AAIB

Air Accidents Investigation Branch

AAIB Bulletin 8/2015

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AAIB investigations are conducted in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, EU Regulation No 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996.

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

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

AAIB Bulletins and Reports are available on the Internet
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Published 13 August 2015

Cover picture courtesy of Richard Ross

ISSN 0309-4278

Published by the Air Accidents Investigation Branch, Department for Transport
Printed in the UK on paper containing at least 75% recycled fibre

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Summaries of Aircraft Accident Reports

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

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

Aircraft Accident Report No: 1/2015

This report was published on 14 July 2015 and is available in full on the AAIB Website www.gov.uk

Report on the accident to
Airbus A319-131, G-EUOE
London Heathrow Airport, England
24 May 2013

Registered Owner and Operator	British Airways Plc
Aircraft Type	Airbus A319-131
Nationality	British
Registration	G-EUOE
Manufacturer's Serial Number	1574
Place of Accident	London Heathrow Airport
Date and Time	24 May 2013 at 0716 hrs (times in this report are UTC, unless stated otherwise)

Introduction

The event was reported to the Air Accidents Investigation Branch (AAIB) at approximately 0736 hrs on 24 May 2013 by Heathrow Airport Operations and an AAIB investigation was commenced immediately. In accordance with the provisions of ICAO Annex 13, France (the state of aircraft design and manufacture) and the United States of America (the state of engine design and manufacture) appointed Accredited Representatives from the BEA[1] and the NTSB[2], respectively. Technical assistance was also provided by the operator, the aircraft manufacturer (Airbus), the European Aviation Safety Agency (EASA), International Aero Engines (IAE) and UTC Aerospace Systems (UTAS).

Summary

During takeoff from Runway 27L at London Heathrow Airport, the fan cowl doors from both engines detached from the aircraft, damaging the airframe and a number of aircraft systems. The flight crew elected to return to Heathrow and on the approach to land on Runway 27R, leaking fuel from a damaged fuel pipe on the right engine ignited and an external fire developed. The left engine continued to operate satisfactorily throughout the flight. The right engine was shut down promptly, reducing the intensity of the fire, and the aircraft landed safely. It was brought to a stop on the runway and the emergency services were quickly in attendance. The fire in the right engine was extinguished and the passengers and crew evacuated via the emergency escape slides on the left side of the aircraft.

Footnote

1 Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile.
2 National Transportation Safety Board.

The investigation determined that a maintenance error had led to the fan cowl doors on both engines being left unlatched following scheduled overnight maintenance on the aircraft. The unlatched condition of the fan cowl doors was not identified prior to the aircraft's departure the next morning. A number of organisational factors were contributory to the maintenance error. The operator has since taken action to address these issues.

This, and numerous other similar events, shows that Airbus A320-family aircraft have a history of departing with the fan cowl doors unlatched. It is also evident that, in practice, the flight crew walk-around inspection is not entirely effective in detecting unlatched fan cowl doors and therefore a design solution is necessary. Enhanced methods of detection through design solutions are being considered by the aircraft manufacturer.

As a result of this investigation, five Safety Recommendations were made concerning: fatigue risk management; fan cowl door position warnings; fan cowl door certification requirements; in-flight damage assessments by cabin crew and aircraft evacuation procedures.

Findings

Operational aspects

1. Photographic evidence showed that the fan cowl doors were in an unlatched condition prior to the flight.

2. The unlatched fan cowl doors were not detected by the tug driver during his inspection of the aircraft prior to pushback.

3. The training and instructions for the tug driver's inspection of the aircraft did not contain the necessary detail to enable him to be able to identify a fan cowl door in the unlatched condition.

4. The unlatched fan cowl doors were not detected during the co-pilot's external walk-around.

5. The operator's training material on the conduct of the flight crew pre-flight walk-around included detailed instructions on checking the security of the fan cowl doors.

6. The co-pilot, who had completed the operator's pre-flight walk-around training several years previously, reported that he was not aware of the gap in the fan cowl doors when the doors are unlatched and held open by the hold-open device.

7. The A320-family FCOM instructions for the pre-flight walkaround contain specific entries for checking that the left and right engine fan cowl doors are closed and latched.

8. The pre-flight walk-around on G-EUOE was not conducted fully in accordance with the procedure as set out in the FCOM.

9. The operator did not conduct regular checks of flight crew's conduct of the pre-flight walk-around, nor was it required to.

10. Passengers were aware of the fuel leak from the right engine soon after takeoff and attempted to bring it to the attention of the cabin crew. The cabin crew did not assimilate this information and it was therefore not passed to the flight crew.

11. The information provided by the cabin crew to the flight crew did not accurately represent the state of the aircraft.

12. The commander did not have all of the available information regarding the damage to the aircraft to assist him in his decision making.

13. The QRH fuel leak procedure called for the right engine to be shut down; however, the commander, on considering the risks, elected to keep it operating.

14. The commander correctly identified and shut down the No 2 (right) engine after the fire warning activated, but this was not performed in accordance with the operator's SOPs and training.

15. The flight crew deviated from the manufacturer's FCOM SOP for task sharing for Abnormal and Emergency procedures.

16. The fire in the right engine continued after the aircraft came to a halt on the runway. The fire was quickly extinguished by the AFRS.

17. The left engine remained running until the AFRS requested that it be shut down.

18. The aircraft was evacuated quickly and without serious injury using only the exits on the left side of the aircraft.

Technical aspects

1. The fan cowl doors detached from the aircraft during takeoff because they remained unlatched following overnight maintenance and the unlatched condition of the fan cowls was not detected prior to the flight.

2. A section of the right engine inboard fan cowl door remained attached. This struck and punctured the FMU spill return pipe, causing a significant fuel leak on the right engine. The leaking fuel ignited during the approach to land.

3. When they decided to defer the IDG oil servicing task, the technicians responsible for servicing the aircraft did not follow AMM procedures for

leaving the aircraft with the cowls either fully open on stays, or closed and latched; nor did they place the required warning notices in the cockpit prior to opening the fan cowl doors.

4. The technicians were not required to, and did not load an IDG gun and oil into their vehicle prior to commencing planned maintenance tasks, due to a low expectation that the equipment would be required during the two Weekly Checks assigned to them during their shift.

5. The IDG oil servicing task was deferred because the technicians did not have the required IDG gun and oil when they needed them for G-EUOE. They elected to return to the aircraft later in their shift once they had completed other planned maintenance tasks and had drawn the necessary equipment from stores.

6. The technicians did not make an open technical log entry for the required IDG oil uplift prior to deferring the IDG oil servicing task.

7. When the technicians later returned to complete the IDG oil servicing task, they attended G-EUXI, an Airbus A321 on Stand 517, instead of G-EUOE on Stand 513. They did not check the aircraft's registration and did not recognise that they were at the incorrect stand or aircraft.

8. Previous cases of aircraft swap errors had occurred within the operator's line maintenance operation, but they had not been reported, and therefore no mitigating actions had been taken to prevent their recurrence.

9. The technicians successfully carried out an IDG oil level check and fan cowl closing procedure on G-EUXI.

10. The fan cowl doors on both of G-EUOE's engines remained unfastened and the IDG oil levels on both engines were below the serviceable level following the overnight maintenance shift.

11. The technicians completed G-EUOE's Daily and Weekly Check paperwork and technical log entries in the Terminal 5A southern crew room and not on board the aircraft, as G-EUOE's technical log had been removed from the flight deck in accordance with a local working procedure.

12. The technicians' working time records showed that both individuals were compliant with the company's working time limitations and legal requirements.

13. The performance of both technicians may have been compromised by fatigue, induced by the significant level of planned and overtime working undertaken prior to the overnight maintenance shift.

14. The quantity and scope of planned work for the technicians' shift was achievable, was not unusual or excessive, and was within their scope of approval as LMAs.

15. Both technicians had been trained in, and were familiar with, the AMM procedures relating to opening and closing the fan cowl doors.

16. Non-compliance with the AMM procedures for opening and closing fan cowl doors on Airbus A320-family aircraft was a common occurrence and was not specific to either of the technicians involved in the incident, or to the aircraft operator.

17. Previous safety actions taken by the aircraft manufacturer to prevent fan cowl door losses were only partially effective.

18. The high visibility paint on G-EUOE's fan cowl door latch handles was in a poor condition, with most of the paint either missing or obscured by blue paint overspray. There was no specific continued airworthiness instruction regarding maintenance of the high visibility paint finish in the AMM and repainting instructions contained in the fan cowl door SRM were ambiguous in that the areas of the latch to repaint differed from those defined in Service Bulletin V2500NAC-71-0227.

Causal factors

The investigation identified the following causal factors:

1. The technicians responsible for servicing the aircraft's IDGs did not comply with the applicable AMM procedures, with the result that the fan cowl doors were left in an unlatched and unsafe condition following overnight maintenance.

2. The pre-departure walk-around inspections by both the pushback tug driver and the co-pilot did not identify that the fan cowl doors on both engines were unlatched.

Contributory factors

The investigation identified the following contributory factors:

1. The design of the fan cowl door latching system, in which the latches are positioned at the bottom of the engine nacelle in close proximity to the ground, increased the probability that unfastened latches would not be seen during the predeparture inspections.

2. The lack of the majority of the high-visibility paint finish on the latch handles reduced the conspicuity of the unfastened latches.

3. The decision by the technicians to engage the latch handle hooks prevented the latch handles from hanging down beneath the fan cowl doors as intended, further reducing the conspicuity of the unfastened latches.

Safety Recommendations

The following Safety Recommendations are made:

Safety Recommendation 2015-001

It is recommended that the European Aviation Safety Agency publishes amended Acceptable Means of Compliance and Guidance Material in Part 145.A.47(b) of European Commission Regulation (EC) No 2042/2003, containing requirements for the implementation of an effective fatigue risk management system within approved maintenance organisations.

Safety Recommendation 2015-002

It is recommended that the European Aviation Safety Agency requires Airbus to modify A320-family aircraft to incorporate a reliable means of warning when the fan cowl doors are unlatched.

Safety Recommendation 2015-003

It is recommended that the European Aviation Safety Agency amends Certification Specification 25.901(c), Acceptable Means of Compliance (AMC) 25.901(c) and AMC 25.1193, to include fan cowl doors in the System Safety Assessment for the engine installation and requires compliance with these amended requirements during the certification of modifications to existing products and the initial certification of new designs.

Safety Recommendation 2015-004

It is recommended that British Airways Plc reviews, and amends as appropriate, its pilot and cabin crew training, policies and procedures regarding in-flight damage assessments and reporting by cabin crew in light of the lessons learned from the G-EUOE fan cowl door loss event.

Safety Recommendation 2015-005

It is recommended that British Airways Plc reviews its evacuation procedures and training to take account of the potential risks of leaving engines running during on-ground emergencies.

AAIB Field Investigation Reports

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

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

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

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-36Q, G-GDFT
No & Type of Engines:	2 CFM56-3C1 turbofan engines
Year of Manufacture:	1998
Date & Time (UTC):	3 September 2014 at 1958 hrs
Location:	East Midlands Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 5 Passengers - 152
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	R1 relay damage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	10,600 hours (of which 4,100 were on type) Last 90 days - 294 hours Last 28 days - 54 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft landed at East Midlands Airport following an electrical failure in flight, which the crew diagnosed as a failure of the battery busbar[1]. As the aircraft taxied towards its parking stand, an acrid smoke haze appeared within the cabin and flight deck and an emergency evacuation was carried out. Although the aircraft was successfully evacuated, cabin communication difficulties were encountered due to the failure of the PA system and a fault with a loud hailer unit.

The battery bus failure was caused by one or more loose R1 relay terminals, leading to a break in electrical continuity. The acrid smoke in the cabin and cockpit was a direct result of the relay failure. The loss of the air cycle machine (ACM) cooling fans caused dust and oil residue to burn off the hot metal duct surfaces in the air conditioning system and the resulting fumes entered the cabin, prompting the evacuation.

History of the flight

The electrical system malfunction

G-GDFT was operating a Commercial Air Transport (CAT) flight from Ibiza Airport, Spain, to East Midlands Airport, UK with 152 passengers and five crew members on board. At

Footnote

[1] Busbar: an electrical conductor distributing power from a power source, such as a battery, to electrical components.

1908 hrs, the aircraft was routing towards reporting point AVANT[2] and descending when the commander, who was making his arrival PA to the passengers, became aware that the PA system had failed. The flight crew then noticed indications of other, seemingly unconnected, failures which included faults with: the left equipment cooling fan; a radio; the weather radar; the autobrake; and the power supply to the standby attitude indicator and standby compass. In addition, indications of terrain, reference speeds, engine fuel flow and N1 (low speed compressor) rpm disappeared from the pilots' displays.

The crew discussed the situation, diagnosed that the aircraft had a problem with the battery busbar, but commented that there were no Non-normal Checklists (NNC) in the Quick Reaction Handbook (QRH) to help them. They also noted that the battery on its own was capable of providing power to systems for approximately 30 minutes. The commander told ATC that the aircraft had suffered a partial electrical failure and asked for expeditious routing to East Midlands Airport.

The cabin interphone was not working and so the co-pilot opened the flight deck door to attract the attention of the Senior Cabin Crew Member (SCCM). The SCCM entered the flight deck and the commander briefed her on the situation and his intention to make an approach and normal landing at East Midlands Airport.

