CONTENTS

SPECIAL BULLETINS

None

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

None

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-131, G-EUPO
No & Type of Engines:	2 International Aero Engine V2522-A5 turbofan engines
Year of Manufacture:	2000 (Serial No: 1279)
Date & Time (UTC):	17 December 2010 at 1320 hrs
Location:	On approach to London Heathrow
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 122
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	16,080 hours (of which 1,221 were on type) Last 90 days - 208 hours Last 28 days - 58 hours
Information Source:	Field Investigation

Synopsis

On approach to London Heathrow Airport, in IMC and icing conditions, there was a loss of communication between the Probe Heat Computers (PHC) and the Centralised Fault Display System (CFDS). The associated Electronic Centralized Aircraft Monitoring (ECAM) actions required the crew to select ADR3 as the data source for the commander's instruments.

Later, on final approach to Runway 27L, the aircraft suffered a loss of displayed airspeed information on both the commander's and the standby flight instruments. The crew carried out a go-around using the *'Unreliable Speed Indication'* procedure from the Quick Reference Handbook (QRH).

The investigation concluded that the loss of displayed airspeed information resulted from a combination of:

- a loss of communication between the Probe Heat Computers (PHC) and the Centralised Fault Display System (CFDS),
- icing of the standby pitot probe resulting in the loss of indicated airspeed displayed on the commander's and standby instruments.

One Safety Recommendation was made.

History of the flight

The incident occurred during a flight from Geneva to London Heathrow Airport. Prior to despatch there were two outstanding Minimum Equipment List (MEL) items, the forward cargo hold was unusable and the APU was unserviceable. Prior to starting the engines at Geneva a VENT AVNCS SYS FAULT[1] caution message appeared on the Electronic Centralized Aircraft Monitoring (ECAM) screen, which was cleared by resetting the circuit breakers in accordance with the Quick Reference Handbook (QRH) procedure. During the initial part of the climb a CAB PR SYS 1 FAULT[2] caution appeared on the ECAM screen. The crew discussed the possible consequence of a subsequent cabin system 2 pressure failure, and continued the flight to Heathrow.

The aircraft was being flown by the co-pilot with the autopilot and autothrust engaged. During the descent the flight was routed to the 'BIG' VOR and then was given radar vectors towards the final approach for Runway 27L. The route from BIG was conducted in IMC and icing conditions. Engine anti-ice was selected ON, and wing ice was selected ON when accretions of ice were seen by the flight crew on the visual ice indicator. During this stage of flight the ANTI ICE CAPT R STAT[3] and ANTI ICE CAPT TAT[4] caution messages displayed on the ECAM. The crew carried out the ECAM actions which were to set the Air Data selector switch to the CAPT 3 position and select the Probe Heat to ON. The standby (stby) ASI was cross-checked with the speed indications on the Primary Flying Displays (PFD) and, as they were in agreement, the crew continued with the approach[5].

Footnotes

[1] Fault in the ventilation system in the avionics bay.
[2] Fault on one of the two cabin pressurisation systems.
[3] Fault on the anti-icing on the Captain's right static probe.
[4] Fault on the anti-icing on the Captain's Total Air Temperature probe.
[5] In this configuration the PFD and standby indications are from the same source, ADIRU 3.

Seven minutes later, with the aircraft descending through 7,000 ft amsl, an ANTI ICE STBY R STAT[6] caution message appeared on the ECAM. Because of the number of messages received relating to anti-icing, the crew decided, as a precaution, to review the QRH procedure for unreliable speed.

On final approach, just as the co-pilot (now acting as PNF) had started to review the procedure, the commander's indicated airspeed showed a reduction to VLS (lowest selectable speed). Up to this point the target airspeed on the PFD had been generated by the Flight Management and Guidance System (FMGS), but in response the commander selected speed on the Flight Control Unit (FCU) and increased the target speed in an attempt to increase airspeed. However, the indicated airspeed continued to decay rapidly to around 50 - 60 KIAS and the stby ASI indication simultaneously fell to 0 KIAS.

The commander announced "UNRELIABLE AIRSPEED" and called for a go-around. The aircraft was in IMC at 800 ft aal and configured for landing with flap FULL when the co-pilot initiated the go-around. He disconnected the autopilot and autothrust, selected TOGA thrust and flew the target pitch attitude of 15° nose up. (Figure 5). The flaps remained at full in accordance with the memory items for the QRH UNRELIABLE SPEED INDIC/ADR CHECK procedure, retraction of the landing gear was not completed until the aircraft had climbed to 4,000 ft. The commander declared a MAYDAY to ATC and advised that the aircraft was going around and would climb straight ahead.

