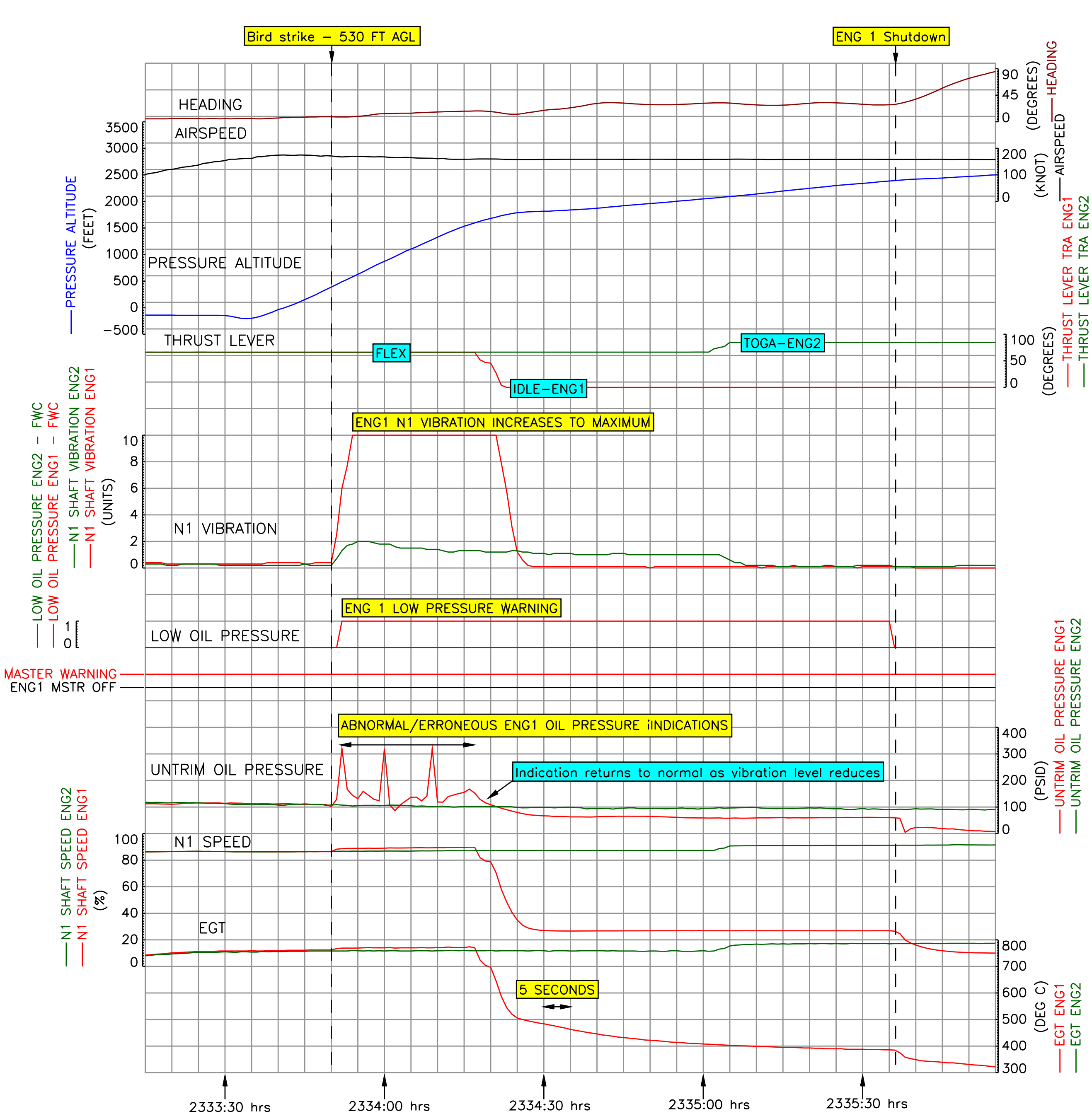

Figure 2

Data recorded between takeoff and engine shutdown

The aircraft levelled at 3,000 ft and MCT (Maximum Continuous Thrust) was selected on the right engine. The maximum recorded right engine N_1 shaft vibration during the flight was 2 units (below the ECAM N_1 shaft vibration advisory message trigger which is 3.3 units).

Preservation of flight recordings

The operator's procedures addressed the need to preserve the CVR record following an incident or accident in accordance with the requirements of EU-OPS 1.160 '*Preservation, production and use of flight recorder recordings*'. However, the operator did not have the same procedures in place for the FDR. Although the incident flight record was still available, the FDR had been allowed to operate for a further 20 hours before it was disabled, resulting in the majority of the previous flight record being overwritten. On this occasion, the loss of data did not impede the investigation, although under different circumstances a loss of FDR data may prove significant.

The operator has advised that it intends to update its FDR preservation procedures in line with that for the CVR. In light of this, the AAIB considers that a Safety Recommendation on this subject to the operator is unnecessary.

Trent 700 oil pressure monitoring

Oil pressure monitoring is provided by three sensors, two oil pressure transducers mounted on the left side of the engine fan case and an oil pressure switch mounted on the gearbox-driven oil pump. Oil is supplied to the pressure transducers through a series of rigid and flexible pipes which are secured to the Integrated Drive Generator (IDG) oil pipes, IDG cooler, support raceways and other pipes on the fan case. The transducers provide oil pressure readings to the Electronic Engine Controller (EEC) at a rate of 5Hz which are then processed and transmitted to the aircraft systems. The oil pressure switch provides a signal directly to the aircraft systems in the event of loss of oil pressure. The aircraft systems will generate a low oil pressure message in the event that any two of the three oil pressure sensors indicate low oil pressure.

To protect the engine's bearings in the event of an lubrication system failure, the oil pump failure logic in the EEC will be activated if it detects both transducer outputs to have a negative differential pressure of between 10 psi and 30 psi within a three-second period. When the failure logic is activated, the EEC overwrites the oil pressure values being transmitted to the aircraft systems with a ZERO value. This results in the aircraft systems generating the ECAM low oil pressure warning and an oil pressure reading of 0 psi is displayed on the respective engine instrument display. The EEC remains latched in this condition until the EEC resets during engine shutdown. Thus even if the oil pressure recovers or stabilises, the ECAM message would remain illuminated and the oil pressure indication to the crew would remain at zero until such time as the engine is shut down.

Previous events

The engine manufacturer provided information which indicated that there have been seven previous events where high vibration resulted in the generation of an low oil pressure message. Of these seven events, five resulted in subsequent precautionary engine shutdowns on the Trent 700 fleet. One event was caused by a combination of incorrect support clipping of the pressure transducer oil feed lines and high engine vibration due to ice formation on the fan. One event was triggered by a bird strike and the remaining five events were caused by IDG failure.

Initial investigation of these events by the manufacturer suggests that vibration generated by a failing IDG, or higher than normal engine vibration, can produce fluctuations within the oil pressure transducer or its supply lines of sufficient magnitude and duration to trigger the EEC oil pump failure logic. The behaviour of the oil pressure monitoring system during high vibration events continues to be investigated by the engine manufacturer.

The Trent 800, which has a similar lubrication and oil pressure monitoring system, has the two oil pressure transducers mounted in a different location on the engine which does not require the oil supply lines to be secured to the IDG. Additionally, the Trent 800 oil pressure is not set to zero if negative pressure differentials are transmitted from the transducers. There have been no reported low oil pressure events due to high vibration on the Trent 800 fleet.

Investigation

Examination of the aircraft in Orlando revealed impact damage to the radome, the left engine nose cowl, three fan blades fitted to the left engine and two fan blades fitted to the right engine. No defects were identified with the engine oil system. Analysis of the bird remains recovered from the engines indicated that the birds were probably Ring-necked Ducks, of between 1.5 lb and 2 lb in weight, and that each engine had ingested one bird.

After confirming the serviceability of both engines, the damaged fan blades and the left engine nose cowl were replaced. The aircraft completed an uneventful ferry flight back to the UK where the left engine was removed for overhaul. Inspection of the engine after removal confirmed that the pressure transducer oil supply lines were secured and routed correctly.

Safety action taken

Following previous events, the engine manufacturer notified all Trent 700 operators of the possibility that high fan vibration or an IDG failure may trigger the EEC oil pump failure logic, which would result in an oil pressure reading of zero being presented to crews. They also alerted operators and overhaul facilities of the possibility of occurrence through incorrect pipe support clipping.

In these communications the engine manufacturer advised operators that two solutions were being progressed to address the issue: a modification of the EEC oil pump failure detection software and a modification of the oil pressure measurement system hardware to reduce sensitivity to vibration. However, the engine manufacturer has not provided the AAIB with indicative timescales for the introduction of either of these two modifications and, as a consequence the following Safety Recommendation is made:

Safety Recommendation 2013-015

It is recommended that Rolls-Royce plc modify the oil pressure indication and failure detection systems of the Trent 700 engine to minimise the possibility of an activation of the Electronic Engine Controller oil pump failure logic as a result of high vibration or an Integrated Drive Generator failure.

SERIOUS INCIDENT

Aircraft Type and Registration:	Jetstream 4100, G-MAJA
No & Type of Engines:	2 Garrett Airesearch TPE331-14GR-807H turboprop engines
Year of Manufacture:	1994 (Serial no: 41032)
Date & Time (UTC):	18 July 2012 at 0835 hrs
Location:	In the cruise, 80 nm north of Newcastle
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 12
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	29 years
Commander's Flying Experience:	2,600 hours (of which 158 were on type) Last 90 days – 158 hours Last 28 days - 50 hours
Information Source:	AAIB Field Investigation

Synopsis

The flight crew experienced a period of EFIS screen blanking whilst passing through an area of electrostatic activity.