When the SCCM returned to the cabin, she briefed the other cabin crew members on the situation and told the crew member at the rear of the aircraft to follow her (the SCCM) lead if circumstances arose where the crew member did not know what was happening. When the SCCM tried to use the PA to brief the passengers, she found that it did not work. She tried using the loud hailer but it became apparent that her instructions were not being heard more than two or three rows ahead of her. She tried to increase the output volume, but the volume control had broken, so she walked through the cabin briefing the passengers a few rows at a time.

After further discussion, the flight crew decided that the aircraft had a problem with the standby power supply. The commander, unsure whether or not the battery was being discharged by aircraft systems, and unsure whether or not electrical power to those systems would be lost at some point, asked the co-pilot to declare a PAN. ATC vectored the aircraft to intercept the localiser for an ILS approach to Runway 09 at East Midlands Airport. Before commencing the approach, the crew reminded themselves that the autobrakes were inoperative and manual braking would be required on the runway, and that the speedbrakes would have to be deployed manually on touchdown. The surface wind at the airport was from 070° at 7 kt, there were few clouds at 3,000 ft, broken clouds at 4,800 ft, and the QNH was 1022 hPa.

During the approach, when the co-pilot selected the landing gear to DOWN, there were no indications in the flight deck to show whether or not the gear had extended fully and locked in place. The crew decided to discontinue the approach to establish whether the landing gear had lowered correctly. They continued towards the airport and flew above the runway at 1,000 ft amsl while ATC personnel tried to establish visually whether the landing gear had

Footnote

2 AVANT is located at N5049.2 W00056.3.

extended. ATC subsequently reported to the crew that the nose gear appeared to be down, but it was too dark for them to see the state of the main landing gear. The aircraft climbed to 3,000 ft and re-positioned for a further approach, during which time the co-pilot used observation ports in the floor of the main cabin and of the flight deck to establish visually that the landing gear had extended properly. The aircraft landed without further incident at 1954 hrs and began to taxi towards its stand.

The evacuation

As the aircraft approached its stand, the cabin crew members sitting near the forward exits smelt smoke and the SCCM decided to tell the flight crew. She entered the normal entry code to request access to the flight deck and began knocking on the flight deck door. She could see smoke in the cabin which appeared to be coming from near the over-wing exits and which looked "misty from seat level up". She also noticed that some passengers were standing up. Because the flight crew had not opened the door, she entered the emergency entry code into the door locking system and then continued to knock on the door.

The pilots also smelt a strong acrid smell which they "felt in the throat". They heard the SCCM knocking on the door and could hear voices and noises from the cabin. The commander instructed the co-pilot to give the "CABIN CREW AT STATIONS" command, which would ready them for a possible evacuation, but the PA system was not working. The co-pilot opened the flight deck door to speak to the SCCM and, as the door opened, the pilots thought that the smell became worse. The SCCM entered the flight deck and reported that they needed to evacuate, the fire alarms had activated and there was smoke in the cabin.

The commander declared a MAYDAY, telling ATC that there was acrid smoke in the cabin and that he needed to evacuate the aircraft. He instructed the co-pilot to begin the evacuation and both pilots carried out their respective actions from the evacuation checklist.

The SCCM, at the forward left exit (1L), deployed the emergency slide and supervised passengers leaving the aircraft through that exit. The cabin crew member at the 1R exit deployed the 1R slide but it twisted as it inflated and became unusable. She guarded the doorway to prevent passengers leaving through the 1R exit and was later helped in that task by the pilots. The cabin crew member at the aft left exit (L2) was unaware initially that the aircraft was to be evacuated and she disarmed the door in preparation for a normal disembarkation. When she saw through the window that passengers were sliding off the trailing edge of the left wing, she re-armed the door, deployed the slide and shouted for passengers to come towards her to use her exit.

The Airport Fire and Rescue Service (AFRS) had been alerted at approximately 1926 hrs that the aircraft had an electrical problem and had positioned three rescue vehicles at the front of the fire station. After the aircraft landed, the vehicles followed it as it taxied towards its stand and were therefore on scene immediately after the commander declared his intention to evacuate. Members of the AFRS assisted passengers during the evacuation and, afterwards, entered the cabin to search for signs of heat or smoke. Although they reported that there was a smoke layer throughout the cabin, no signs of a heat source were detected in the cabin, avionics bays or cargo holds by their thermal imaging camera.

Information from the flight crew

The pilots were not sure whether the battery was discharging and did not know which additional systems would be lost if it discharged fully. Despite the fact that both engine driven electrical generators were functioning normally, the pilots decided that it would be sensible to attempt to land within 30 minutes from when the symptoms were first observed. This was because they expected a fully charged battery to be able to power connected systems for at least 30 minutes. Despite uncertainty over the exact nature of the failure, the pilots were content that they knew which systems would be unavailable during the landing.

Recorded data

The aircraft was fitted with a CVR and an FDR. Both recordings captured the onset of the problem and stopped when electrical power was disconnected as part of the evacuation checklist. The recordings of the ATC communications were also analysed. Pertinent extracts are provided in the History of the flight section of this report.

The data showed that the crew action of switching the standby power to battery during the evacuation checklist resolved many of the FDR parameter losses triggered by the original failure.

Aircraft description

General

The Boeing 737 is an all-metal, low-wing passenger aircraft powered by two CFM56-3C1 turbofan engines. Primary electrical power is supplied by two engine-driven generators which each supply three-phase 115V AC 400Hz. Each generator normally supplies its own bus system but it can also supply power to the transfer bus of the opposite side automatically via the Bus Transfer Relay if one generator fails. The APU drives a generator that can supply power to one Main AC Bus and both Transfer Buses in flight. The DC system consists of three major buses: DC Bus 1, DC Bus 2, and the Battery Bus. DC Bus 1 and DC Bus 2 are powered directly by two Transformer Rectifier (TR) units that operate in parallel, each receiving AC inputs power from its respective 115V AC Transfer Bus. These two buses are backed up by a third, identical TR (TR-3) through an isolation diode. In addition to its back-up function, TR-3 is the primary source of power for the Battery Bus. As long as power is available to TR-3, it will power the Battery Bus. If power is lost to TR-3, the Battery Bus will automatically transfer to receive power from the Hot Battery Bus.

The aircraft is air-conditioned and pressurised using ambient external air and hot air generated from the engine compressors. The system operates automatically to maintain the settings and demands required of it using electro-mechanical devices.

Battery busbar description

The third TR or the Hot Battery Bus supplies 28V DC to the Battery Bus through a series of relays: Battery Bus Relay (R355), Battery Bus Relay Auto (R1), and Battery Bus Relay Manual (R326). If both Main AC Buses lose power, the Hot Battery Bus automatically connects to the Battery Bus via Battery Bus Relay Auto (R1), providing power to the

115V AC (via the Static Inverter) and 28V DC Standby Systems. If the Battery Bus Relay Auto (R1) fails in an open circuit condition, power may be restored to the Battery Bus by selecting the Standby Power Switch to the BAT position. This action connects the Hot Battery Bus to the Battery Bus via Battery Bus Relay Manual (R326).

Pressurisation control

The pressurisation system is electrically operated and electronically controlled and meters the exhaust of ventilation air to provide controlled pressurisation to the passenger cabin and cockpit. The main components in the system are: a pressure controller, cabin and cargo compartment pressurisation outflow valves, pressure sensing devices, and an indication system.

The outflow valves are electrically driven and are fitted at the front and rear of the aircraft. The rear valve controls the cabin pressure whilst the forward valve, working in harmony with the rear outflow valve, controls the cargo and avionics bay pressurisation. In normal operation the rear outflow valve receives signals from the pressure controller to modify the position of its gate valve automatically to maintain differential cabin pressure. At touchdown the landing gear air/ground sensor signals the controller, which modifies the outflow valve opening to match cabin pressure with ambient pressure on the ground.

Air conditioning

Air conditioning and cabin ventilation is provided by two cooling packs which receive high energy and hot air bled from the engine compressors. The cooling packs consist of heat exchangers, water extractors, control devices and an air cycle machine (ACM). The ACM is an energy change machine which uses an air-driven compressor and turbine to extract heat energy from the bleed air. This device operates automatically, is self-lubricating and runs at very high speed. The cooling pack machinery heat exchangers are cooled using ambient ram air assisted by electrically driven fans.

Engineering investigation

Electrical system

Following the incident, the ground engineers made the aircraft safe and disconnected the battery. During these actions they were aware of an “odd hot” smell, but could not pinpoint the source. With the emergency services present, access was gained to the equipment bays in order to locate and isolate potentially damaged equipment, but all appeared normal. When the AAIB attended the aircraft the same night, nothing unusual was detected. On the morning after the incident, the aircraft was moved to a hangar at East Midlands to troubleshoot the problem. There was no obvious evidence of equipment failure so, after having taken appropriate safety precautions, the battery was reconnected and AC ground power applied to the aircraft. As systems were progressively brought on-line, exactly the same losses and indications experienced by the crew during the incident reappeared. However, at no point during this testing did the aircraft produce smoke or a smell of burning.

An examination of the circuit diagrams and the list of system losses indicated that the fault lay with the R1 or R326 relay. Power-off continuity checks were carried out across the two pairs of terminals on the R1 relay, but these were inconsistent and therefore inconclusive. The R1 relay was removed to aid further examination, but its removal was somewhat difficult as the terminals were loose and tending to rotate rather than remain stationary when an undoing torque was applied to the nuts. The outer collars had to be gripped with pliers in order to remove the nuts. It was difficult to carry out this task in the confined area at the bottom of the P6 bay in which the relay is located. It was also observed that the relatively large and stiff 'A' gauge cables and terminations were rigid, tightly tied within their wiring harness and did not naturally align with the terminals when the nuts were removed. When examined, the relay appeared to contain a loose object which rattled within the casing. Closer inspection of the relay terminals B1 and B2 found them to be loose and no longer fixed to their insulated mounting in the relay, to the extent that they fell out when the relay was inverted. The A1 and A2 terminals were also loose within their insulated collar, but remained in place. Figure 1 shows the R1 relay after removal.

Figure 1

R1 relay with detached B1 and B2 terminals

A replacement relay was fitted and further aircraft power supply tests were carried out, during which all aircraft systems functioned normally. In order to verify the diagnosis, the aircraft ground power was left on the aircraft for approximately one hour, with no emergent faults. The R326 relay was found not to be involved and operated correctly.

Heat and smoke

Further system and equipment inspection found the ACM lubrication oil levels to be low and the reservoir sight glasses slightly discoloured from overheating due to the loss of the cooling fans following the electrical failure. The ACMs were therefore replaced as a precaution. There was no evidence of heat distress or fire within any of the other aircraft systems.

R1 relay examination

The R1 relay was not subjected to overheating and showed no external signs of burning or heat damage.

An X-ray examination showed the misalignment of the A terminals, but did not identify the loose object. The relay was then opened by cutting access holes through the side plates. The B2 terminal contact surface was found to be marked with normal arc spatter and slight sooting and appeared to have been contacting in a slightly misaligned position towards its edge. The terminal insulator on A1 was cracked, with a small piece missing. That piece was found resting at the bottom of the relay casing; its material type does not show under X-ray. The terminal mounting faces had parted, revealing the soldered surfaces between the terminal and its insulator mount. The relay internal components had no evidence of heat damage other than very slight sooting of the B2 terminal.

Each terminal had failed at the point where a flange on the terminal was soldered to the metal collar bonded to a ceramic insulator on the relay casing. Although the A and B pairs of terminals were loose, the solenoid terminals, labelled -X1 and +X2 were intact. The solenoid was heard (and seen under X-ray) to operate when 28 VDC was applied across the X terminals. Examination of the fracture surfaces by binocular microscopy identified what appeared to be solder porosity and areas of mechanical damage in the form of 'smearing', indicating rotation of the terminals. It was also found that the surface morphology was consistent with brittle overload. A high magnification picture of the surface is shown in Figure 2. An independent laboratory initially examined the loose terminals and observed

Figure 2

Terminal insulator soldered joint fracture face the characteristics of porosity on the joint faces. However, the component manufacturer considered the brittle overload surface morphology to be the predominant characteristic. A particular example was the B2 stud and terminal insulator interface that showed signs of rotational motion.

The 'B' terminals were straight and could be lifted straight out of the relay. The 'A' terminals were 'cranked' and could not be removed without being excessively destructive. It was considered very likely that the failure mode of all four terminals was the same, so the 'A' terminals were left in place.

Escape slide

The cabin crew initiated a full emergency evacuation, opening the forward cabin doors, which automatically deployed the escape slides. However the Number 1 Right (1R) slide inflated but twisted upside down, becoming jammed against the fuselage and not in contact with the ground. This rendered the slide unusable. The slide was fully inflated and under considerable tension at the top and so for safety reasons the slide was deflated and removed before the AAIB's arrival. Prior to deflation, with the 1R door fully open, it was found that it took very little effort applied at its lower end to right the slide and once righted, it settled in its correctly deployed position. The engineers removing the slide manually took careful note of the girt bar[3] and reported that it was correctly engaged in its fittings. Examination of the slide in its deflated condition off the aircraft found it to be undamaged, despite the twist and tension to its girt bar apron. All the ancillary devices attached to the slide were undamaged. The slide did not appear to have any pre-existent faults or damage. Figure 3 shows that slide in its twisted state prior to removal.

Figure 3

1R slide fully inflated and twisted

Footnote

[3] Girt bar – The girt bar is a high strength metal bar attached to the top of the slide. It is clipped into substantial brackets mounted on the cabin door threshold and its purpose is to attach the slide to the aircraft such that in 'automatic'; ie when the cabin door is opened in emergency, the slide self-deploys, ready for use.

Loud hailer

There were two battery powered emergency loud hailers fitted in the overhead lockers; one at the front and one at the rear of the aircraft. The crew reported that they had difficulty using the loud hailer at the front of the aircraft. Examination of the loud hailer (Figure 4) found that, although the unit was fully charged and the press-to-speak handle worked correctly, the volume was set to minimum and the volume control knob was missing. The knob spindle was present and undamaged. The loud hailer fitted at the rear of the aircraft was fully serviceable.

Figure 4

Emergency loud hailer missing volume control knob

Previous incidents and recommendations

Incident to Boeing 737-500, registration EI-CDT

On 20 July 1997, the Danish Air Accident Investigation Board investigated an event to a Boeing 737-500, registration EI-CDT, during which the crew experienced seemingly unconnected cockpit indications, and instrument and system failures. The Board determined that the cause of the event was the failure of the R1 relay associated with the battery busbar, one of the effects of which was to remove power from the equipment cooling fans.

Following the investigation, the Board made two recommendations. The first recommendation related to the performance of the R1 relay in Boeing 737 series aircraft and, in response, the manufacturer issued Service Letter 737-SL-24-120. The Service Letter identified preferred R1 relay part numbers for use in the R1 location. The second recommendation was intended to ensure that Boeing 737 crews would have information readily available to them which would allow them to restore electrical power quickly following a failure of the R1 relay. In response to this recommendation, the manufacturer issued Flight Operations Technical Bulletin 737-300/400/500 98-1, which gave background information on failure of the battery busbar, along with failure indications that could be expected. The bulletin stated that:

> *'The loss of normal EFIS[4] display cooling is not indicated and, thus, the flight crew will not be alerted to accomplish the EQUIPMENT COOLING OFF NNC. Without cooling, the EFIS displays may transition from colour to monochromatic and eventually shut down. This can result in a loss of all attitude information.'*

The bulletin commented that the manufacturer did not consider loss of the battery to be a hazardous situation because normal AC power would provide sufficient instrument indications to flight crew for continued flight and landing. Although the manufacturer had no technical objection to an operator incorporating into its Operations Manual a procedure for the loss of the battery busbar, they were unable to publish a generic procedure in the Boeing Operations Manual because there were many different electrical configurations throughout the Boeing 737 fleet. In circumstances of loss of power to the battery busbar, the only indication common to all aircraft in the 737-300/400/500 fleets would be the loss of N1 engine indications.

Incident to Boeing 737-300, registration G-EZYN

On 22 March 2005, a Boeing 737-300, registration G-EZYN, diverted in flight as a result of symptoms experienced following the loss of power from the battery busbar. An AAIB investigation determined that there had been a failure of the R1 relay[5]. Power to the battery busbar could have been restored by moving the Standby Power switch on the overhead panel from AUTO to BAT, but there was no QRH procedure which would have prompted the crew to carry out this action.

The AAIB commented that, had a relevant procedure been available to the crew, it would have made diagnosis of the problem and decision-making more straightforward, while also restoring the electrical systems that had been affected. The AAIB recommended that the Federal Aviation Administration (FAA) in the USA should require Boeing to examine the electrical configurations of Boeing 737 aircraft, with the intention of providing operators with an Operations Manual procedure to deal with loss of power to the battery busbar.

In its response to the recommendation, the FAA stated that the top-level unsafe condition was the loss of all attitude indications, and the EFIS cooling system did not account for the effects of failure of the R1 relay. It issued FAA Airworthiness Directive (AD) 2009-12-05 mandating corrective actions which were subsequently detailed in Boeing Service Bulletin 737-21A1156, *Air Conditioning – Equipment Cooling System – Electronic Flight Instrument System Cooling Supply Off Light Wiring Change*. The FAA stated that, after the modification to the cooling system, it would be unnecessary to revise the Operations Manual.

Footnote

[4] EFIS: Electronic Flight Instrument System.

[5] The AAIB report is available here: http://www.aaib.gov.uk/cms_resources.cfm?file=/Boeing%20737-33V,%20G-EZYN%2004-06.pdf

Safety action by the operator

Immediately following this incident, as an interim reminder to crews, the operator reissued an Operating Staff Instruction, *Battery Bus Failure,* originally issued in 2007, which contained Boeing Flight Operations Technical Bulletin 737-98-1 referred to above. Subsequently, the operator incorporated a procedure into its Operations Manual, the objective of which was to confirm failure of the battery busbar and restore power to it if possible (See Appendix 1). In circumstances where the battery bus failed, crews would be directed to select the Standby Power switch to BAT, which should remove symptoms of the failure. Should power not be restored to the busbar, the procedure informed crews of system failures that they should anticipate, including loss of landing gear indications and loss of the PA system. The procedure also directed crews to select the Equipment Cooling Supply switch to ALTERNATE, if necessary, to restore cooling to the EFIS and prevent loss of the electronic attitude display indicator (EADI) and electronic horizontal-situation indicator (EHSI) displays.

Analysis

Operational aspects

This event was triggered by a failure of the R1 relay, for which there was a simple remedial procedure which was not contained within the operator's Operations Manual. The crew diagnosed correctly that there was a problem with the standby power supply and anticipated some of the consequences that would affect them during the landing, ie that the speedbrakes would have to be deployed manually on touchdown and manual braking would be required on the runway. However, the crew did not anticipate that there would be no landing gear indications when the gear was lowered; this led to them going around from the approach because the position of the landing gear could not be determined in the time available. Failure of the R1 relay also led to acrid smoke appearing in the cabin as the aircraft taxied in and the commander's decision to evacuate the aircraft.

Following the incident, the operator added a procedure to its Operations Manual which, in similar circumstances, will direct crews to select the Standby Power switch to BAT to restore power to the battery bus. If this action does not restore power, the procedure prepares the crew for consequential system loss, including the loss of landing gear indications. The procedure also includes action to select the Equipment Cooling Supply to ALTERNATE, if required, to restore cooling to the displays. This addresses the possibility that all attitude information might be lost, which was the FAA top-level safety condition.

The operator's Operations Manual procedure should aid diagnosis and decision-making for crews in similar circumstances while restoring electrical systems that are affected. Understanding in advance that there will be no indication of landing gear position should allow crews to lower the gear early in order to carry out a visual check that it has extended before making the final approach. This should reduce the likelihood that a go-around will be required which, in itself, is an unusual procedure that can provoke errors in crew performance. The procedure should also prevent the situation deteriorating to such an extent that an evacuation becomes necessary, with its attendant increase in risk to passenger safety.

Engineering aspects

Electrical failure

The reproduction of the electrical power distribution system symptoms after the incident and the rectification by replacement of the R1 relay, confirmed the failure of the R1 relay as being causal. In order to lose power to the battery bus there needs to be a loss of continuity between the A or B terminals; for this to happen one or both of the terminal post must be permanently misaligned or become ‘out of reach’ of the contactor plate. The continuity checks in situ, with power off, (ie the relay in a de-energised condition) were inconclusive, probably due to the terminals being loose.

Forensic examinations by an independent laboratory and by the OEM offered differing conclusions as to why the terminals became loose. There appeared to be evidence of porosity of the soldered joint and brittle overload between its surfaces. However, the difficulty experienced in the disassembly of the terminals and cables means that evidence of these two characteristics could not be relied upon to show the exact failure mode. Furthermore, all the terminals appeared to turn when an undoing torque was applied to the nuts, but exactly how loose each terminal was at the time could not be determined accurately. When the R1 relay was examined in situ, the terminals all appeared to be correctly in place when viewed from the top. However, the position of the relay in the bay made it very difficult to see whether any of the terminals had lifted away from their mountings; in addition the stiffness of the cable harness made everything look and feel tightly assembled.

Despite the exact material failure mode, the loss of the battery bus was due to the loss of electrical continuity across the B1 and B2 terminals, as this is the normal position of the Battery Bus Auto (R1) contacts for the Battery Bus to receive 28V DC from TR-3 before the relay failure. In order for this to happen a misalignment or small movement away from the contactor blade must have taken place. The length of the terminal within the relay would effectively amplify any movement at the cable connection end of the terminal, thus increasing the risk of the loss of contact. The cause of the movement cannot be determined beyond doubt. However, an over-torque on a terminal and the presence of a constant side load or tension from the stiff wiring harness is the most likely scenario to have taken place on one or more of the terminals. It is possible that excessive torque was applied to the terminals at installation or during subsequent maintenance, resulting in a weakening of the terminal insulator soldered joint.

Smoke in the cabin and cockpit area

The crew and passengers became aware of an acrid smell and smoke haze in the cabin and flight deck of the aircraft as they taxied to the stand. Previous incidents have shown that a secondary effect of the R1 relay failure can result in smoke within the cabin and cockpit. The loss of the DC Bus causes the R320 ground sense relay to drop out causing the ACM cooling turbo fans to stop. Without the forced air cooling, the ACM will overheat over a period of time as it is in constant receipt of heated air from the engine compressor. As a result any oil residue and dust within the ACM and ducts will start to produce vapour, smoke and fumes. The examination of the ACMs showed that the lubricating oil in the sight glasses appeared to be discoloured and overheated indicating the possibility of heat distress. It was reported that the passengers become aware of the acrid smell and smoke in the cabin after landing during the taxi to the stand. The design of the air conditioning system within the Boeing 737, and many other similar aircraft types, means that there is a natural increased air movement, followed by stagnation of air within the aircraft cabin as the system resets to the aircraft being on the ground and as the aircraft and its systems are shut down. Taking into consideration the source of the smoke it would be normal, although disconcerting for passengers, for acrid air in the ACM ducts to move and collect within the cabin as a smoke haze.

Escape slide

Examination of the 1R door escape slide and girt bar after the incident revealed that it was correctly attached to the aircraft and therefore was in its automatic position. The slide material and its inflation equipment were undamaged and there was no evidence of a pre-existent fault. There did not appear to be a technical reason why the slide became twisted during deployment, but anecdotal evidence suggests that there have been previous occasional mis-deployments of the slides. Of those, the majority seem to have taken place with the right front cabin door; ie the 1R slide, as in this case. It is not clear exactly how these mis-deployments occur. In some cases the doors have been observed not to be completely clear of the slide as it deploys and so can deflect the slide while partially inflated. A twist then sets in at the top, then, as the moment (ie length and leverage of the inflating slide) increases with extension, the twist tightens and remains in place. When this happens, the resulting twist causes the slide to adopt a highly unusual angle and places the bustle apron under extreme tension, as was found in this case. A possible reason why the 1R door may not be clear in time is that the cabin crew two-handed muscular auto-motor skills are more used to opening the Number 1 Left (1L) door in one smooth, well-practiced movement. Research and discussion at a UK-based Boeing 737 cabin crew simulator suggested this was a distinct possibility.

Loud hailer

The cabin crew reported difficulties with the handheld emergency load hailer at the front of the aircraft. The volume was turned down and the knob was missing, leaving the end of the spindle to which it was attached below the level of the casing. It was unclear how, or when, the knob came to be missing and a search of the overhead locker in which the hailer was stowed failed to locate the missing item.

Conclusion

The electrical difficulties experienced in this aircraft were as a direct result of the loss of continuity between the R1 relay terminals. This was due to one of its terminals loosening in its insulated mounting over an indeterminate period of time and moving away from the contactor, thus breaking continuity. It is possible that this was caused by an overtightened terminal nut weakening the terminal and insulator soldered joint whilst at the same time being under a degree of tension or side load from the heavy gauge electrical cables.

Appendix 1

Operator's procedure for Battery Bus Failure

Battery Bus Failure

Condition: Blanking of BOTH N1 gauges. Multiple failures of items connected to the Battery Bus, caused by Bus failure

Objective: Confirm bus failure, attempt to restore bus power

Note: No single light or message will indicate a battery bus failure

1 Choose one:

- With BAT BUS selected on the DC Metering Panel, Volts and Amps indications are erratic or indicate zero (0):

  Go to step 2

- With BAT BUS selected on the DC Metering Panel, Volts and Amps indications are **not** erratic or indicate zero (0):

  Complete other QRH checklists as appropriate

■ ■ ■ ■

2 STANDBY POWER switch..BAT

3 Choose one:

- With BAT BUS selected on the DC Metering Panel, Volts and Amps indications remain erratic or zero (0):

  Go to step 4

- With BAT BUS selected on the DC Metering Panel, Volts and Amps indications are **not** erratic or indicate zero (0):

  The battery is continuously charged. To avoid potential overheating of the battery, consider landing at the nearest suitable airport

■ ■ ■ ■

4 STANDBY POWER switch..AUTO

5 EQUIP COOLING SUPPLY switch..ALTERNATE

This restores EFIS Cooling and prevents loss of EADI and EHSI displays

6 Land at the nearest suitable airport.

Note: System functions and indications may not be normal. Affected major systems and indications vary and include (but are not limited to):

Indications:

Master Caution annunciation
Engine parameters (e.g. N1)
Landing gear lights
Aural Warnings
Standby Attitude Indicator
Pressurization status

Systems:
Passenger Address (PA)
Engine and Wing Anti-Ice control
Thrust reverser control
Inboard Antiskid
Parking brake control
Passenger Oxygen System
Pack valve control
Engine fire detection
APU ignition
Fuel crossfeed control

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 757-3CQ, G-JMAB
No & Type of Engines:	2 Rolls-Royce RB211-535E4-B-37 turbofan engines
Year of Manufacture:	2001 (Serial no: 32242)
Date & Time (UTC):	31 October 2014 at 1130 hrs
Location:	During takeoff from London Gatwick
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 10 Passengers - 239
Injuries:	Crew - None Passengers - None
Nature of Damage:	Slide carrier, pivot forging and actuator deformed, slide loss and fuselage scuff marks
Commander's Licence:	Airline transport pilot's licence
Commander's Age:	50 years
Commander's Flying Experience:	15,300 hours (of which 8,765 were on type) Last 90 days - 196 hours Last 28 days - 57 hours
Information Source:	AAIB Field Investigation

Synopsis

A 'wing slide' advisory message activated on the Engine Indication and Crew Alerting System (EICAS) during takeoff. The crew entered a hold to burn off fuel until the aircraft was at an appropriate landing weight and returned to Gatwick. Whilst positioning for final approach, the right over-wing slide unravelled from the slide carrier and subsequently detached from the aircraft. Although the crew experienced some uncommanded roll on final approach, the aircraft landed safely. The investigation determined that a series of technical issues with the slide panel and carrier locking devices caused the slide carrier to deploy and the slide to unravel. A Service Bulletin was already in existence to address some of these issues, but it had not been actioned on this aircraft at the time of the incident. During the course of the investigation, issues were identified on aircraft door designations and the Quick Reference Handbook. Two Safety Recommendations are made.