History of the flight

The aircraft was on a scheduled flight from Southampton International Airport to Aberdeen International Airport. The co-pilot was the pilot flying.

The flight was uneventful and flown clear of cloud for the first hour. The aircraft then entered cloud and an area of airframe icing, with some 'light chop' and an increase in icing. About 20 mins later, in the cruise at FL220 about 80 nm north of Newcastle, the commander's Attitude Direction Indicator (ADI) on the Electronic Flight Instrument System (EFIS) went blank and the autopilot (A/P) disconnected. The commander re-engaged the A/P and actioned the '*Symbol Generator Failure'* checklist from the QRH; this requires the selection of one of the two symbol generators. This had no effect so the commander changed the symbol generator reversion switch (SG REV) to the other symbol generator, still with no effect.

About 2 minutes after initial failure, the three remaining EFIS screens went blank. The commander took control and flew the aircraft with reference to the aircraft's main altimeter and standby instruments, situated left

Figure 1
G-MAJA cockpit

of centre on the main instrument panel (Figure 1). The co-pilot declared a PAN to ATC. After discovering that the current weather to the north was unfavourable for their situation, the crew elected to divert to Newcastle International Airport.

As ATC vectored the aircraft towards Newcastle the crew noticed that the standby compass appeared to be stuck and, as a result, they requested ATC to initiate, and then stop, any turns that were required. They then descended to 3,000 ft amsl, becoming visual with the sea and coastline. At about 39 nm from Newcastle, following the resetting of the avionic master switches, the EFIS screens turned blue and faded into the compass rose, and the speed tape appeared on the ADI.

Having remained clear of cloud over the sea the crew became visual with Newcastle and flew an uneventful visual approach and landing onto Runway 25.

During the flight the windscreen heaters were on at all times.

Weather information

An aftercast for the area where the incident happened was obtained from the Met Office. In summary it stated that the weather was driven by low pressure over Scotland and a very active frontal system, giving persistent, and at times heavy rain over much of the area. Satellite and radar imagery both suggested the presence of embedded convection. There was also evidence of medium-level instability, as described by the crew.

The Met Office commented that the medium-level instability could have led to high-based cumulonimbus forming in the area. Lightning had not been recorded over the area of interest but the system is optimised for detecting cloud-to-ground lightning and often misses cloud-to-cloud discharges. Given that the instability leading to convection was not surface-based, but probably based at about 10,000 ft, this would increase the chances of any lightning being a cloud-to-cloud discharge.

Aircraft information

This aircraft was equipped with electronic ADI and HSI as well as a standby attitude indicator, altimeter and ASI.

In 1993 Jetstream Aircraft Ltd (later BAe Regional Aircraft) published Service Bulletin J41-30-007 which called for the installation of electrostatic transient absorbers ('transzorbs') in the windscreen heat circuits to prevent EFIS screen blanking due to static charge accumulation on the windscreens. G-MAJA was modified to comply with the requirements of this Service Bulletin and the operator applied an operational life of 6,000 flying hours to the transzorbs, after which they are removed and replaced. The units fitted to G-MAJA had been installed for 3,921 flying hours.

Transzorbs are designed to 'fail' (short-circuit temporarily) when exposed to an abnormally high voltage. Failure of a transzorb with residual resistance will normally affect the function of the windscreen heat system, and thus provide an indication of the failure, and may not affect the ability of the transzorb to protect the avionics equipment from high-voltage static charge on the windscreen.

Operator's and manufacturer's comments

The operator commented that after this failure the Flight Management Computer and RMIs should have been available, giving NDB and VHF Nav information. The Standby Attitude Indicator would have provided ILS information. Stand-alone DME repeaters would provide DME information. Both radio management units should also have been available to tune the navigation frequencies required. The aircraft manufacturer commented that the RMIs should also have provided heading information.

Recorded data

The aircraft was fitted with a solid-state Flight Data Recorder (FDR) and a 30-minute CVR. The FDR recorded just over 51 hours of operation and the CVR captured the approach and landing at Newcastle. Although limited by the absence of EFIS parameters, the flight recorder data was consistent with the information provided by the flight crew.

Technical examination

The aircraft was inspected by the AAIB at Newcastle airport on the day after the incident and no evidence of a lightning strike was identified. Examination of the flight compartment maintenance panel showed that no failure indicators had been activated.

A test of the EFIS system confirmed that it functioned normally. The aircraft manufacturer provided detailed information to allow the windscreen anti-ice system transzorbs to be tested to determine if they had failed with residual resistance. Due to a lack of suitable test equipment, it was not possible to carry out this test on the aircraft and the transzorbs were removed for further testing. After replacement of the transzorbs, a function test of the windscreen anti-ice system confirmed that it operated normally. The aircraft was subsequently returned to service and no further defects regarding the EFIS system were reported.

Laboratory testing confirmed that the left inboard windscreen anti-ice transzorbs had failed, but retained residual resistance. This failure mode would not have been detected by the windscreen anti-ice controller.

Analysis

Failure of the any of the transzorbs in the windscreen anti-ice system would have resulted in an increased possibility for EFIS screen blanking when the aircraft operated in areas of high electrostatic activity. The aircraft systems would normally detect the normal transzorb 'open circuit' failure mode but tests confirmed that, in G-MAJA, the left inboard windscreen transzorbs had failed with residual resistance, rendering the failure dormant and undetectable.

The transzorbs fitted to G-MAJA had achieved approximately 65% of their operational life. However, given the undetectable nature of the failure mode they could have failed a considerable time before the incident flight. Currently there is no method for the detection of failures of this nature during routine maintenance, hence the operator's life restriction of 6,000 flying hours.

During the incident the standby instrumentation continued to function normally and after leaving the area of electrostatic activity, both pilots' EFIS screens returned to normal operation.

Conclusion

When flying through an area of electrostatic activity both flight crews' EFIS screens failed, probably due to a failure of the left inboard windscreen transzorbs. The failure mode of the transzorbs rendered their failure undetectable to the windscreen anti-ice controller.

The aircraft's standby instrumentation, and main altimeter, continued to operate throughout the incident and the aircraft's EFIS screens began to operate normally a short time after leaving the area of electrostatic activity. The aircraft's safety was not, therefore, compromised.

ACCIDENT

Aircraft Type and Registration:	Jabiru UL, G-VILA
No & Type of Engines:	1 Jabiru Aircraft Pty 2200A piston engine
Year of Manufacture:	1999 (Serial no: PFA 274A-13364)
Date & Time (UTC):	8 December 2012 at 1119 hrs
Location:	Aldham, near Hadleigh, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	634 hours (of which 260 were on type) Last 90 days - 6 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft departed from a grass airstrip for a local flight. Although the weather at the time of departure was fine, the forecast included substantial areas of low cloud and fog. Following an extended period of flying, in poor weather and at times below 300 ft agl, the aircraft crashed while manoeuvring in the vicinity of Elmsett Airfield. The pilot suffered fatal injuries in the impact and there was a severe post-crash fire.

History of the flight

The pilot owned G-VILA and had based the aircraft at a grass airstrip in the village of Newton, near Sudbury. His exact movements on the morning of the accident are unknown but another Newton-based pilot had arrived at the airfield at 1000 hrs and seen the pilot there. They had a short and inconsequential conversation before the other pilot departed in his aircraft.

Recorded information was available from the radar at Debden, a GPS[1] recovered from the aircraft[2] and a ground-based radio telephony (RTF) recorder at Wattisham Airfield. The history of the flight was constructed using these sources of information and additional information from eyewitnesses.

Figure 1 shows the progress of the flight. G-VILA departed from Newton airstrip (Point A in Figure 1) at

Footnote

[1] Garmin manufactured unit, model 196.
[2] The GPS unit, which was normally attached to the top of the instrument panel in G-VILA, was found below the main wreckage.

1031 hrs, with the pilot transmitting on the Wattisham frequency that he was climbing to 2,000 ft and had set a QNH of 1025 hPa. The aircraft initially climbed to 700 ft amsl but then descended to about 400 ft (about 200 ft agl) as it approached Boxford (Point B). The aircraft flew to the south of Boxford and then climbed to about 850 ft amsl. Reaching Ipswich (Point C) the pilot flew an orbit near the city (Point D) before tracking towards Felixstowe, 7 nm to the south-east (Point E).

At 1053 hrs, having flown along the coastline at Felixstowe, the aircraft flew over Ipswich, in a north-westerly direction, at between 800 ft and 850 ft amsl (Point F) and tracked towards Newton. A friend of the pilot recognised the aircraft as it passed over Ipswich and called the pilot's mobile phone. The pilot answered the incoming call at 1105:05 hrs and the call ended at 1106:28 hrs; during the conversation the pilot described his route and commented that there was mist ahead and that he would need to descend to 300 ft. The phone call ended with the pilot saying he would visit his friend's house later in the day. At 1107:04 hrs (Point G) the aircraft started to descend at about 300 ft/min. Having descended to 440 ft (approximately 240 ft agl), the aircraft flew over an industrial area located at the easterly edge of Hadleigh (Point H), following which it started to climb at about 250 ft/min.