History of the flight

The aircraft was on a scheduled flight from London Gatwick Airport to Hurghada Airport, Egypt. During the takeoff run, at a reported 70 kt, the R WING SLIDE advisory message appeared on the Engine Indication and Crew Alerting System (EICAS). The commander advised the co-pilot, who was pilot flying (PF), to continue the takeoff. The crew reported that the aircraft handled normally during the takeoff and there were no other abnormal indications or symptoms. The crew decided they would continue with the departure and assess the situation when the aircraft was safely established in the climb. After the immediate departure procedures, they alerted the cabin manager and asked her if anyone had heard or seen anything unusual in the cabin. They also completed the Quick Reference Handbook (QRH) procedure which, with the continued absence of any other indications, showed that no further action was required. The crew diagnosed that the warning was probably spurious and continued the climb. Subsequently, they contacted company operations to alert them to the problem and this consultation resulted in the crew deciding to return to Gatwick Airport.

At this stage, the aircraft was approximately nine tonnes above the normal landing weight and, sharing the crews' suspicion that the warning was probably spurious, the operator's operations department advised the crew to hold and burn off fuel rather than carry out an overweight landing. London ATC vectored the crew to an extended holding pattern where the crew used a combination of landing gear, flap and speedbrake to achieve a high drag and fuel-burn rate configuration. The crew did not declare an emergency.

After approximately 40 minutes of holding, ATC vectored the aircraft to a normal approach onto Runway 26L at Gatwick. The aircraft was on base leg, descending to 3,000 ft at a speed of 188 kt with flaps 20 selected, when some of the cabin crew and passengers heard a number of bangs or felt a brief period of airframe "shuddering". Two passengers reported seeing a white object detach from the aircraft on the right side. The cabin manager passed this information to the flight crew.

The crew established the aircraft on final approach and selected flaps 30. Shortly afterwards the commander noticed that the control yoke was offset to the left and commented that the autopilot seemed to be "struggling" to maintain wings level. He disconnected the autopilot and took manual control of the aircraft. He reported that a "significant amount of left aileron" was required to maintain the centreline, although the aircraft remained fully controllable.

The commander landed the aircraft and taxied onto the parallel taxiway where the aircraft was shut down. Subsequently, following inspection by the fire and rescue service and engineers, it was discovered that the right over-wing slide had detached from the aircraft. The aircraft was then towed to a stand where the passengers were able to disembark normally. The total flight time was 2 hours 6 minutes.

Aircraft over-wing escape system description (Figure 1)

The Boeing 757-300 is fitted with an over-wing emergency escape and evacuation system which consists of two hatches fitted side by side above the wing and an automatic slide deployment system. The system is duplicated on the left and right sides of the aircraft. When either of the wing escape hatches are manually opened and lifted clear, by the crew or passengers during an emergency, the over-wing slide automatically deploys and inflates over the inboard flap trailing edge. The slide activation system consists of a stored energy gas bottle and valve, a slide pack mounted on a carrier, various mechanical locking devices and a pneumatic actuator. The actuator is situated behind a small maintenance access panel in the fuselage just above the flap trailing edge. The action of opening either of the two wing escape hatches initiates an electrical input to a discharge valve assembly squib which releases gas pressure. The gas charge is held in the bottle situated behind the forward bulkhead of the cargo bay. The gas pressure energises a pneumatic slide panel release and slide deployment actuator which unlocks and rotates the slide carrier out of its stowage to its slide inflation position. The last few degrees of movement causes the slide container bag unlacing pin to withdraw and as the slide carrier abuts a fixed stop the remainder of the gas pressure inflates the slide ready for use.

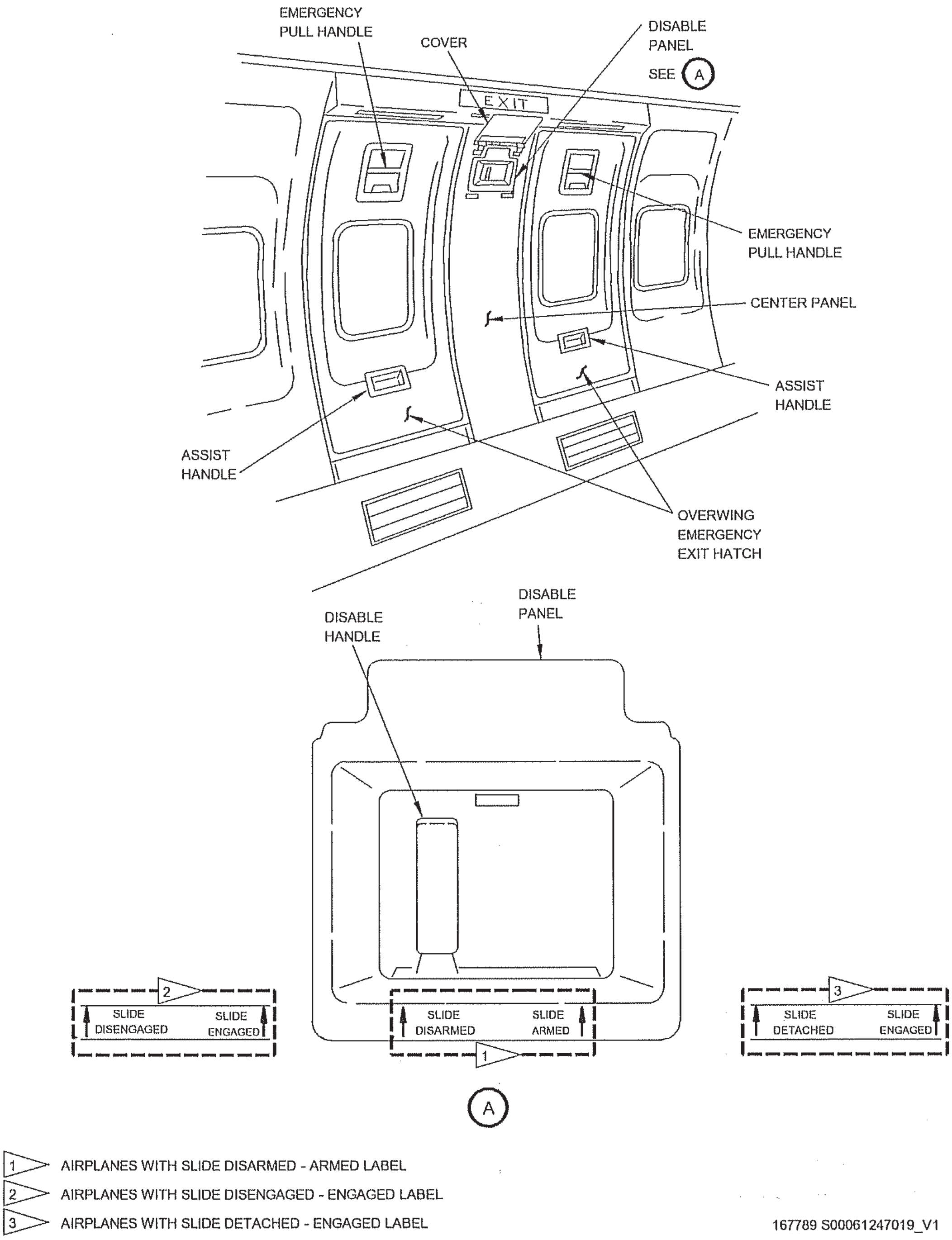

Figure 1

Over-wing escape hatches general arrangement within the cabin
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Figure 1 shows the general arrangement of the over-wing escape hatches. For safety the system is fitted with a several interlocks to prevent unwanted slide deployment during maintenance. The electrical input to the squib is isolated by a SLIDE ENGAGED and SLIDE DISENGAGED lever situated between the two escape hatches behind a plastic trim cover on the cabin sidewall.

The actuator (Figure 2) is fitted with a vent lever, coloured red, which when rotated outwards to the 'manual' position allows the actuator piston to be moved manually and prevents gas pressure acting on the actuator. When the vent lever is in the manual position its handle protrudes outside the fuselage and its access panel cannot be closed.

In addition to the vent lever there is also a yellow crank handle fitted alongside the actuator. It is normally in the down, just below horizontal, position. When it is moved upwards, to approximately 30º above the horizontal, it releases the slide door, by retracting the door latch tube, and withdraws the slide carrier restraint device. Its purpose is to replicate the unlocking actions of the actuator to allow maintenance and inspection of the slide and its carrier without having to operate the actuator using gas pressure. The crank handle has a secondary function whereby the lifting of a trigger assembly on the handle and rotating it back down engages a hook on the slide carrier with the door latch tube to lock the slide carrier in the deployed position. To enable maintenance staff to check for the correct orientation of the crank handle, yellow paint marks are specified on the doubler plate, known as the land, surrounding the access hole on the inside, which abuts against and supports the back of the access panel when it is closed. The marks align with the lever when it is correctly positioned with the slide carrier locked and the slide panel closed. Figure 2 shows the slide actuator and crank handle assembly.

The slide bay panel is hinged along its top edge and is fitted with a proximity switch which provides an EICAS R WING SLIDE or L WING SLIDE caution if the panel opens; this is also recorded on the Flight Data Recorder (FDR). The slide panel latch assembly consists of two tappets mounted on a spring-loaded door latch tube. The latch tube runs along the bottom outboard edge of the bay and the tappets engage in machined slot plates fitted to the inner front and rear corners of the panel. The spring provides a constant positive engagement of the tappets in their slots providing the crank handle is in the shut position.

Recorded information

The aircraft was fitted with a 2-hour CVR and an FDR which recorded just over 26 hours of operation. The FDR captured the entire flight, but due to the duration of the flight, the CVR recording began just over an hour after takeoff.

The FDR data shows that as the aircraft accelerated (at a groundspeed of approximately 14 - 37 kt) on takeoff, the recorded right wing slide door parameter[1] changed state from CLOSED to OPEN. After takeoff, at approximately 1,500 ft, the autopilot was engaged and approximately 5.5º of left control wheel was applied in order to maintain a wings-level attitude. As the flaps were retracted, the aircraft climbed and the airspeed increased, the amount of left control wheel applied reduced to less than 1º.

Footnote

[1] This parameter is only recorded once every four seconds so this could have occurred any time within the preceding four seconds.

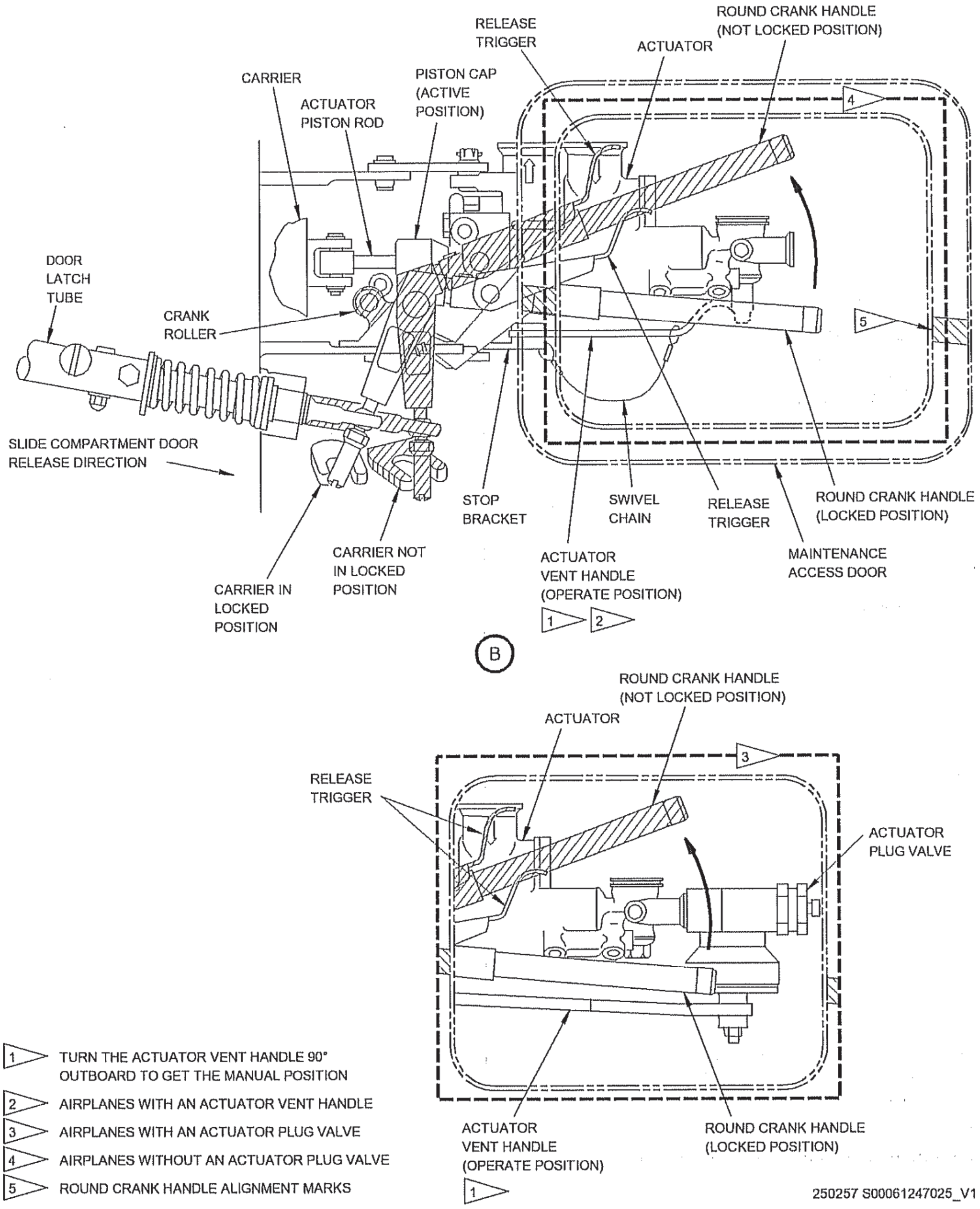

Figure 2

Slide carrier actuator assembly (left side shown)
(Boeing Proprietary. Copyright © Boeing
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Ten minutes prior to entering a holding pattern, the CVR recording commenced. The aircraft was established in the hold for approximately 40 minutes before turning to a heading for the base leg return to Runway 26L. With the autopilot still engaged, flaps 20 was selected and approximately 5º of left control column was applied in order to maintain a wings-level attitude.