When the aircraft was about 0.5 nm to the north of Hadleigh, it made a left turn, routing overhead the town in an easterly direction. East of the town, the aircraft

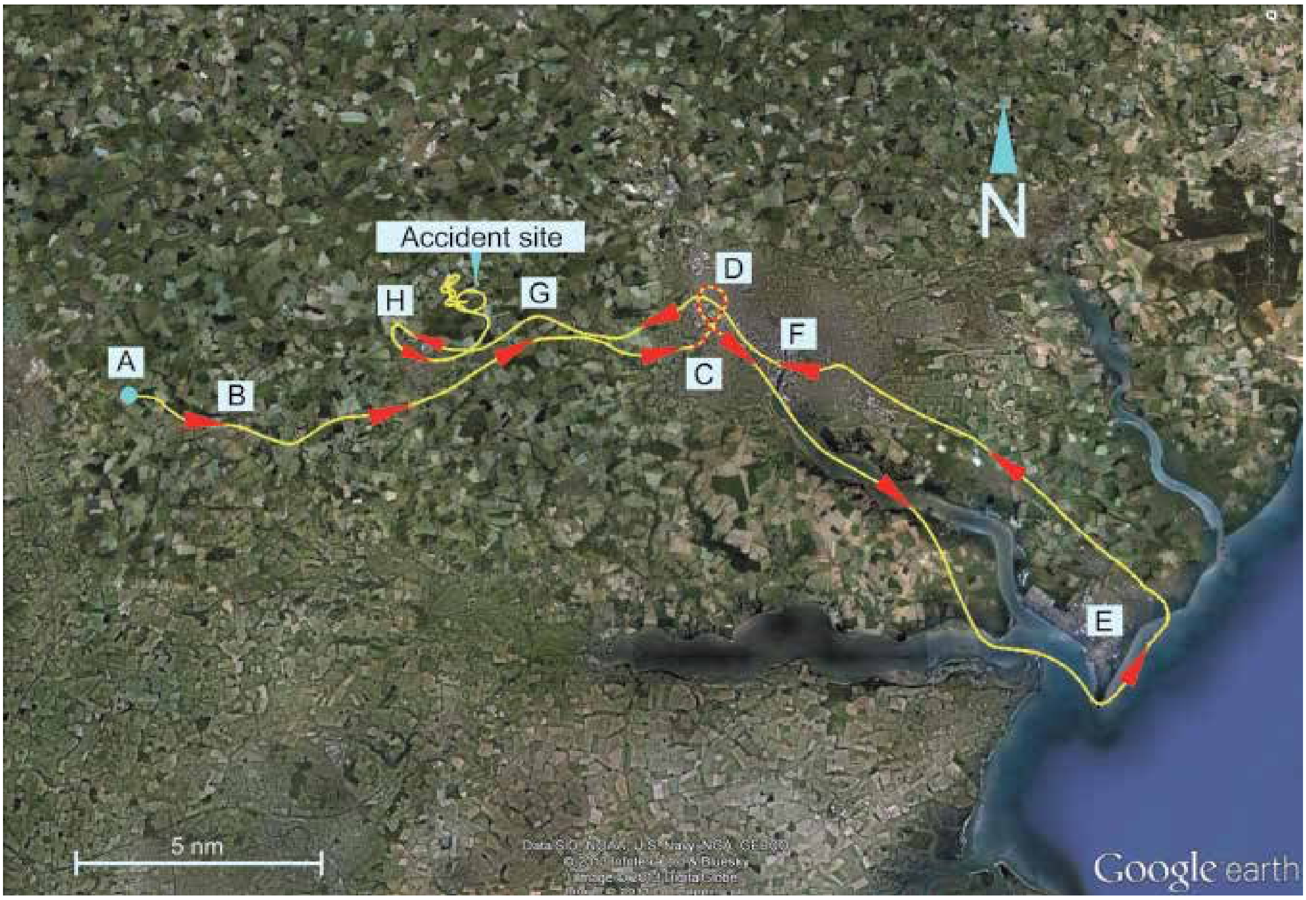

Figure 1

Overview of track of G-VILA (Points A to H) had climbed to about 1,000 ft; this was the maximum recorded altitude during the flight. The aircraft then started to descend towards Elmsett Airfield, located approximately 1.3 nm to the north-northeast of Hadleigh. At about this time a military pilot walking his dogs about 1 nm east of Hadleigh heard and saw a light aircraft, which he estimated as being at 500 ft agl, on a heading of about 070° and travelling at about 70 kt. The aircraft was operating in the base of the cloud which he estimated as "…in the region of 300 ft, with a surface visibility of approx 3 to 4 kilometres but this was rapidly reducing as the front or weather system was approaching fast".

Figure 2 shows the last seven minutes of flight. Approximately 0.5 nm south-east of Elmsett Airfield, the aircraft flew an orbit down to about 260 ft, (Figure 2, Point 1) before making a series of turns ending almost overhead the threshold of Runway 05, at 200 ft aal. The aircraft tracked along the runway centre line, continuing to descend (Point 2). About two-thirds along the runway the aircraft had descended to approximately 50 ft, at a groundspeed of 58 kt. The aircraft then climbed in a left-hand turn, consistent with positioning for a further approach to Runway 05 (Point 3). Reaching the threshold, the aircraft flew a tight left-hand orbit at about 180 ft, and then flew south, away from the runway.

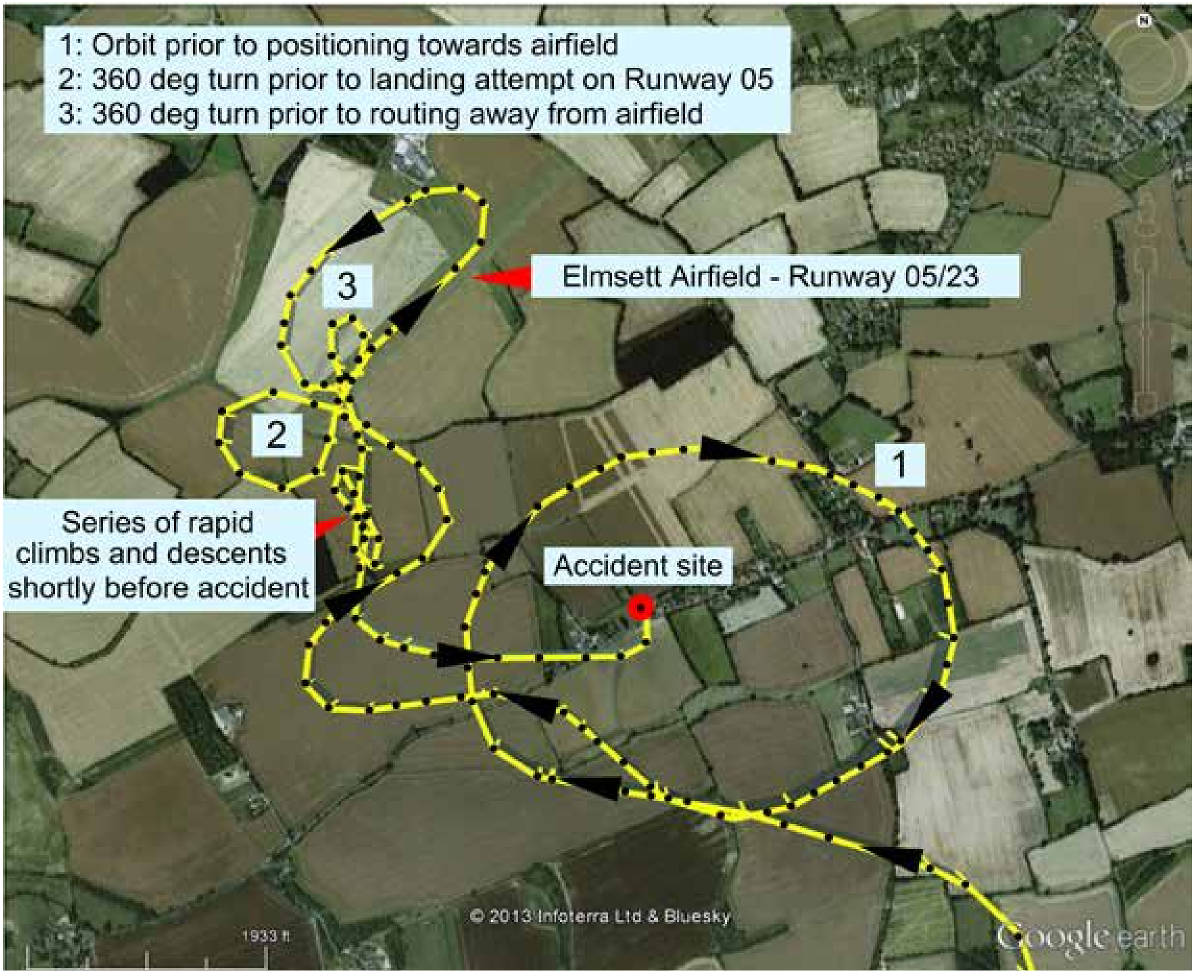

Figure 2

GPS-derived position and altitude of G-VILA - final seven minutes

The aircraft then climbed rapidly before descending to a height of about 150 ft. It climbed again and then descended to 170 ft, whilst making two 180° turns. Coincident with these manoeuvres, an open microphone transmission lasting about 3.5 seconds was recorded on the Wattisham radio frequency. The transmission contained no speech but some breathing, consistent with an inadvertent transmission being made by the pilot of G-VILA. The aircraft then made a left turn towards the east and briefly climbed to a height of about 480 ft, before descending at a rate of 3,300 ft/min, in a left turn. The aircraft impacted the ground a few seconds later (Point 4).

A farmer in a house on The Street, Aldham heard an aircraft which he believed to be doing aerobatics. He went outside to watch and realised the weather was poor with, he estimated, a cloudbase of 150 ft. He considered it odd that an aircraft would be doing aerobatics in those conditions. As he followed the sound he saw the aircraft "hop" over a line of trees and farm buildings to the west of him and head towards him. He considered that the aircraft was no more than 150 ft agl and just below the clouds. It then seemed to pull up at a very steep angle, passing out of sight in the cloud as it crossed above him. He was able to follow the engine sound which he described as being a roar as the aircraft pulled up, followed by a spluttering noise as it went overhead. The witness then saw the aircraft drop out of the cloud about 150 m east of his location, striking a power cable before disappearing from view behind buildings and trees. A severe fire developed immediately.