Analysis of the recorded accelerations, aircraft attitude and manoeuvring could not identify any obvious reasons why the slide would deploy as the aircraft flew abeam the location where the escape slide was eventually found. Just over a minute after passing the point where the slide was discovered, the CVR recorded the cabin crew reporting to the flight crew a loud bang and that something had fallen off the aircraft.

Flaps 30 was selected after the turn onto the final approach after which the control wheel input increased to an average of 20º to the left (see Figure 3). The autopilot was disconnected as the aircraft descended through 1,400 ft on the final approach.

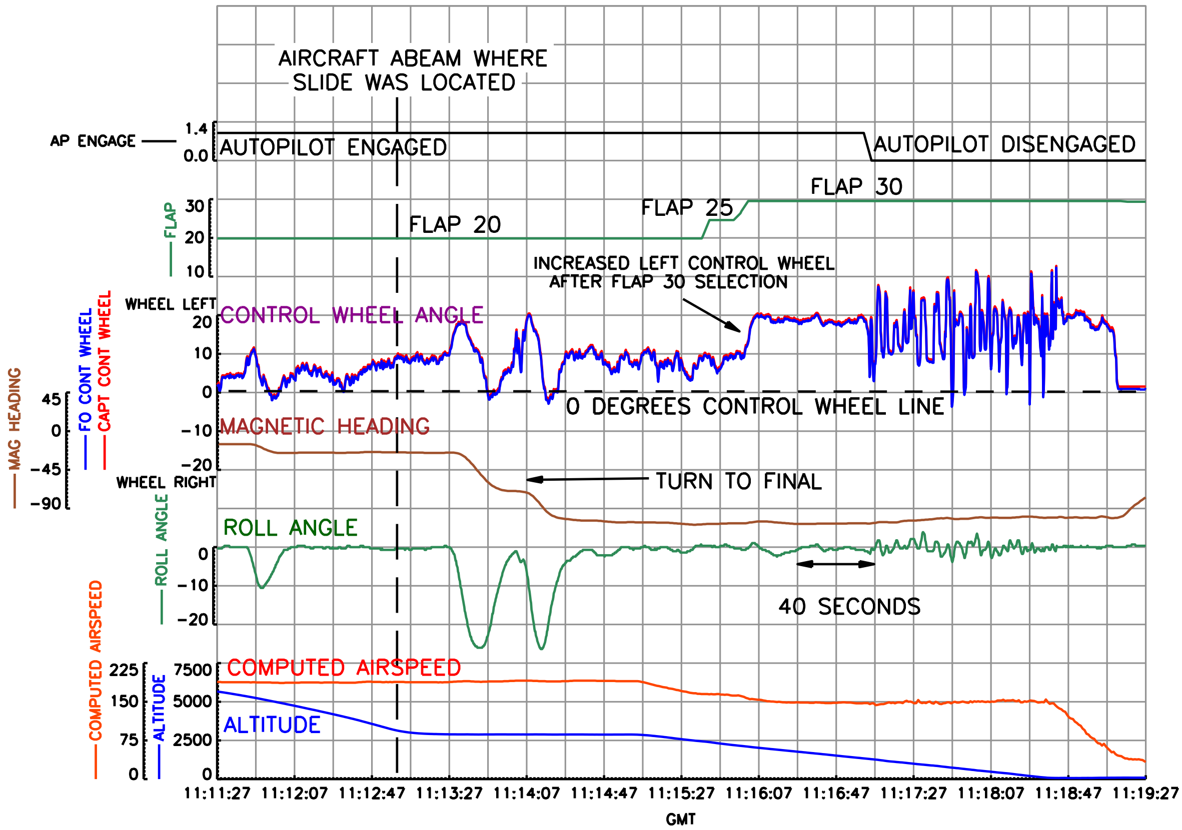

Figure 3

G-JMAB FDR data during approach to Gatwick Airport

Aircraft examination

On examination it was evident that the right over-wing slide carrier had deployed and had rotated outwards. The carrier bay panel was open, attached by its hinges, and resting on the carrier. The slide pack cover was open and the slide was missing. The outer rigid sideboard of the pack had detached and was on the hardstanding beneath the aircraft. The carrier outward travel stop hook had broken from its mounting tube and detached. The carrier had over-rotated causing damage to the fuselage wing root upper fairing, forcing the actuator rod to extend and bend and cause damage to the carrier pivot forging. The slide pack lacing pin had withdrawn from the slide cover and was hanging loose attached to the aircraft by its pip-pin and lanyard. Figure 4 and Figure 5 show the slide carrier as found.

Figure 4
The slide carrier as it was found after landing

Figure 5
A close-up of the slide carrier after landing

The carrier locking device was retracted into its release position and was undamaged as were the panel latch rod tappets and slots. The forward and aft slots and tappets were covered in a protective layer of grease. The aft slot and tappet grease layer exhibited marks indicating where the tappet had been located. One of the marks was within the forward end of the slot, the locked position, and the other more pronounced mark was at the opening to the slot indicating movement of the panel during tappet and slide disengagement. The forward tappet and slot had the only marks in the grease on top of the slot edges and indicated that the tappet had not been engaged within the slot in any position as shown in Figure 6 and Figure 7.

Figure 6

The slide panel aft latch tappet imprints within the slot

Figure 7

Slide panel forward latch slot with the tappet imprint in the grease on the slot outer face

The slide gas bottle was fully charged and none of the initiation devices had activated. The actuator access panel was found closed. The vent lever was found positioned in the 'operate' position. However, the yellow crank lever was in the slide panel OPEN AND CARRIER RELEASE position. The lever and its trigger assembly were undamaged.

The left crank handle was examined as a comparison and found to be in the closed position as was the associated vent lever. Further checks were carried out after the aircraft had been removed from service. This included a visual examination and pull-off checks on the crank handles. The pull-off checks found that the left lever required 50 N (11.25 lb) and the right lever required 25.4 N (5.71 lb). Both these figures are within the manufacturer's maximum of 25 lb. The levers had a smooth action with no detectable backlash in their mechanisms. It was observed that the access panels and crank handle assembly differed from the line diagrams shown in the Aircraft Maintenance Manual (AMM). There should have been yellow painted markers on the land of the panel to indicate the correct closed and locked position of the crank handle. The paint marks were not present on this aircraft. However, on the inside of the panel there was a placard giving instructions on how to operate the crank handle and includes a lever position picture, but it did not include or draw attention to safety alignment marks. Figure 8 and Figure 9 show the right and left slide release cranked handles with the maintenance access panel open.

Figure 8

Right slide release cranked handle in the up position as found after the incident

Figure 9

Left slide release cranked handle in the correct down position.
(Note the absence of alignment marks in Figures 8 and 9)

The slide unravelled in the slipstream and struck the aircraft fuselage, causing no damage except for some light scoring on one of the cabin windows. Eventually the doubler material where it attaches to the carrier and the gas inflation pipe collar failed leaving the uninflated slide to detach and fall to the ground and land in a tree. Apart from the attachment material and pipe collar damage the slide was intact. Figure 10 shows the slide (face down) after recovery.

Figure 10

The recovered slide

Maintenance history and activity

The last recorded maintenance activity on the slide and carrier was on 18 February 2013 and involved removal and replacement of the right over-wing slide for routine servicing. On 24 February 2013, a work order was raised which recorded the right over-wing slide pack carrier access door had been found open at its rear edge during a walk-round inspection. Subsequent inspection at the time found the yellow door lock handle incorrectly positioned. The door was checked and reclosed satisfactorily.

Immediately prior to the incident work had been carried out on the right over-wing slide system on the night of 30 October 2014. This involved removal and replacement of the stored energy bottle for scheduled out of phase maintenance. This activity was carried out in accordance with the Boeing AMM procedure. Part of the procedure details the actions to be taken in order to make the slide deployment initiation system safe, both electrically and mechanically. It was made safe electrically by moving the slide arming handle in the cabin to SLIDE DISENGAGED, fitting a safety pin to the master control valve and removal of the electrical connector on the squib. In addition, the AMM instructs rotation of the vent lever to isolate the actuator and open the gas pressure supply line to atmosphere as a precaution should an inadvertent bottle discharge occur. These actions were carried out by the maintenance team without difficulty. The replacement fully charged bottle was fitted and the work completed and certified during the shift. The bottle which had been removed remained fully charged. Other servicing work was carried out and completed on the aircraft during the shift on unrelated systems and therefore have no bearing on this incident. It was not a particularly high workload shift with all the staff commenting that, although they were busy, all the work allocated was completed in a timely and unrushed manner. The work on the slide system was carried out by more manpower than would normally be required. This was because it was considered to be an infrequent task and so was a good learning opportunity.

After the incident the aircraft was withdrawn from service for a C check. Whilst this work was being carried out the maintenance engineers found that the No 6 flap screw jack trunnion bush was missing and one of the flap track attachment brackets loose. These components are attached to the fuselage structure in the wing root beneath the right over-wing slide compartment. This fault had not been directly reported by crews but an examination of the aircraft records showed that on several occasions a technical log entry had been made concerning a 'vibration noise'. A number of actions were taken to locate the source of the noise including an examination of the wing slide panels for wear and security. This led to replacement of the spring loaded hinges on the left and right side of the aircraft as a precaution. However, on 15 September 2014 an entry noted;

> *'in the cruise around Row 24 there is very loud droning noise and vibration, at times you almost cannot hear yourself talk.'*

The cause could not be found at the time so a note was made to monitor the problem in the technical log and the G-JMAB vibration sheet.

Previous events

Several operators had previously reported in-flight over-wing uninflated escape slide losses. The cause was identified as the slide compartment panel not being fully locked and secured, even though appearing to be so, after access for maintenance. Accordingly the manufacturer issued Service Bulletin (SB) 757-25-0298 which was subsequently mandated by a FAA Airworthiness Directive (AD) 2012-01-09. The SB instructed operators to fit modified parts to the panel latching mechanism to provide more positive locking. It also introduced placards for better visual indication of the correct position of the crank handle (Figure 11). The AD required the actions of the SB to be completed by end of February 2017. SB 757-25-0298 was not embodied on G-JMAB at the time of the incident.