Recorded information

Basis of recorded information used in history of the flight

The radar at Debden is located approximately 27 nm to the west of the accident site and recorded the aircraft's position and pressure altitude (to a resolution of 25 ft) at a nominal rate of once every six seconds. The record commenced shortly after G-VILA took off from Newton airstrip and ended at 1119:01 hrs, with the final radar position 48 m from where the aircraft impacted the ground.

The GPS contained a track log of the accident flight, with aircraft GPS-derived position, track, altitude and groundspeed recorded. The record commenced with the aircraft positioned for takeoff from the easterly strip at 1027 hrs and ended at 1119:05 hrs, shortly before the aircraft impacted the ground. There was a close correlation between the radar and GPS information during the flight, confirming the accuracy of the two information sources. Information from the GPS is shown in Figures 1 to 3; Figure 3 showing the time-history plots.

Pilot information

The pilot's licence was not found and was probably destroyed in the post-crash fire. CAA records show that the pilot had held a UK PPL (A) since 1989 with a Microlight class rating held since 1993. There was no record of the pilot holding any qualification to operate aircraft in Instrument Meteorological Conditions. Two pilot logbooks were located, though the dates were not contiguous. The earlier logbook, numbered "*3*" covered a period from February 2000 to April 2006. The later logbook commenced in April 2007 and the last entry was dated 11 November 2012. It included a current Certificate of Experience dated 1 September 2012, valid for 13 months. A running total of 634 hrs flying was recorded in this logbook including 330 hrs of flex-wing microlight flying. All the pilot's recorded flying since 2007 was in G-VILA.

Official Record Series (ORS) 4 No 912 permits the holder of a UK PPL (A) to operate a microlight aeroplane, for which an appropriate class rating is held,

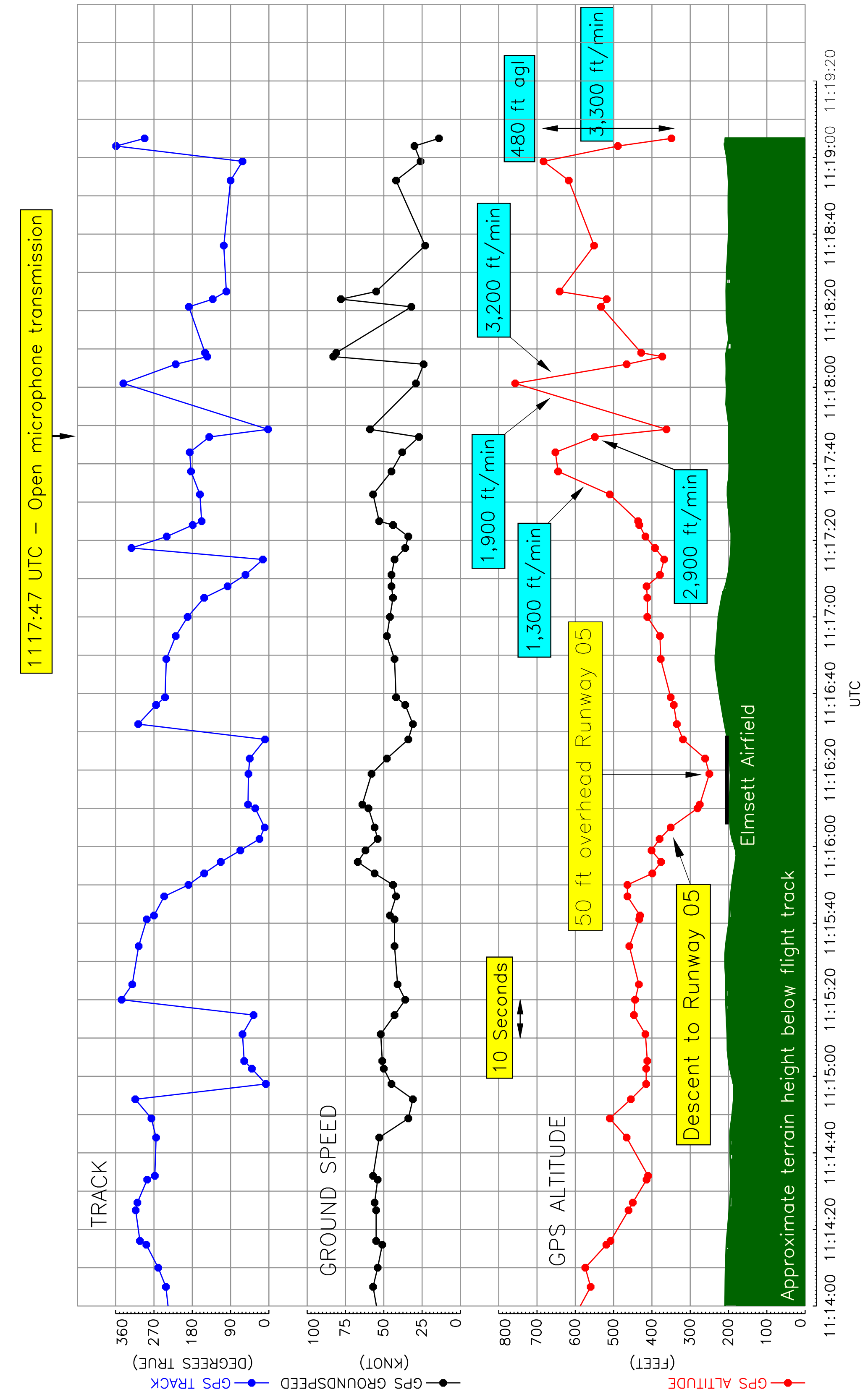

Figure 3

G-VILA - GPS track, altitude and groundspeed without holding a medical certificate so long as they have a medical declaration appropriate to a National PPL (NPPL). In April 2008 the pilot had signed, and his GP countersigned, a medical declaration which remained valid at the time of the accident. However, ORS 4 No 912 also includes the following restriction:

> *'The licence holder shall not fly any such… microlight aeroplane on a flight outside controlled airspace when the flight visibility is less than 3 km.'*

Aircraft information

The Jabiru UL is a three-axis home-built microlight aircraft. G-VILA was powered by a single Jabiru PTY 2200A engine and had a maximum takeoff weight of 430 kg. It was built in 1999. At the time of the accident the engine and airframe had both logged 907 flying hours. The aircraft was issued with a Permit to Fly on 11 August 2012.

Paragraph 5 of Article 23 of the Air Navigation Order 2009 states:

> *'An aircraft flying in accordance with a permit to fly may only be flown by day and in accordance with the Visual Flight Rules unless the prior permission of the CAA has been obtained.'*

Wreckage site

The wreckage was located approximately halfway between two houses, which were about 20 m apart. Most of the fuselage wreckage was located in a 3 m wide drainage ditch which was approximately 50 cm deep. On both sides of the ditch there were woody hedges approximately 4 m high. There was evidence, from the freshly broken branches and twigs in the hedges, that the left wing had struck the hedge on one side of the ditch and that the right wing had struck the other side of the ditch. From the orientation of the freshly broken branches it was concluded that the aircraft had struck the hedge area approximately 70° nose-down. The wreckage was contained in a small area except for most of one propeller blade that was found on the roof of one of the houses, about 10 m from the main wreckage. The small wreckage area was consistent with the aircraft being intact when it struck the hedge. There had been an intense fire that had consumed much of the aft fuselage and empennage, and it had badly damaged most of the cockpit area. There was comparatively little fire damage to the wings. The wreckage of the fuel tank, which was located in the fuselage, was recovered, but only ditch water was recovered from it.

Located 2 m from the ditch, and close to the main wreckage, was a 10 m wooden pole which carried electric power cables. One of the cables was broken and the pole had been fire damaged where it was close to the fuselage. There were witness marks on the right wing leading edge and on the right wing bracing strut that matched the damage to the electricity cable. It was evident from these marks and the piece of propeller found on the nearby roof that the propeller and right wing had struck the cable. The location of the piece of propeller blade 10 m from the main wreckage indicated that the engine was probably turning when it struck the power cable.

Detailed examination of the wreckage

The examination of the wreckage was limited due to the extensive fire damage.

The aircraft controls were checked. The ailerons, rudder, elevator and pitch trim were all actuated by Teleflex cables; all these cables were present and had been attached at both ends. The fire damage was such that parts of the flap lever and the control stick no longer existed. In summary, no evidence of a control restriction was found, although it was not possible to determine conclusively there had not been a control problem, due to the extensive fire damage.

The engine was inspected. There was significant fire and heat damage which limited the extent of the inspection, but no evidence of a mechanical defect was found.

Weather

The UK Met Office provided an aftercast of the accident area, along with additional data. On the morning of the accident the forecast available to pilots included Metform F215, (Figure 4) The accident occurred in area C1 for which the Met Office report had the following forecast:

> *'30 KM visibility in nil weather, with scattered or broken cloud bases at 1,500 – 3,000 ft*
>
> *Isolated 7 km visibility in moderate rain showers*
>
> *Isolated 3,000 m in mist until 1300 UTC with scattered or broken stratus bases 300 – 800 ft*
>
> *Isolated 200 m in fog or freezing fog until 1200 UTC with associated cloud base at the surface*
>
> *Isolated hill fog.'*

They added that '*isolated'* as used in an F215 area forecast is defined as affecting up to 25% of the area in question.