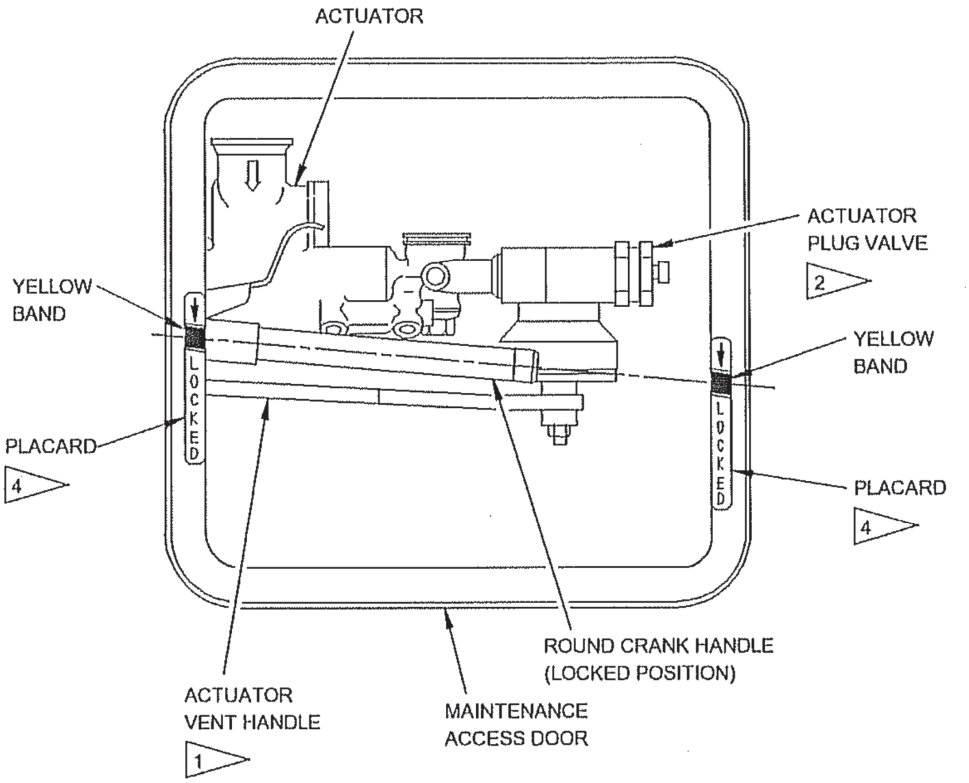

Figure 11

Revised safety markings (Boeing Proprietary. Copyright © Boeing Reprinted with permission of The Boeing Company)

Aircraft doors

The Boeing 757-300 is fitted with three passenger entry doors on each side of the aircraft, the forward and centre entry doors serve the forward section of the cabin and are located forward of the wing and the aft entry door is at the rear of the cabin. The passenger entry doors also serve as emergency exits. In addition, there is one emergency door located on each side of the fuselage just aft of the wing. These doors are hinged at the bottom, equipped with evacuation slides and are only used as emergency exits. Finally, there is a pair of smaller over-wing escape hatches located side-by-side over the wing on each side of the aircraft. These escape hatches are only used as emergency exits.

During the course of the investigation, it became apparent that the system used by the cabin crew to designate entry and exit doors at the rear of the aircraft was different from that expected by the airport fire and rescue service (AFRS). The operator had, a few days before the incident, changed their numbering system for the doors. Before this change, aircraft doors were designated L1 to L4 on the left side and R1 to R4 on the right side with the escape hatches not being part of the sequence. After the change, the over-wing escape hatches were included and were designated L3 and R3 respectively with the doors in the rear fuselage assumed the designations L4, L5, R4 and R5. The AFRS stated that they would expect to use a similar system for designating doors but do not include any over-wing exits in the door count. Table 1 summarises the different methods of door designation used with this aircraft.

Door description	EICAS designation (Light: advisory messages)[1] (See note)	Cabin crew designation, post-numbering system change	AFRS expected designations
Forward passenger entry doors	ENTRY DOORS: L FWD, R FWD	L1, L2	L1, L2
Centre passenger entry doors	ENTRY DOORS: L CTR, R CTR	L2, R2	L2, R2
Escape Hatches	EMER DOORS: L FWD, L AFT, R FWD, R AFT	L3, R3	Over-wing exits
Emergency doors	EMER DOORS: L EMER DOOR, R EMER DOOR	L4, R4	L3, R3
Aft passenger entry doors	ENTRY DOORS: L AFT, R AFT	L5, R5	L4, R4

NOTE: [1] The generic exterior door annunciator lights are on the overhead console. The specific advisory messages are shown on the EICAS primary display.

Table 1

Table showing the different door designation on the incident aircraft

A survey of major aircraft manufacturers and a cross section of UK airline operators, revealed that there appears to be no standardised system for operating crews and AFRS to use to designate aircraft doors.

Roll control with wing slide door / carrier open

Immediately after takeoff, an average of 5.5º of left control wheel was required to maintain the wings level . This observation is consistent with the right wing slide panel, and possibly the slide carrier entering the airflow, generating an uncommanded right rolling moment. As the flaps were retracted, the amount of control wheel required for wings-level flight decreased.

From comments recorded on the CVR, the uncommanded roll was apparent to the crew during the approach once flaps 30 was selected. The manufacturer stated that in their experience of in-flight wing slide deployments, small amounts of uncommanded roll were not unusual. They confirmed that as the flaps were extended, the amount of uncommanded roll increased and that above flaps 20, this is more noticeable. Once flaps 30 was selected, the amount of control wheel deflection required to maintain level flight increased from approximately 10º to 20º to the left. This was still within the autopilot control authority and equated to approximately 25% of the control wheel's maximum deflection.

Quick reference handbook

The QRH procedure for a WING SLIDE warning is shown in Figure12.

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EMER DOORS **WING SLIDE**

G-JMAA, G-JMAB

Messages: EMER DOORS
L WING SLIDE R WING SLIDE

Condition: One or both wing slide doors are not closed and secure.

1 Choose one:

◆Visual or aural observation does **not confirm** that the overwing ramp slide is deployed and is still attached to the airplane:

■ ■ ■ ■

◆Visual or aural observation **confirms** that the overwing ramp slide is deployed and is still attached to the airplane:

►►**Go to step 2**

2 Minor damage to the trailing edge flap, aft fuselage, and empennage may occur.

3 **If** needed to minimize slide oscillations and subsequent airplane damage:

Operate at a reduced airspeed.

4 If performance allows, use Flaps 20 and VREF 20 for landing.

▼ Continued on next page ▼

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▼WING SLIDE continued▼

5 Choose one:

◆Flaps 20 and VREF 20 **can** be used for landing:

GND PROX FLAP OVRD switch . . . . . OVRD

►►**Go to step 6**

◆Flaps 20 and VREF 20 **cannot** be used for landing:

Use normal flaps and speeds for landing.

■ ■ ■ ■

6 **Checklist Complete Except Deferred Items**

Figure 12

QRH procedure for Wing Slide alerts. (Boeing Proprietary. Copyright © Boeing Reprinted with permission of The Boeing Company)

The QRH procedure for wing slide alert messages covers only two possibilities. Firstly, the wing slide is not confirmed as being deployed, in which case no further action is required. Secondly, the procedure considers the possibility that the wing slide has deployed and is still attached to the aircraft. In this eventuality, the QRH procedure states that, if performance allows, use flaps 20 and V_{REF} 20 for the subsequent landing.

In this incident, the crew experienced an unexpected and uncommanded roll on final approach once flaps 30 was selected, with the slide carrier deployed into the airflow but with the slide detached, a configuration not covered by the QRH procedure.

Deployment of the wing slide in-flight was assessed by the manufacturer during the design and certification process. They determined that if a wing slide deployed in-flight and detached from the aircraft, it would most likely pass underneath the empennage. However, should the slide strike the horizontal stabiliser, moderate buffet might result, and the horizontal stabiliser's leading edge is capable of sustaining relatively severe damage across the major portion of its span without a significant reduction of aircraft controllability. Any damage to the hydraulic system at the leading edge of the stabiliser would only render two of the six elevator actuators inoperative and should the horizontal stabiliser should become inoperative, the Boeing 757 can be safely landed using elevator control only. Also, in their assessment they concluded that should the wing slide remain attached after the slide has been deployed, it would not cause a controllability or performance problem.

Analysis

Engineering aspects

Examination of the aircraft right over-wing escape slide carrier and its fittings indicated that a series of interrelated events occurred leading to the opening of the cover panel and deployment of the carrier. The marks within the grease of the tappet and slide assemblies, designed to hold the panel shut, show that only the rear tappet was properly engaged. The forward marks show that the tappet was not engaged within the slot but was only in contact with the top surface of the slot. It also appears that its adjustment was such that the panel did not sit proud of the surrounding fuselage skin and therefore remained unnoticed by ground staff and crews doing visual inspections. It is possible that this existed for some time. The last recorded specific right wing slide and panel maintenance took place in February 2013. More recently the left and right slide panel hinges were replaced as a precaution as part of the vibration diagnosis.

Boeing 757-300 fleet-wide experience and manufacturer's data shows that on a number of occasions the tappet and slot mis-engagement has resulted in the opening of the slide panel leading to carrier deployment in flight. However, on this occasion this appears not to be the primary cause but would have increased the risk of opening in flight.

The absence of mechanical damage to the panel latches and the carrier locking device show that these items had become fully disengaged at the time of the incident. For this to happen the cranked handle, which as part of its movement withdraws the latches, must have moved upwards to the release position as it was found.

There are several possibilities for this to occur. Maintenance work was carried out on the slide gas bottle the night before the incident. Part of the preparatory procedure prior to carrying out the work was to make the gas pressure side of the actuation system safe by moving the vent lever to the open position. This was carried out in accordance with the AMM. Then, following the AMM instructions, the team of engineers changed the gas bottle and re-established the slide gas system into the service condition by closing the vent lever and securing its access panel. When carrying out this action the individual concerned did not recall touching or moving the crank handle. Furthermore he would not have needed to do so due to the position and design of the vent lever. None of the engineering staff involved at the time noticed anything unusual about the cranked handle or its position. However, with hindsight they were not completely sure that it was correctly positioned when later compared to diagrams in the AMM. The possibility that the lever was inadvertently knocked towards the release position cannot be discounted. However, had it been fully moved to the release position, the slide carrier panel would have opened slightly and been seen by the engineers. It would also have caused an immediate EICAS caution of R WING SLIDE during pre-flight checks. However, it is possible it had only been partially moved such that it remained closed but in a position that it would require an additional factor to cause its continued travel. It may therefore be concluded that the crank handle was not fully down in the safe position but was engaged enough to hold the panel and slide carrier in place. The absence of the alignment markings on the panel, designed to indicate if a crank lever is not correctly secured, would have reduced the possibility of its mis-position being identified by the engineers. SB 757-25-0298 mandated under FAA AD 2012-01-09 introduces clearer crank handle position indication but it had not been incorporated on G-JMAB.

The lever and its mechanism were found to have a smooth and backlash free action but when compared to the left side crank handle required less force to initiate movement, ie it had a reduced breakout friction. In addition the No 6 loose screw jack right flap system, which is in close proximity to the slide cranked handle, had been causing high vibration and noise. As the handle required less force to move, it is possible that the flap system vibration and resonance resulted in a gradual movement upwards of the crank handle over a period of time to the point whereby it allowed the slide carrier and panel to open with its locking devices in the released condition. Once open, it was in the air flow with the slide itself now no longer restrained within its pack. Thus it eventually unravelled in the slipstream flailing about against the fuselage until its attachment material failed allowing it to detach and fall to the ground. There was no pre-existent damage or faults found with the slide and therefore it has no bearing on the incident. On this occasion the slide had not contacted the tailplane.

Operational aspects

During the takeoff run, the EICAS displayed a R WING SLIDE message to the flight crew. On seeing the message the commander instructed the PF to continue the takeoff. Rejecting a takeoff carries additional risk and would normally only be carried out for warnings, significant cautions or significant non-annunciated events such as a blocked runway

Aircraft doors

The investigation discovered that the there was a discrepancy between the system used by the AFRS and the cabin crew to designate the exit doors of this aircraft. In the event of an emergency evacuation, had the AFRS needed to communicate information to the aircraft crew relating to the safety or otherwise of a particular exit, then it is possible that this information would have been communicated incorrectly. It is vital that this information be communicated in a clear and unambiguous manner, so a standard system for referring to aircraft exits would reduce the potential for a misunderstanding. As no such standardised system for exit door identification exists, the following Safety Recommendation is made:

Safety Recommendation 2015-022

It is recommended that the European Aviation Safety Agency, in conjunction with the Federal Aviation Administration and other regulators, implement a standardised system of door and emergency exit designations to reduce potential misunderstanding between aircraft crews and airport emergency services in the event of an emergency evacuation.

Quick Reference Handbook (QRH)

Should a wing slide unravel or deploy in flight, it is visible from the cabin. However, should only the wing slide carrier enter the airflow or a wing slide door open, neither are visible from the cabin. Therefore, in the case of a R(L) WING SLIDE EICAS message, without any visible slide deployment, the crew are not able to establish the position of the wing slide door or the slide carrier. Should either of these enter into the airflow, the effect is an uncommanded roll, which is exacerbated once the flaps reach a position of greater than 20.

The current QRH procedure only recommends the use of flaps 20 for landing when the slide is confirmed as deployed, but still attached to the aircraft. As there is a case where the R(L) WING SLIDE EICAS message is generated but cannot be followed up with a visual confirmation of the wing slide door or carrier position by the crew, the following Safety Recommendation is made.

Safety Recommendation 2015-023

It is recommended that Boeing Commercial Airplanes amend the Quick Reference Handbook WING SLIDE alert procedures for Boeing 757-300 aircraft to make the instructions on the use of flaps 20 for landing applicable to all cases of WING SLIDE alerts.

Conclusion

The right over-wing slide carrier deployed in flight, allowing the slide to unravel possibly as a result of the crank handle with a reduced breakout friction progressively moving, over an indeterminate period of time, to an unsafe position. A contributory factor was possibly the loose number 6 screw jack in the flap system which resulted in vibration in the area of the crank handle. The insecurity of the lever went undetected whilst the maintenance panel was open due to the lack of alignment marks and unfamiliarity of the observer(s) with how the crank handle should look when correctly positioned. SB 757-25-0298 addresses locking of the compartment door and provides revised and clearer alignment placards for the lever.

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:	A330-323, N273AY
No & Type of Engines:	2 Pratt & Whitney PW4168A turbofan engines
Year of Manufacture:	2000 (Serial no: 0337)
Date & Time (UTC):	5 February 2015 at 0715 hrs
Location:	Stand 325, London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 12 Passengers - 156
Injuries:	Crew - None Passengers - None
Nature of Damage:	No 1 engine and front of engine cowl
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	26,748 hours (of which 2,706 were on type) Last 90 days - 60 hours Last 28 days - 30 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquires by the AAIB

Synopsis

Having parked on stand the commander observed an OK message on the stand guidance system and, believing chocks were in place, released the parking brake. The aircraft then rolled forward and its left engine cowling struck the airbridge.