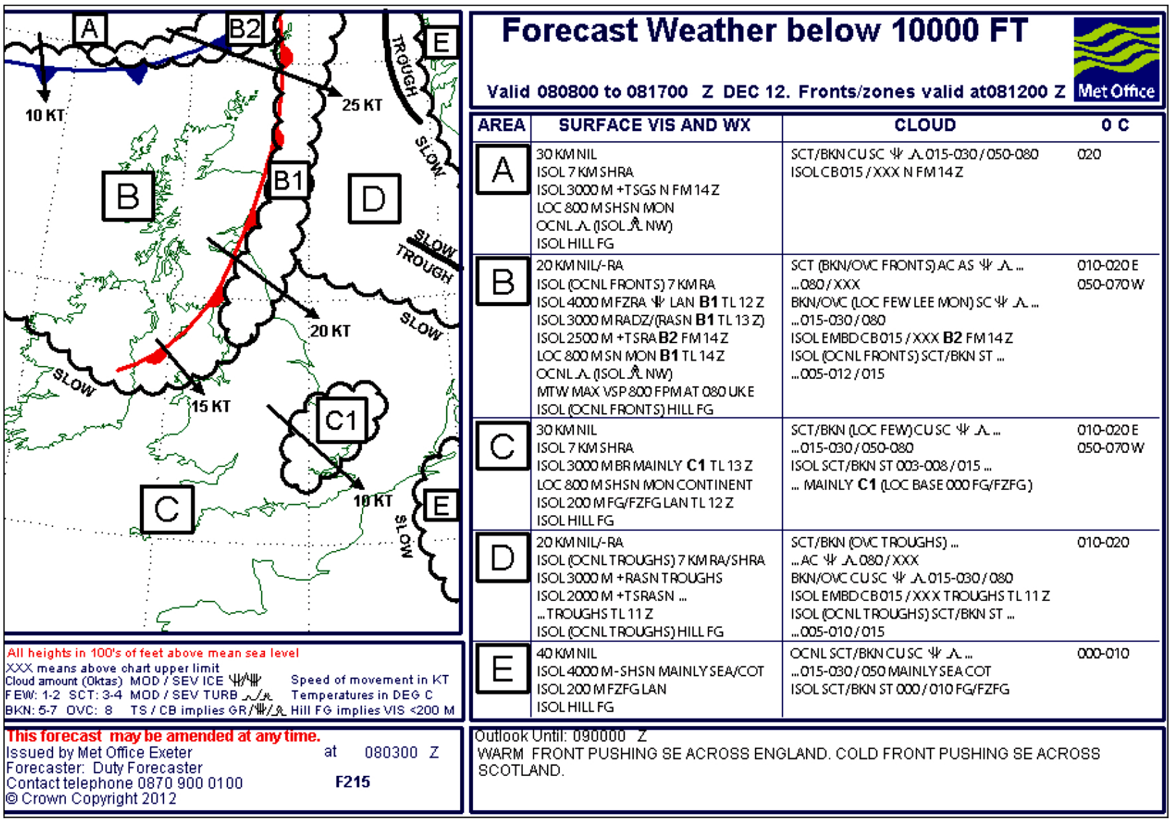

Figure 4

Metform F215

Reviewing the aftercast, the Met Office commented that:

'The weather over England was settled under a ridge of high pressure, however there were some areas of fog and low cloud. Looking at the satellite pictures from that morning much of the fog and low cloud cleared but there was a significant area over East Anglia which did not clear and was moving slowly south east. (Figure 5)

This area of advection fog and low cloud dropped the visibility to (between) 500-4000M. Cloud bases varied between the surface and 400FT. Visibility outside of the area of cloud was at least 8-10 KM. The visibility and cloud base can vary quite significantly and rapidly within such an area of low cloud. These conditions were forecast on the F215 chart within the area C1.'

Wattisham Airfield is located 3.7 nm north of the accident site. Although the local meteorological office at Wattisham was closed that day, an automated weather station recorded rapid changes in cloud base and visibility (Table 1).

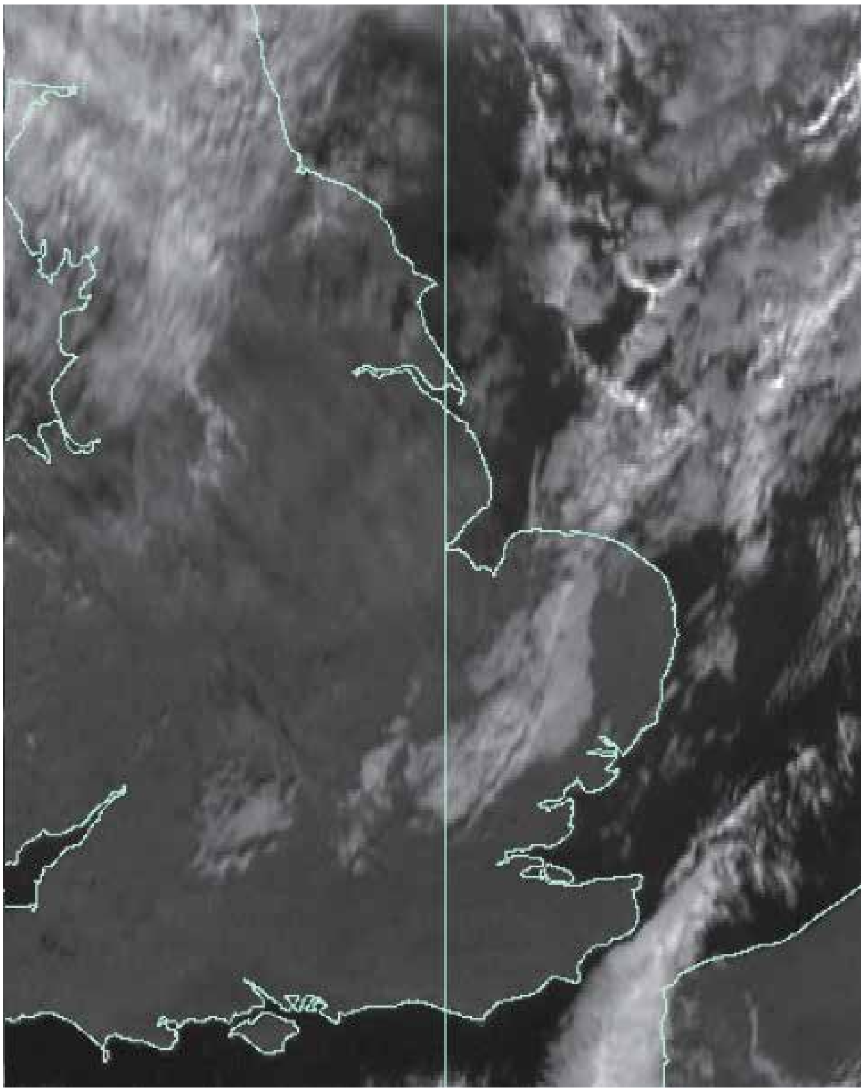

Figure 5

Satellite image of visible cloud and fog at 1115 hrs, 8 December 2012

Time	Surface Visibility	Cloudbase
1030	7 km	Overcast 4,000 ft
1040	6 km	Broken 4,000 ft
1050	700 m	Scattered 100 ft
1100	400 m	Scattered 100 ft
1110	1000 m	Scattered 100 ft
1120	800 m	Broken 100 ft
1130	900 m	Broken 100 ft

Table 1

Wattisham visibility and cloud base (surface visibility is rounded to 100 m)

Further information was extracted from the Wattisham weather station's memory. During the period between 1030 hrs and 1130 hrs the lowest visibility reading was at 1102 hrs with 438 m recorded, although this was only for a one-minute period. At 1119 the Wattisham station recorded a visibility of 764 m with the '*sky obscured*'.

SAR commander's weather report

Immediately following the accident the Wattisham-based Police Air Support Unit and the Air Ambulance were both unable to operate due to the visibility and low cloud. The emergency services therefore requested assistance from Distress and Diversion (D&D) Cell at Swanwick, who passed the request onto the Aeronautical Rescue Co-ordination Centre (ARCC). They scrambled a RAF SAR helicopter from Wattisham and a Coastguard SAR helicopter from Lee-on-the-Solent.

The commander of the RAF SAR helicopter described the weather conditions as "most unpleasant". He estimated that the in-flight visibility was 500 metres, with a solid cloud base at 200 ft agl. Given the poor visibility close to the ground, and the prevalence of low-level obstructions, the crew decided to climb and then transit above the cloud to the accident site. The cloud layer was between 250 and 400 ft thick, with good visibility above the cloud layer, but the layer was so dense that the SAR helicopter crew were unable to find a safe path back below the cloud for a considerable period of time.

The SAR crew considered aborting the mission. However, the Fire and Rescue service repeated a request for overhead thermal imagery, to allow an effective search of the water areas surrounding the accident site. The SAR helicopter then returned to Wattisham and, operating at a 'hover-taxi' speed, followed roads to reach the accident site. The aircraft had been scrambled at 1148 hrs and reached the accident site at 1227 hrs. The commander estimated that the cloud cover had extended to the coast, some 20 nm to the south and east.

Distress and Diversion cell ('D&D')

D&D is the emergency centre based at the London Area Control Centre (LACC) at Swanwick, near Southampton. It is available 24 hours a day to pilots flying within UK airspace who are in distress, in urgent need of assistance or who are experiencing difficulties which could lead to an emergency. They also act as an information-gathering tool for the ARCC located in Kinloss.

The D&D cell have access to weather and airfield status information and can co-ordinate access to airspace or airfields that are normally unavailable to general aviation pilots. By taking on the navigation and co-ordination task they can reduce the pilot's workload, allowing him or her to concentrate on maintaining safe flight.

D&D received no calls for assistance from aircraft operating in the East Anglia region during the day of the accident.