History of the flight

The commander taxied the aircraft onto Stand 325, under the direction of the stand's parking guidance system. Upon observing a STOP message on the guidance system he set the aircraft's parking brake. After completing the aircraft's shutdown procedure he observed an OK message. Believing chocks were in place he released the parking brake.

Having observed the parking brake light illuminate, initially the ground crew placed a chock behind the aircraft's nose wheel. They then noticed the aircraft starting to move so quickly withdrew to a safe location. The commander heard "we are moving" so he "jumped" on the toe brakes and reset the parking brake.

At the time the commander was not aware the aircraft had hit anything. It was subsequently discovered that the front cowl of the left engine was damaged as a result of impacting the airbridge. There were no injuries.

The aircraft had rolled about 0.4m, measured by the stand guidance system.

Operator's message to crews

The operator sent the following message to all crews that operate to European destinations on 9 February 2015:

> *'Subject: Keep Parking Brake Set in Europe*
>
> *We are currently performing a European ground handler audit to ensure all vendors are aware of the requirement to provide a "Chock In" signal upon gate arrival after the chocks have been installed.*
>
> *Until this audit is completed, leave the parking brake set when arriving at the gate at all European stations.'*

Aircraft handling agent's procedures

Normal practice for the ground crew is to chock the rear of a wheel first, as the majority of aircraft stands at London Heathrow Airport have a gradient that slopes away from the terminal buildings.

Aircraft stand information

The surface of Stand 325 slopes towards the terminal building with a gradient of approximately 0.86%. When an OK message is indicated on the stand guidance system it indicates that the aircraft is parked in the correct position.

Commander's comments

The commander believed the incident was a result of the slope on the ramp and a "mix-up" with the airline's procedures and no chock signal procedure.

Discussion

Having observed an OK message and believing the chocks were in place the commander released the parking brake. This was contrary to an operator message to crews.

As the stand has a gradient down towards the terminal the aircraft started rolling until the left engine cowl came into contact with the airbridge and the commander applied the toe brakes.

INCIDENT

Aircraft Type and Registration:	Boeing 777-236, G-RAES
No & Type of Engines:	2 General Electric Co GE90-85B turbofan engines
Year of Manufacture:	1997 (Serial no: 27491)
Date & Time (UTC):	6 March 2015 at 1530 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 14 Passengers - 221
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	15,541 hours (of which 3,108 were on type) Last 90 days - 202 hours Last 28 days - 73 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional inquiries by the AAIB

Synopsis

The aircraft had taken off from London Heathrow Airport. During taxi, takeoff and initial climb, the crew felt unusually warm and noticed very low airflow from the flight deck vents. As the flight reached initial cruise level, all three crew members on the flight deck started to feel unwell and opened the cockpit door to improve ventilation. The decision was made to return to Heathrow with all three crew members on oxygen and the cockpit door closed.

An uneventful landing was carried out and it was found that debris in the conditioned air duct below the cockpit floor was almost completely blocking airflow to the flight deck. The source of the debris and how long it had been present could not be determined.

History of the flight

During taxi, takeoff and initial climb, the pilot and the two co-pilots noticed very low airflow from the various flight deck vents, and that the flight deck was becoming unusually warm but normal flight deck temperature control was having no effect. Passing 10,000 ft, they made a VHF radio call to MAINTROL (MAINTenance ConTROL) for technical support and any possible solutions to the airflow problem. Pressurisation and passenger cabin temperatures were normal; there were no EICAS (Engine Indicating and Crew Alerting System) or STATUS messages displayed and no smoke or fumes were detected.

All air conditioning pack, trim air and recirculation fan switches were cycled off/on one at a time and AIR COND RESET switch pressed, but the problem remained. As the flight continued at initial cruising level (FL 340), they began to feel slightly unwell. The symptoms included headache, nausea, light-headedness, a constant urge to take deep breaths and difficulty maintaining concentration. Each of the co-pilots made separate visits to the passenger cabin and noted an improvement in their condition whilst outside the flight deck. All the cabin crew felt normal. The crew reviewed the various unannunciated checklists, but none of them were relevant to their situation. A second call was made to MAINTROL with this new information, but they could not provide any solutions at that time. The crew decided to open the flight deck door temporarily in an attempt to lower the flight deck temperature and improve the air quality. They were also concerned that the cockpit electronics may not have been getting sufficient cooling due to the low airflow. Two cabin crew members were positioned by the open flight deck door at all times and the 'heavy' co-pilot remained on the flight deck for added security. In addition, the forward toilet was withdrawn from passenger use and the curtains drawn to prevent the passengers from seeing that the cockpit door was open.

The flight deck temperature reduced quite quickly, but the crew did not feel any noticeable improvement in their condition. Still feeling the symptoms, they decided that the operating co-pilot, who was Pilot Flying (PF), should don his oxygen mask and reduce the risk of any further pilot incapacitation. Within a few minutes he noted that most of his symptoms had disappeared. A third call was made to MAINTROL, but they still did not have any solutions other than what had already been tried. Their position was now north of Glasgow and they had been unable to resolve the situation.

With the flight deck door open and one pilot using his oxygen mask, they decided that they could not continue the flight. They planned to return to Heathrow with all three flight crew using their oxygen masks so that the flight deck door could be closed. A PAN PAN call was made to Air Traffic Control (ATC), with a request to jettison fuel and divert back to Heathrow. An immediate landing at the nearest suitable airport was considered, but they agreed that, with the use of oxygen masks and the flight deck door closed, the aircraft would be in a safe condition to return to its departure airport.

The commander then briefed the Cabin Service Director (CSD) using the company's "NITS" (Nature, Intention, Time, Special considerations) format. Once the cabin crew were briefed by the CSD, the pilot made an announcement to the passengers, informing them of their return to Heathrow. With these actions complete, the pilot and the heavy co-pilot donned their oxygen masks and the flight deck door was closed again for the remainder of the flight. The pilot believes the flight deck door had been open for a maximum of 15 to 20 minutes. With his oxygen mask on, he also noticed his symptoms were subsiding.

ATC vectored the aircraft out over the Irish Sea where approximately 28,000 kg of fuel was jettisoned and the flight continued on to Heathrow for a normal landing, during which the Airport Fire Service escorted the aircraft to the terminal as a precaution.

Engineering investigation

In normal operation, the Boeing 777 delivers air from the left air conditioning pack to the cockpit via two mufflers in the forward freight bay sidewall and thence into ducting feeding multiple outlets on the flight deck. There were no routine maintenance tasks to check the flight deck airflow although it was required to replace the recirculation air filters at every 'B' check (every 400 days). On G-RAES, this had last been done in September 2014.

The engineers tasked with investigating the crew reports of low airflow on G-RAES found that there was no airflow in the distribution ducting forward of panel P310 in the Main Equipment Centre underneath the flight deck. When the ducting was broken down for inspection a large amount of debris was found to be blocking the duct about 12 inches upstream from panel P310. The debris comprised wire, bubble wrap and insulation material. Further material was found in the general area when the ducting was borescoped and the blackened and brittle appearance of the debris suggested it had been there for some time.

A search of the technical records showed that, across the B777 fleet, pilot reports of low flight deck airflow existed but were sufficiently rare that it could be concluded that such problems were not endemic. The rectification actions had also been varied and it appeared that the only physical restriction found had been blocked filters.

However, on G-RAES there had been a pilot report of inadequate airflow from cockpit vents on 18 February 2015. Although it had been rectified by "cleaning restrictors", on 26 February another report was generated which complained of poor airflow through the flight deck vents and high temperatures. The recorded rectification action was that both flight deck temperature sensors were found contaminated and soiled and were causing the trim air valve to modulate to high temperatures. However, the engineer also added:

> *'Both sensors cleaned please report further, as this defect has history.'*

Two days later, on 28 February, a flight crew reported that:

> *'FYI, all puncalouvres (sic) valve in F/D have minimal airflow'*

The action taken was:

> *'Puncalouvres (sic) adjusted satis'*

The engineer involved later reported that he had found one of the punkah louvres to be misassembled.

Conclusion

The problems which afflicted the flight deck ventilation on G-RAES during February 2015 and led to the events on the incident flight were almost certainly caused by the migration of debris which had accumulated in the underfloor ducting from an unknown source at a time which could not be pinpointed.

The company's internal investigation identified two potential actions which could help prevent recurrences of a similar nature:

- Publicising the event throughout the airline to improve awareness
- Requesting the aircraft manufacturer clarify references in their Fault Isolation Manual (FIM) to airflow being 'satisfactory' or 'not satisfactory'.

ACCIDENT

Aircraft Type and Registration:	1) Cessna 182F Skylane, G-WARP 2) Grumman AA-5 Traveller, G-BBSA
No & Type of Engines:	1) 1 Continental Motors Corp O-470-R piston engine 2) 1 Lycoming O-320-E2G piston engine
Year of Manufacture:	1) 1963 (Serial no: 182-54633) 2) 1974 (Serial no: AA5-0472)
Date & Time (UTC):	12 June 2015 at 1626 hrs
Location:	Ronaldsway Airport, Isle of Man
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - 3 2) Crew - 1 Passengers - 1
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) G-WARP - Right wingtip and aileron severed 2) G-BBSA - Slight damage to propeller, engine shock-loaded
Commander's Licence:	1) Private Pilot's Licence 2) Private Pilot's Licence
Commander's Age:	1) 67 years 2) 67 years
Commander's Flying Experience:	1) 745 hours (of which 406 were on type) Last 90 days - 11 hours Last 28 days - 4 hours 2) 1,140 hours (of which 638 were on type) Last 90 days - 20 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilots

Synopsis

The outer section of the right wing and aileron on a taxing aircraft (G-WARP) struck the rotating propeller of a stationary aircraft (G-BBSA). The occupants of both aircraft were uninjured.

History of the flight

The Senior Air Traffic Control Officer at Ronaldsway Airport reported that it was Race Day on the Isle of Man, there were a large number of aircraft movements and Taxiway D had been reclassified as an apron with approximately 70 light aircraft parked on the grass either side of this taxiway. All aircraft were required to obtain clearance to taxi, but only aircraft conducting IFR flights were require to obtain clearance to start their engines.

Both G-WARP and G-BBSA had been parked on the grass on the north side of Taxiway D. The pilot of G-BBSA reported that due to the uneven surface he was concerned at taxiing on the grass and had been advised by the ground staff, several days earlier, to pull the aircraft onto the taxiway before he started his engine.

Just prior to the accident, the pilot of G-BBSA pulled the aircraft forward until the nosewheel was on the taxiway and the mainwheels were on the edge of the taxiway, Figure 1. He then started the engine and waited for an opportunity to contact the Tower on the radio to request taxi and departure clearance. He heard an aircraft being given taxi and departure clearance and watched G-WARP as it taxied along Taxiway D, which had been reclassified as an apron, towards him. Initially he thought the right wing on G-WARP would clear his aircraft, but at the last moment realised that it would hit his propeller and therefore attempted to shut the engine down. However the outer section of the wing struck his propeller while the engine was rotating at approximately 1,000 rpm.

Figure 1

Position of G-BBSA and G-WARP after the collision
(Photograph courtesy Ronaldsway Airport)

The pilot of G-WARP reported that he was aware of an aircraft with an engine running parked on the left side of the taxiway and G-BBSA, which had its nosewheel on the taxiway, parked on the right side of the taxiway. He positioned his aircraft two metres to the left of the centre line and judged that there was sufficient room for him to clear the aircraft on both sides of the taxiway. The pilot of G-WARP reported that the engine on G-BBSA was not running as his cabin passed the other aircraft.

The occupants of both aircraft were uninjured. Approximately 0.3 m of the outer section of the right wing and aileron on G-WARP had been severed. The propeller on G-BBSA sustained some slight damage and the engine was suspected of having been shock-loaded.

SERIOUS INCIDENT

Aircraft Type and Registration:	Cessna F172E Skyhawk, G-ASNW
No & Type of Engines:	1 Continental Motors Corp O-300-D piston engine
Year of Manufacture:	1964 (Serial no: 31)
Date & Time (UTC):	27 March 2015 at 1100 hrs
Location:	Draycot Aerodrome, Wiltshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Propeller and tow bar
Commander's Licence:	Light Aircraft Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	369 hours (of which 180 were on type) Last 90 days - 2 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reports that he conducted his pre-flight check of the aircraft in the barn where the aircraft is stored. He then pulled the aircraft out of the barn, started the engine, taxied approximately 150 yards to the runway and conducted his before takeoff checks. He then flew two uneventful circuits.

Sometime after landing, the pilot was shown some pieces of metal which had been found on the grass runway; he recognised the metal as having been a part of the aircraft towbar. A subsequent inspection of his aircraft revealed damage to the propeller, consistent with it having struck the towbar.

The pilot considered the most likely reason for him to have inadvertently left the towbar attached to the aircraft was that he conducted the walkaround inspection in the barn, and after pulling the aircraft out was distracted by another task prior to flight.

The pilot's report highlights the importance of checking around the aircraft immediately before any flight.

ACCIDENT

Aircraft Type and Registration:	Cessna U206G Stationair, G-CCSN
No & Type of Engines:	1 Continental Motors Corp IO-520-F piston engine
Year of Manufacture:	1978 (Serial no: U206-04224)
Date & Time (UTC):	13 May 2015 at 1025 hrs
Location:	Strathallan Airfield, Perthshire
Type of Flight:	Aerial work
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	778 hours (of which approximately 600 were on type) Last 90 days - 30 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional enquiries by the AAIB

The aircraft was late downwind, to land, when the engine stopped. The pilot checked the engine controls, including the magneto switches and fuel selector, but saw nothing amiss. He continued with a glide approach, selected flaps back to UP and turned onto the runway heading. Unfortunately, he was unable to reach the airfield and landed heavily in the field before it, detaching the nose landing gear and breaking the rear fuselage. One passenger sustained a minor injury.

The operator of G-CCSN witnessed the accident and quickly attended the scene. In the presence of another witness, he removed the fuel caps and dipped his fingers in to verify the presence of fuel, estimating that both tanks were about ½ to ¾ full. He then took fuel samples and checked for obvious anomalies, finding none. He checked for the presence of fuel in the injection system and found a normal amount, so he decided to run the engine. After recovery, the damaged propeller blades were cropped, the battery reconnected and the engine started, running quite smoothly, despite the lack of propeller blades.

At the time of preparation of this Bulletin, there is no obvious reason for the engine failure.

ACCIDENT

Aircraft Type and Registration:	Glastar, G-GERY	
No & Type of Engines:	1 Lycoming O-320-E2D piston engine	
Year of Manufacture:	2002 (Serial no: PFA 295-13475)	
Date & Time (UTC):	21 March 2015 at 1100 hrs	
Location:	Hollym Airfield, Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to fuselage, wings, tailplane; engine shock-loaded	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	72 years	
Commander's Flying Experience:	1,641 hours (of which 826 were on type) Last 90 days - 11 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was planning to depart from Runway 32 grass, which is 570 m long. The wind was from 340° at 16 kt with occasional gusts. The pilot observed a Cessna 172 departing from this runway and although it "looked a little bumpy" he judged it safe to take off in G-GERY. The takeoff ground roll was normal and once airborne he remained low, to accelerate. He initiated a turn to the right but the aircraft suddenly rolled to the left and applying right stick and right rudder had no effect. The left wing tip struck the ground and the aircraft yawed to the left; the nose dropped and the aircraft hit the ground. It then swung round to the left and came to rest. The pilot shut down the fuel and electrical systems and then exited with his passenger, via the passenger door as the pilot's door was jammed. The pilot later assessed that the accident had been caused by a stronger than expected gust from the right.

ACCIDENT

Aircraft Type and Registration:	Luscombe 8A Silvaire, G-BVGW
No & Type of Engines:	1 Continental Motors Corp A65-8 piston engine
Year of Manufacture:	1947 (Serial no: 4823)
Date & Time (UTC):	22 March 2015 at 1530 hrs
Location:	Shifnal Airfield, near Telford, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to outboard left wing, fuselage panels, windscreen and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	493 hours (of which 249 were on type) Last 90 days - 24 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot was flying a third approach to an unfamiliar airfield, having had to go-around from two earlier approaches. As the pilot manoeuvred the aircraft onto final approach it appeared to be close to the point of stalling. The left wing then dropped suddenly and the aircraft struck the ground. It came to rest in an upright attitude and the pilot was able to make the aircraft safe before vacating.

History of the flight

The pilot flew the aircraft from Abbots Bromley Airfield where it was based, to Shifnal Airfield near Telford, a direct distance of about 20 nm. The weather was fine, with a light and variable wind, good visibility and no low cloud. All pre-flight preparations and checks had been normal, and the pilot had flown a short local flight at Abbots Bromley before landing and telephoning Shifnal to book his visit.

On arrival overhead Shifnal, the wind, although light, was seen to favour Runway 10, a grass runway 445 m long. The circuit height for all runways was 500 ft. From published information the pilot was aware that power lines, 30 ft agl, crossed the approach to Runway 10, but as he neared the runway he found it difficult to discern them amongst the adjacent trees (measured using satellite imagery, the power lines were approximately 120 m short of the runway threshold). The trees also blocked his view of the runway. Once the aircraft had cleared the power lines and the pilot could see the runway, he side-slipped the aircraft at idle throttle to lose height, mindful of the runway length, the light wind and the fact that the aircraft was not equipped with wing flaps. However, with the aircraft already at a relatively low airspeed of 50 kt, a high rate of descent developed quickly and the aircraft contacted the ground harder than intended. It bounced, and the pilot applied power and flew a go-around.

The pilot flew a second approach, and again did not see the runway until very late, but on this occasion was too far displaced from it to continue the approach so again flew a go-around and opted to fly a right hand circuit. As he turned the aircraft onto base leg, the pilot was aware of its controls becoming less responsive and realised it was close to stalling. He lowered the nose and applied some power, but this did not improve the situation. The aircraft's left wing dropped suddenly and the aircraft impacted the ground soon after.

The aircraft came to rest in an upright attitude. The pilot, who suffered only bruising, was able to make the aircraft switches safe before vacating through the door, which had partially opened. He observed that the aircraft's normally docile flight characteristics had probably given him the false impression that it would always be so forgiving.

AAIB comment

Visual circuits are typically flown at about 1,000 ft agl, and the pilot was used to flying at this height. Unless pilots are used to flying from an airfield which has a permanently lower circuit height (as at Shifnal), the challenges of flying a low level or 'bad weather' circuit may not be readily apparent. One problem may be in maintaining visual contact with the runway environment, particularly if the pilot is tempted to start descending at a normal descent point rather than maintaining height until intercepting the normal approach path. The pilot's account of achieving very late visual contact with the runway suggests that this may have happened in this case. It is also likely that the aircraft's left wing stalled, the wing drop probably being due to the use of ailerons at about the point of stall.

ACCIDENT

Aircraft Type and Registration:	Skyraider Aviation Phantom, G-MJTZ
No & Type of Engines:	1 Rotax 462 piston engine
Year of Manufacture:	1983 (Serial no: MBS-01)
Date & Time (UTC):	21 June 2015 at 0810 hrs
Location:	Approximately 2 nm southeast of Newport, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 Passengers - N/A
Nature of Damage:	Nosewheel and left mainwheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	372 hours (of which 102 were on type) Last 90 days - 7 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft departed from Sandown Airport, Isle of Wight, on a planned flight to Defford Airfield. After climbing to an altitude of 1,900 ft, the engine failed. The pilot made a successful forced landing in a grass field approximately 2 nm southeast of Newport, Isle of Wight, but during the landing roll the aircraft encountered uneven ground that was obscured by long grass and the aircraft sustained damage to the nosewheel and left mainwheel. The pilot was uninjured. He reported that during the post-flight examination of the engine, fuel was present in the fuel tank and the carburetor float bowl but when the spark plugs were removed, the rear plug was found soaked with unburned fuel. This indicated a failure of the rear cylinder's ignition system.

SERIOUS INCIDENT

Aircraft Type and Registration:	XA42, G-XTME
No & Type of Engines:	1 Lycoming AEIO-580-B1A piston engine
Year of Manufacture:	2011 (Serial no: 110)
Date & Time (UTC):	10 June 2015 at 0915 hrs
Location:	White Waltham Airfield, Berkshire
Type of Flight:	Aerial work
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Canopy destroyed and minor damage to stabilisers
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	7,264 hours (of which 82 were on type) Last 90 days - 65 hours Last 28 days - 24 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Shortly after takeoff from Runway 03 at White Waltham Airfield, passing 400 ft agl, the one piece bubble canopy opened and was torn off by the slipstream. The pilot flew a modified circuit and landed on Runway 07 without further incident. Neither occupant was injured. The canopy was recovered from the airfield, but had been destroyed.

Both occupants of the aircraft believed, before takeoff, that the canopy was closed. However, the pilot considered that the canopy opened in flight because it was not properly secured, despite appearances. He reported that he would be conducting more robust canopy security checks in the future.

ACCIDENT

Aircraft Type and Registration:	Flight Design CT2K, G-CCNG
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2003 (Serial no: 8004)
Date & Time (UTC):	23 May 2015 at 1300 hrs
Location:	North Coates Airfield, Lincolnshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left main and nose landing gear and collapsed, damage to wingtips, firewall, engine frame and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	1,343 hours (of which 93 were on type) Last 90 days - 9 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on Runway 05 at North Coates Airfield. The pilot described the approach and weather conditions, with a light crosswind from the right, as "satisfactory". However, on touchdown the aircraft bounced and began to drift to the left, so he applied power to go around. The left wing then dropped and the aircraft struck the ground, causing damage to the landing gear, wingtips, propeller and engine mount.

The pilot believes he may have applied rudder in the wrong sense when trying to correct the drift and wing drop.

ACCIDENT

Aircraft Type and Registration:	Fournier RF4D, G-BHJN
No & Type of Engines:	1 Rectimo 4AR-1200 piston engine
Year of Manufacture:	1967 (Serial no: 4021)
Date & Time (UTC):	17 April 2015 at 1800 hrs
Location:	Enstone Airfield, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Landing gear mounting destroyed, damage to wing, fuselage and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	241 hours (of which 67 were on type) Last 90 days - 4 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was returning to Enstone after a 15 minute local flight. The pilot reports that the north-easterly wind had increased in strength since he had taken off and the turbulence caused by trees on the northern perimeter of the airfield was "the worst he had encountered". After two go-arounds, he again attempted to land, applying full spoiler at about 100 ft. However, as he flared, the stall warning light illuminated and the aircraft landed heavily and bounced, breaking away the landing gear monowheel and both propeller blades before skidding to a halt. The pilot switched off the engine, which was still running, before vacating the aircraft.

The pilot believes that the turbulence and his failure to execute a go-around after the bounce were responsible for the accident.

ACCIDENT

Aircraft Type and Registration:	Kolb Twinstar MkIII Twinstar, G-MZGJ
No & Type of Engines:	1 Rotax 582/48 piston engine
Year of Manufacture:	1998 (Serial no: PFA 205-12421)
Date & Time (UTC):	10 March 2015 at 1402 hrs
Location:	Otherton, Penkridge, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Airframe structure buckled, left landing gear damaged, nose cone cracked and left wing internal structure damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	27 years
Commander's Flying Experience:	153 hours (of which 4 were on type) Last 90 days - 2 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further inquiries by the AAIB

Following departure from Runway 25 at Otherton Airfield, the pilot encountered a control restriction in pitch during a shallow left turn at approximately 450 ft. The aircraft began to descend and altitude could not be maintained. The pilot initiated a forced landing but during the latter stages of the approach, the left wheel struck a wooden post, yawing the aircraft to the left. The left leg dug into the ground and the aircraft slewed to the left before skidding to rest after approximately 15 metres. The pilot and passenger were uninjured.

The pilot reported that he had performed a control check prior to takeoff, with no anomalies, and that the restriction was no longer apparent after the forced landing. The aircraft was examined by the Light Aircraft Association (LAA), who concluded that the control restriction was probably caused by excess slack in the elevator control cables allowing contact with the tail boom. Bulky clothing may have exacerbated the effect by pushing a turnbuckle into the side of the boom, thereby causing a temporary restriction.

The LAA advise they will write to UK-registered Twinstar owners, reminding them of the importance of maintaining correct cable tensions and the risk of clothing impinging on controls. They also intend to increase general awareness by discussing this occurrence in their publication, '*Light Aviation*'.

ACCIDENT

Aircraft Type and Registration:	Montgomerie-Bensen B8MR, G-CBNX
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2002 (Serial no: PFA G/01A-1345)
Date & Time (UTC):	4 May 2015 at 1200 hrs
Location:	Private airstrip, Reading, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Rotorblades, nosewheel fork and nose cone damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	442 hours (of which 263 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot commenced his takeoff roll on a grass runway and everything was normal until the point of rotation, when he reported that a sudden gust of wind pushed the aircraft sideways. He decided to abort the takeoff but there was insufficient runway remaining and the aircraft struck a hedge before coming to rest. The pilot was uninjured but the aircraft sustained damage.

ACCIDENT

Aircraft Type and Registration:	Rans S6-ES Coyote II, G-TIVS	
No & Type of Engines:	1 Rotax 582-48 piston engine	
Year of Manufacture:	2004 (Serial no: PFA 204-14236)	
Date & Time (UTC):	13 April 2015 at 1640 hrs	
Location:	Staple Lawns Farm, Corfe, Somerset	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Substantial	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	205 hours (of which 30 were on type) Last 90 days - 1 hour Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was flying from Tracy Island, Chard, to Dunkeswell at approximately 1,800 ft amsl. Approaching Corfe the weather conditions deteriorated, with visible moisture and cloud ahead. The pilot reduced power to descend below the cloud and shortly afterwards the engine failed. He reported that he turned the aircraft directly towards the only field he considered suitable for a forced landing. He then realised, late on the approach, that he was now too high to reach this field. He turned the aircraft steeply to lose height and avoid obstacles but lost more height than he anticipated. He considered that the aircraft was now too low. He levelled the wings but was unable to prevent the aircraft landing heavily on its nose in an unsuitable field. The nose wheel collapsed and the aircraft suffered substantial damage. The pilot and his passenger were uninjured and vacated the aircraft normally.

The pilot thought the cause of the engine failure was carburettor icing, following which he misjudged the forced landing and did not reach the only suitable field.

Miscellaneous

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

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

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

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.

1/2014 Airbus A330-343, G-VSXY
at London Gatwick Airport
on 16 April 2012.

Published February 2014.

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

Published June 2014.

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

Published September 2014.

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

Published July 2015.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

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

Air Accidents Investigation Branch