Pathology

A post-mortem examination was conducted by a specialist aviation pathologist. He commented that:

> *'the crash forces…were beyond the range of human tolerance.'*

There was no evidence that the pilot had been alive during:

> *'either the post-crash fire or during submersion.'*

In his summary the pathologist stated that:

> *'no medical or toxicological factors have been identified which could have caused or contributed to the accident.'*

CAA operational rules

The CAA Guide to Visual Flight Rules (VFR) in the UK states that:

> *'Visual Flight Rules (VFR) require an aircraft to be flown in accordance with the Visual Meteorological Conditions (VMC) minima appropriate to the classification of airspace.'*

It continues that for aircraft operating outside controlled airspace and at 140 kt or less the minima are:

> *'1500m flight visibility, clear of cloud and in sight of the surface.'*

These conditions are the minimum and individuals should apply pragmatic limits considering their experience and equipment. Conditions of lower visibility, inability to see the surface or entry into cloud mean that an aircraft is in Instrument Meteorological Conditions (IMC) which requires the commander to comply with the Instrument Flight Rules (IFR).

Rule 5

Rule 5 of the UK Rules of the Air Regulations 2007 places certain constraints on aircraft, described in the Directorate of Airspace Policy information sheet (Number 2):

> *'Aircraft are not permitted to fly over a congested area of a city, town or settlement below a height of 1,000 ft above the highest obstacle within a horizontal radius of 600 meters of the aircraft.*
>
> *Away from congested areas, aircraft are not permitted to fly closer than 500 ft to any person, vessel, vehicle or structure.'*

Use of mobile phones in light aircraft

The UK CAA issued Safety Notice 2013/003 in January 2013 highlighting that:

> *'A mobile phone is a highly practical and useful tool for communicating but except in emergency should not be used in flight.'*

Analysis

Based on CAA records and his logbooks, the pilot held the appropriate licence and medical declaration for flying G-VILA in VFR conditions and was in recent flying practice.

From the damage to the hedges it was concluded that the aircraft had struck the ground approximately

70° nose-down. The damage caused by the post-crash fire made it impossible to eliminate that a defect affected the operation of the aircraft. However, no technical defect was found and, from the evidence that the propeller was rotating when the aircraft struck the ground, there was probably no technical fault that contributed to the accident.

It is not possible to know what weather information the pilot considered before deciding to fly but an extensive area of fog and low cloud was forecast on the Metform F215. The reference, on the Metform F215, to '*isolated*' low cloud and fog meant that up to 25% of the indicated area could be affected. In this case, 25% of area C1 comprised several thousand square miles, and represented a hazard to light aircraft. The SAR commander's estimate of a 20 nm radius of solid fog is corroborated by the satellite data, but still would not have comprised more than 25% of area C1.

At the time the flight commenced, the Wattisham automated system recorded 7 km visibility and a cloudbase of 4,000 ft. Both of these measurements were suitable for visual flight in accordance with the Rules of the Air. However, the conditions rapidly deteriorated and by the time of the accident they were not compliant with either the 3 km visibility required by the pilot's licence or the Visual Flight Rules required by the aircraft's permit to fly.

The radar and GPS data show that the aircraft was operating at a low height before the cloud and poor visibility were encountered. The pilot's telephone call near Ipswich indicates that at this point he intended to continue the flight, descending to 300 ft. There was then an extended period of low-level flying, in poor weather. Once in the area of Hadleigh the pilot appears to have abandoned his return to Newton and diverted towards Elmsett Airfield. However, the ground rises between Hadleigh and Elmsett and the eyewitness report of a 500 ft cloudbase near Hadleigh would equate to one of about 150 ft over Elmsett.

From the evidence derived from the GPS onboard G-VILA, it is likely that the pilot was attempting to land at Elmsett Airfield. The GPS data from 1116 hrs showed rapid changes in speed, track and altitude, suggestive of an aircraft not fully under control. The description from the eyewitnesses of the aircraft's final manoeuvres suggests that, as the aircraft approached Aldham, the pilot pulled up into a cloud layer and hence his visual references would have been compromised. In the cloud, control of the aircraft was probably lost almost immediately, which resulted in a steep descent and ground impact.

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.

ACCIDENT

Aircraft Type and Registration:	DynAero MCR-01 VlA Sportster, G-MCRO
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2011 (Serial no: LAA 301-14802)
Date & Time (UTC):	6 May 2013 at 1530 hrs
Location:	Newton Peverill Airfield, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Significant structural damage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,449 hours (of which 128 were on type) Last 90 days - 10 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing at a grass airstrip when the accident occurred. The airstrip was 461 m long and 9 m wide, and orientated east-west. The weather conditions were warm and fine, with a light southerly wind of 5 kt or less. With no headwind, the pilot was aware of the need not to delay braking after landing, which he carried out in a westerly direction. However, when he started braking, he applied too much brake and the aircraft skidded towards standing crops which were to each side of the airstrip. The pilot ceased braking to regain control, but then did not brake hard enough, with the result that the aircraft approached the end of the strip at too high a speed. The pilot steered the aircraft to the left, onto a freshly cut turning area, and it skidded again. Its right wingtip made contact with a hedge that ran along the end of the airstrip, causing the aircraft to yaw sharply right, into the hedge.

ACCIDENT

Aircraft Type and Registration:	Europa, G-OURO
No & Type of Engines:	1 NSI Propulsion Systems EA-81/100 piston engine
Year of Manufacture:	1995 (Serial no: PFA 247-12522)
Date & Time (UTC):	5 July 2013 at 1130 hrs
Location:	Turweston Airfield, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Detached door damaged and superficial damage to left wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	261 hours (of which 17 were on type) Last 90 days - 8 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft's gull-wing doors were closed during pre-flight preparation. However, the pilot reported that he did not turn round to check that the rear securing pin was properly engaged to ensure door locking. Nothing unusual was noticed during takeoff until the aircraft was passing a height of 300 ft, at which point the pilot's door opened and, after about four seconds, detached from the aircraft. As the door detached, it struck the port wing trailing edge, causing superficial damage. The pilot made a 'PAN PAN' call and returned to a normal landing at Turweston. He attributed the loss of the door to his failure to carry out a visual check for correct engagement of the rear locking pin.

ACCIDENT

Aircraft Type and Registration:	Pietenpol Air Camper, G-PIET
No & Type of Engines:	1 Continental Motors Corp C90-12F piston engine
Year of Manufacture:	1999 (Serial no: PFA 047-12267)
Date & Time (UTC):	11 September 2011 at 1630 hrs
Location:	Panshanger Airfield, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Right landing gear and propeller damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	820 hours (of which 10 were on type) Last 90 days - 17 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

On landing on the grass Runway 11 at Panshangar Airfield, the right landing gear collapsed causing the propeller to strike the ground. The pilot reported that the approach was normal, with a "reasonably smooth" landing; however, as the aircraft slowed to taxiing speed the right landing gear collapsed. On a previous landing, the pilot reported that he had landed heavily, bounced and then carried out a go-around. He therefore attributed the collapse to possible overstressing of the landing gear during this previous heavy landing.

ACCIDENT

Aircraft Type and Registration:	Piper PA-22-160 Tri-Pacer, G-ARFD
No & Type of Engines:	1 Lycoming O-320-B3B piston engine
Year of Manufacture:	1960 (Serial no: 22-7565)
Date & Time (UTC):	25 May 2013 at 1349 hrs
Location:	Elstree Aerodrome, Hertfordshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to engine compartment, propeller and nosewheel
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	706 hours (of which 2 were on type) Last 90 days - 12 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB

Synopsis

The aircraft was landing at Elstree Aerodrome when the pilot sensed that the brakes had failed and realised that it would not stop before the end of the paved surface. At a very slow speed the aircraft ran onto the grass and came to a halt in a nose-down attitude with the nosewheel in a ditch. The braking system was found to be operational after the aircraft was recovered; the reason for the overrun could not be established.

History of the flight

The aircraft was returning to Elstree after a 30-minute trial lesson with two passengers. A normal approach to asphalt Runway 08, which has a Landing Distance Available (LDA) of 651 metres, was carried out at 65 kt; the wind was light and variable and landing flap was selected.

After the aircraft touched down in the normal area, as confirmed by witnesses, the pilot reached for the lever underneath the instrument panel which applies the brakes (an unmodified Tri-Pacer such as G-ARFD does not have differential toe brakes). At first, the pilot reported that his pull on the lever generated some retardation but it progressively deteriorated until, by the mid-point of the runway, he realised that he was not going to stop before the end of the paved surface and radioed the ATC tower that he "had no brakes". After further attempts using his maximum strength with both hands, he sensed further retardation but insufficient to prevent the aircraft from over-running the end of the runway, crossing a patch of long grass before the nose landing gear dropped into a small ditch. Although the nose gear did not collapse, the aircraft came to rest in a nose-down attitude with the propeller spinner embedded in the far side of the ditch. The pilot radioed the tower to advise there were no injuries before shutting down the aircraft, and then he and his passengers exited the aircraft normally. The pilot could smell fuel and saw some leaking from the cowling area.

Discussion

The original PA-22 aircraft was not equipped with differential toe brakes, relying instead on a single hydraulic master cylinder operated by a handle under the instrument panel which applies drum brakes on both wheels. Whilst there have been a number of Supplemental Type Certificate (STC) modifications to improve the braking system, including fitment of disc brakes, G-ARFD did not have any of these.

The pilot attributes the overrun to "brake failure combined with downhill sloping runway". However, the operator reports that, during the recovery operation, it was found that the brakes were working and that it has therefore not been possible to establish the reason for the overrun.

INCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BOVK
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1985 (Serial no: 28-8516061)
Date & Time (UTC):	25 May 2013 at 1849 hrs
Location:	Pudsey, West Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Dents in the leading edges of both wings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	35 years
Commander's Flying Experience:	93 hours (of which 23 were on type) Last 90 days - 7 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries.

Synopsis

Shortly after the pilot had turned the aircraft on to base leg on the approach to Leeds Bradford Airport (LBA) at approximately 1,000 ft agl, the engine hesitated, lost power and stopped. The pilot selected a suitable landing site, configured the aircraft for a glide and carried out an engine-off landing in a field approximately 4 miles south of LBA. The aircraft sustained damage to the left and right wing leading edges caused by a set of livestock electric fence posts positioned across the field. The pilot and passengers were uninjured and vacated the aircraft. The engine stoppage was caused by the right fuel tank running dry.

History of the flight

The pilot took off from LBA to conduct a pleasure flight with three passengers on a route which took in the Lake District and Blackpool, to return to LBA. On return the pilot was cleared to re-enter LBA controlled airspace and position for base leg on Runway 32. On turning to enter the base leg there was a sudden engine power loss. This was followed by a splutter or hesitation, run down to idle and stop. The pilot considered there to be little time for diagnosis so, mindful of his height and position over a built-up area, he decided to glide clear and select a suitable open field to make a forced landing. After a MAYDAY call the pilot carried out a successful landing in the selected field. As the aircraft travelled across the field it passed through livestock electric fences and at least two fence posts impacted the leading edges of the main plane, damaging the skin surfaces. After the aircraft came to rest the pilot and passengers vacated the aircraft. There were no injuries sustained during the incident.

Aircraft fuel system

The Piper PA-28-161 fuel system consists of left and right wing tanks feeding an electric pump and an engine-driven pump to supply the carburettor. The pilot has manual control of the fuel supplied from the tanks via a three-position fuel selector valve. The fuel contents indication gauges are situated on the left side of the instrument panel and to the right of the pilot's control yoke. The fuel selector valve control is situated on the cockpit left side panel forward of the pilot's seat. When the control is pointing to the rear of the aircraft fuel is shut off. Rotating the control clockwise to point upwards selects the left tank and further clockwise to point forwards, to the front of the aircraft, selects the right tank.

The contents of each tank were checked during the aircraft recovery. The left tank was found to contain 15 gal imp. The right tank was found to be empty. There was no evidence of fuel leakage.

Pilot's comments and analysis

The pilot volunteered an analysis of the sequence of events leading to the forced landing in a full and frank account.

On this occasion he was taking the opportunity to practice navigation using a navaid, a tablet device, in preparation for a long-distance navigation flight to be taken at a later date as part of his CPL training. He prepared for the flight using a chart and the navaid. He was in the habit of marking his chart to indicate his planned fuel tank changeover point, which usually coincided with a turn or waypoint. He put the chart aside in the cockpit and concentrated on his navaid, which he had mounted on a proprietary bracket on the control yoke.

His flight was uneventful, although he modified one of his turning points due to the presence of isolated low cloud which, by chance, coincided with his planned turn and tank switchover point. He had been reminding himself of the need to switch fuel tanks but the slight turn change caused it to slip his mind. In addition to this he considered that the position of his navaid obscured his view of the right tank contents gauge, enough for its depleting contents not to catch his attention during his regular instrument scans. His position over a built-up area and his altitude meant that he felt it prudent not to attempt a tank switchover and engine restart, so he concentrated on a controlled glide to an engine-off landing. As the incident unfolded he realised the cause of the engine shutdown was fuel starvation and that the right fuel tank was empty.

ACCIDENT

Aircraft Type and Registration:	Pitts S-1E Special, G-OKAY
No & Type of Engines:	1 Lycoming IO-360-B4A piston engine
Year of Manufacture:	1977 (Serial no: 12358)
Date & Time (UTC):	25 June 2013 at 0830 hrs
Location:	Knettishall Airfield, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Wings, fin, tailplane damaged
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	580 hours (of which 180 were on type) Last 90 days - 8 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

On arrival overhead Knettishall Airfield, Suffolk, the weather was good with the surface wind mainly westerly at 10 kt but also light and variable. Following a low approach and go-around, the pilot made an approach to Runway 23 which has a grass surface 600 m long and estimated as 25 m wide, narrowing to 18 m. The approach was normal but as the aircraft touched down it yawed to the right and, despite the pilot's attempts to correct it entered the one-metre high wheat crop adjacent to the runway. Both mainwheels were caught in the crop and the aircraft somersaulted before coming to a stop. The aircraft was severely damaged, but the pilot was able to exit the aircraft without assistance.

An inspection of the right main landing gear showed no binding of the brake or wheel bearing. The wheel spats had been refitted the previous weekend and were known to be clear of any debris. After the accident, a solid clump of soil and grass was found in the spat which, the pilot considered, had been picked up on landing and "jammed the tyre" causing the yaw to the right on touchdown.

ACCIDENT

Aircraft Type and Registration:	Tri Kis, G-BVZD
No & Type of Engines:	1 Continental Motors Corp IO-240-B1B piston engine
Year of Manufacture:	1995 (Serial no: PFA 239-12416)
Date & Time (UTC):	8 June 2013 at 1150 hrs
Location:	Near Thornton, Fife
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	68 hours (of which 17 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst in flight and when opening the throttle to climb, the engine failed. During the subsequent forced landing in a field, the nosewheel dug into the ground and caused the aircraft to flip over and come to rest inverted.

History of the flight

The pilot had fuelled the aircraft in preparation for a two-hour local flight from Fife Airport, Scotland. The pre-takeoff engine power checks were normal and the aircraft took off, departed the circuit to the south and climbed to 1,600 feet amsl without incident. Whilst waiting to obtain transit clearance from Edinburgh ATC, the pilot decided instead to fly firstly to the north and then toward the east in order to cross the Forth river outside controlled airspace.

The pilot briefly leaned the engine mixture, then selected full rich after which he waited for the engine to settle and checked that the temperatures and pressures were satisfactory. He then attempted to climb and advanced the throttle; the engine immediately failed and lost all power, although the propeller continued to "windmill". The pilot started to look for an appropriate field in which to carry out a forced landing and found that the majority of the fields in the immediate vicinity were not suitable as they had power cables running across them or were bounded by walls and houses. He carried out the normal forced landing procedure and attempted to restart the engine but without success, so he called a MAYDAY and then selected an appropriate crop field for the forced landing.

On landing in the crop, the nose wheel dug into the ground and collapsed; the aircraft flipped over before coming to rest inverted. The canopy of the aircraft had collapsed as the aircraft inverted and the pilot was trapped. He had been wearing a four-point harness and sustained minor injuries. He was able to make the aircraft safe and use his mobile phone to call emergency services, who then assisted in freeing the pilot from the aircraft before taking him to hospital.

It has not been possible to establish the reason the engine failed in flight.

ACCIDENT

Aircraft Type and Registration:	Cosmik Aviation EV-97 Eurostar, G-MPAT
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2010 (Serial no: 3919)
Date & Time (UTC):	28 June 2013 at 1700 hrs
Location:	Chesham, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to nose landing gear and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	1,030 hours (of which 113 were on type) Last 90 days - 7 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was conducting a local flight from a private grass airstrip; the weather was fine and calm. During the landing roll, the aircraft hit a surface undulation and became airborne again. The pilot reduced the pitch attitude and the aircraft touched down again before bouncing twice more. The nose landing gear collapsed, causing the propeller to strike the ground, stopping the engine. The pilot, who was uninjured, commented that immediate application of power and a go-around would have been the correct course of action after the first bounce.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade, G-BZPZ
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	2001 (Serial no: 1265-1200-7-W1059)
Date & Time (UTC):	8 June 2013 at 1925 hrs
Location:	Otherton Airfield, Staffordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to trike keel, seat frame, landing gear and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	450 hours (of which 374 were on type) Last 90 days - 32 hours Last 28 days - 27 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The microlight aircraft was engaged on a circuit training exercise when the accident occurred. The instructor reported that his student was flying a glide approach to the grass Runway 07 at Otherton, with a surface wind from 070° at 7 kt. The aircraft encountered an area of 'sink' shortly before touchdown, which could not be arrested despite the instructor taking control and applying full power. The aircraft landed heavily, collapsing the rear suspension leg and damaging the keel and seat frame. The instructor reduced power to idle and brought the aircraft to a stop in about 100 m; neither occupant was injured. The instructor noted that sink due to local topographical factors was not uncommon on the approach to Runway 07, but he had not been overly concerned on the day as the surface wind was only light.

ACCIDENT

Aircraft Type and Registration:	P and M Aviation Mainair Blade, G-CDOR
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	2005 (Serial no: 1372-0805-7-W1167)
Date & Time (UTC):	14 July 2013 at 1030 hrs
Location:	Boston Aerodrome, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (minor) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	502 hours (of which all were on type) Last 90 days - 8 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Climbing through about 200 ft after takeoff from Runway 27 at Boston, and whilst banked to the right, the microlight's engine failed. The pilot turned right towards a playing field north of the runway but assessed the aircraft would not be able to clear a dyke beforehand. He therefore turned further right, back towards the runway, but was unable to clear a second dyke that ran parallel to the runway on its northern side. The aircraft struck the top of the dyke and rolled forward onto the airfield, coming to rest beside the grass runway. The weather conditions were fine and warm, with a temperature of about 28°C. The pilot thought this may have led to vapour lock which disrupted the fuel supply to the engine.

ACCIDENT

Aircraft Type and Registration:	P and M Aviation Quik GT450, G-CFWJ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2009 (Serial no: 8447)
Date & Time (UTC):	15 June 2013 at 1810 hrs
Location:	1 mile north of Hart, County Durham
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers -N/A
Nature of Damage:	Damage to hang bracket, hang bolt and trike pod
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	221 hours (of which 38 were on type) Last 90 days - 5 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had performed a precautionary landing in a stubble field in order to check his location and onward route. Landing in a south-westerly direction with the wind from the west at 15-20 mph, touchdown and ground roll were normal but, as he taxied, the into-wind wing rose and the aircraft toppled onto its left side. The pilot states that he should have held the wing lower as he turned the aircraft.

ACCIDENT

Aircraft Type and Registration:	Rotorsport Cavalon, G-CIAT
No & Type of Engines:	1 Rotax 914 UL piston engine
Year of Manufacture:	2013 (Serial no: 003)
Date & Time (UTC):	11 June 2013 at 1515 hrs
Location:	Chiltern Air Park, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to rotor
Commander's Licence:	Student Pilot
Commander's Age:	59 years
Commander's Flying Experience:	70 hours (of which 25 were on type) Last 90 days - 33 hours Last 28 days - 25 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The gyroplane veered left after landing and rolled over onto its right side. The student pilot attributed the accident to inputting left rudder and putting the stick forward too quickly, and hence not allowing the energy to dissipate. There were no injuries.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK Calidus, G-CGMD
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	2010 (Serial no: RSUK/CALS/015)
Date & Time (UTC):	10 April 2013 at 1125 hrs
Location:	Wickenby Aerodrome, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Damage to rotor, mast, propeller, tail fin and nosewheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	132 hours (of which 86 were on type) Last 90 days - 0 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst attempting to take off the pilot applied aft control stick in order to raise the nosewheel. A 'hammering' vibration occurred and the aircraft veered to the left, off the runway, coming to rest on its side. It was concluded that the rotor rpm may have reduced as a result of the pilot not having held the stick fully aft during the takeoff roll; this may then have caused retreating blade stall.

Circumstances of the accident

After pre-rotating the rotor to approximately 220 rpm, in accordance with the Flight Manual procedure, the pilot lined up the gyroplane on the runway, applied a moderate rearward position of the control stick and applied full throttle. After reaching a speed of approximately 30 mph the pilot applied additional back-pressure on the stick in order to raise the nosewheel. A 'hammering' vibration occurred, which the pilot attributed to a rough patch on the runway surface. The aircraft then veered sharply to the left, leaving the paved surface and causing the pilot to lose his grasp on the throttle and hence his ability to close it. The main rotor blades dug into the ground on the left and the aircraft was thrown over onto its right side before coming to a halt. The pilot switched off the ignition and the electrics and waited for assistance to arrive so that he could escape via the unbroken canopy. In the event the rescue crew asked the pilot to break the canopy and they assisted his egress. He found that a yaw pedal had impacted his right leg, causing a minor injury.

In a subsequent statement, the pilot considered he had been *"too cautious with* [the] *rearward position of the stick to avoid excessive nose wheel lift"* during the takeoff roll.

Takeoff technique

In common with most gyroplanes, G-CGMD is equipped with a pre-rotator system that, when activated, connects a drive system from the engine to the main rotor so that the latter spins up prior to starting the takeoff roll. This serves to reduce the takeoff distance that otherwise would be required. In order to avoid unintended engagement in flight, the pre-rotator can only be activated with the control stick in its fully forward position.

The following is an extract from the aircraft Flight Manual Take-off procedure:

- *While holding wheel brake adjust 1800* [engine] *RPM with throttle*
- *Activate and hold pre-rotator*
- *Let pneumatic clutch fully engage (stabilization at about 110 rotor RPM). There may be a little throttle required to prevent engine RPM from dropping below 1800 RPM*
- *Carefully increase throttle to achieve 200 – 220 rotor RPM*
- *Release pre-rotator button*
- *Bring control stick fully aft*
- *Release wheel brake with throttle unchanged*
- *Monitor rotor speed and adequately increase throttle to take-off power*

A series of Warnings, Cautions and Notes then ensues, including the following:

WARNING

Prior to releasing the wheel brake make sure that the control stick is fully aft. A take-off run with flat rotor system may have fatal consequences.

The Flight Manual deals with the take-off run thus:

- *Check min. 5400 [engine] RPM for take-off. Otherwise, abort takeoff*
- *Minimize lateral drift by applying appropriate lateral control stick input into cross wind direction*
- *Maintain directional control i.e. runway alignment with sensitive pedal input*
- *When nose comes up allow nosewheel to float at about 10 – 15 cm above the runway by a balanced reduction of control stick back pressure*
- *Maintain attitude until speed increases and gyroplane lifts off*
- *Allow gyroplane to build up speed in ground effect*

Discussion

In any gyroplane, the main rotor relies on an upwards flow of air through the rotor disc in order to provide the autorotative force on the blades, which in turn provides the lift. The rotor rpm, and hence the lift, will be reduced in the event of a reduction in the airflow passing upwards through the rotor disc. This could occur as a result of, for example, a delay between de-activating the pre-rotator and commencing the takeoff roll, and/or not holding the stick fully aft during the takeoff roll. The pilot's statement suggested that the latter may have been a factor in this accident, especially as he moved the stick aft in order to raise the nosewheel, rather than wait for the nosewheel to lift before checking forward with the stick in order to balance the aircraft on the main wheels, as advised in the Flight Manual.

The main rotor on this gyroplane rotates counter-clockwise when viewed from above. In the event of the rotor disc angle suddenly being increased as a result of an aft stick input, at low rotor rpm, it is likely that retreating blade stall would occur, and at the same time the advancing blade will rise due to the increased lift generated. This would result in a loss of lift and an increase in drag on the left side, causing the aircraft to roll and yaw to the left. In addition the motion of the rotor disc so caused is likely to result in the rotor head reaching the limit of travel and contacting the teeter stops. This may have been responsible for the 'hammering' vibration described by the pilot.

ACCIDENT

Aircraft Type and Registration:	Thruster TST Mk 1, G-MTPY
No & Type of Engines:	1 Rotax 503 piston engine
Year of Manufacture:	1987 (Serial no: 8107-TST-043)
Date & Time (UTC):	9 June 2013 at 1012 hrs
Location:	Rhosgilwen Mansion, Pembrokeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Substantial
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	12,000 hours (of which 108 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot lined up on Runway 26 and set takeoff power. The aircraft became airborne and initially achieved the normal rate of climb but shortly after there was a marked reduction in the rate of climb. The pilot lowered the nose in order to maintain airspeed, but the aircraft struck a tree at the end of the runway before landing heavily, seriously injuring both people onboard.

History of the flight

The pilot and his passenger intended to carry out a flight to another microlight site to attend a social function. The aircraft had been operated out of the field near Rhosgilwen Mansion for about four years and even in the still wind conditions prevailing had always climbed out clearing the trees at the western end of the runway by a safe margin. The runway surface was mown grass with a Takeoff Run Available (TORA) of 600 m orientated 08/26. There were trees at the western end of the runway with a narrow gap between them on the northern side. The aircraft normally lifted off after approximately 100 m at the maximum All Up Weight (AUW) of 380 kg. The AUW on the accident flight was 373 kg and the weather was CAVOK with a calm surface wind as indicated by the windsock at the midpoint of the runway.

The aircraft was lined up at the beginning of the TORA and takeoff power was set. Acceleration was normal and it lifted off at the expected point on the runway. The initial rate of climb was normal with clearance of the trees assured but then the rate of climb reduced dramatically with no change in engine note or abnormal indications. The pilot lowered the nose to maintain airspeed and realised that he would no longer clear the trees. He attempted to manoeuvre through the gap in the trees, but struck the top of one of the trees. The aircraft descended rapidly, landing heavily and extensively damaging the structure. There was no fire and the pilot was able to isolate the fuel and electrical systems before crawling clear of the wreckage. Both the pilot and his paasenger onboard had suffered serious back injuries but were able to contact the emergency services using a mobile telephone and were evacuated to hospital by air ambulance.

The pilot could not identify the reason for the reduction in rate of climb. With the engine performing normally and the usual initial rate of climb it is possible that it encountered an unexpected tailwind component shortly after becoming airborne.

Miscellaneous

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

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

BULLETIN CORRECTION

Aircraft Type and Registration:	ATR42-300, EI-FXA
Date & Time (UTC):	22 February 2012 at 0700 hrs
Location:	On approach to Glasgow Airport
Information Source:	AAIB Field Investigation

AAIB Bulletin No 8/2013, page 12 refers

The first line of the first paragraph on page 12 incorrectly states that the co-pilot obtained the Newcastle ATIS report, this should read:

> 'The co-pilot obtained the **Glasgow** ATIS report, which stated that …..'

The online version of this report was corrected on Friday, 9 August 2013.

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

1/2010 Boeing 777-236ER, G-YMMM
at London Heathrow Airport
on 17 January 2008.

Published February 2010.

2/2010 Beech 200C Super King Air, VQ-TIU
at 1 nm south-east of North Caicos Airport, Turks and Caicos Islands, British West Indies
on 6 February 2007.

Published May 2010.

3/2010 Cessna Citation 500, VP-BGE
2 nm NNE of Biggin Hill Airport
on 30 March 2008.

Published May 2010.

4/2010 Boeing 777-236, G-VIIR
at Robert L Bradshaw Int Airport
St Kitts, West Indies
on 26 September 2009.

Published September 2010.

5/2010 Grob G115E (Tutor), G-BYXR
and Standard Cirrus Glider, G-CKHT
Drayton, Oxfordshire
on 14 June 2009.

Published September 2010.

6/2010 Grob G115E Tutor, G-BYUT
and Grob G115E Tutor, G-BYVN
near Porthcawl, South Wales
on 11 February 2009.

Published November 2010.

7/2010 Aerospatiale (Eurocopter) AS 332L
Super Puma, G-PUMI
at Aberdeen Airport, Scotland
on 13 October 2006.

Published November 2010.

8/2010 Cessna 402C, G-EYES and
Rand KR-2, G-BOLZ
near Coventry Airport
on 17 August 2008.

Published December 2010.

1/2011 Eurocopter EC225 LP Super Puma, G-REDU
near the Eastern Trough Area Project Central Production Facility Platform in the North Sea
on 18 February 2009.

Published September 2011.

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

Published November 2011.

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