The aircraft climbed on the runway heading, until safely above the Minimum Safe Altitude (MSA), and

Footnote

[6] Fault on the anti-icing on the right standby static probe.

was then levelled at 4,000 ft amsl, using the pitch and power settings obtained from the QRH UNRELIABLE SPEED INDIC/ADR CHECK procedure. The aircraft was given a radar vector to turn onto a northerly heading and climbed to 5,000 ft, which took it clear of the icing conditions. The crew then continued with the QRH procedure, diagnosed the failure by cross-checking the displayed airspeed indications and altitude against the GPS data, and determined that ADR 2 was the only source of reliable air data.[7] In accordance with the QRH actions for one reliable ADR, the crew turned ADR 1 and 3 OFF. The aircraft was now in Alternate Law and the Flight Path Vector function was used to aid the flying of the aircraft.

A squawk of 7700 was issued by ATC. The crew reviewed the weather conditions, and their options, and decided to divert to Luton Airport where the weather was better and the aircraft could remain clear of icing conditions. The landing was made on Runway 26 in Direct Law with the flaps set at configuration 3. After the aircraft was brought to a halt on the runway, one of the inoperative systems messages displayed on the ECAM status page was NW STRG[8]. The commander requested that the aircraft be towed to a stand because of the possible difficulty of manoeuvring without nosewheel steering on a surface which might be icy.

Meteorological information

The weather at London Heathrow Airport was reported as a surface wind from 290º at 11 kt, scattered cloud at 600 ft, broken cloud at 2,400 ft, heavy snow showers, visibility of 900 m, temperature -1°C, dew point - 4°C, and QNH of 997 HPa.

The crew reported heavy cloud cover and sub-zero temperatures along much of the route between BIG and Heathrow Airport. They observed accumulations of rime ice and clear ice on the external visual ice indicator at various times during the flight.

Post-Flight Report

The Post-Flight Report (PFR) for the incident flight provided the following ECAM warning and failure messages shown in Tables 1 and 2.

System information

Electronic Instrument System

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

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

Centralised Fault Display System

The Centralised Fault Display System (CFDS) provides a central maintenance aid which allows maintenance information to be extracted as well as system, and sub-system, BITE tests to be initiated from the cockpit.

Footnotes

7 The Air Data selector switch was selected to the CAPT 3 position thus the ADR1 data was not displayed.

8 The NW STRG message appeared on the ECAM as a result of ADIRU 1 and 3 having been turned OFF. Above 260 kt ADIRU 1 and 3 close the Green hydraulic safety valve which powers the nose wheel steering. With ADIRU 1 and 3 turned OFF the hydraulic safety valve would have remained closed and hydraulic power would not have been available for nose wheel steering.

ECAM Warning Messages			
Time	Flight Phase	Message	
11:26	2[1]	VENT AVNCS SYS FAULT	
11:45	5[2]	CAB PR SYS1 FAULT	
12:55	6[3]	ANTI ICE CAPT TAT	
12:55	6	ANTI ICE CAPT R STAT	
13:02	6	ANTI ICE STBY R STAT	
13:08	6	MAINTENANCE STATUS F/CTL	
13:09	6	NAV IAS DISCREPANCY	
13:09	6	AUTO FLT A/THR OFF	
13:19	6	F/CTL ALTN LAW	
13:19	6	NAV ADR 1 FAULT	
13:19	6	AUTO FLT RUD TRV LIM1	
13:19	6	SFCS	
13;19	6	NAV ADR 1 – 3 FAULT	
13:33	6	F/CTL DIRECT LAW	
13:33	8[4]	F/CTL ALTN LAW	

Table 1

Failure Messages				
Time	Flight Phase	Message	Source	Ident
11:23	2	MCDU3(3CA3)/ATSU1(1TX1)	ACARS MU	
11:45	5	PRESS CONTR 1	CPC 1	
12:55	6	NO PHC 1 DATA	CFDS	
13:01	6	NO PHC 3 DATA	CFDS	
13:08	6	AIR3	EFCS 2	EFCS 1 / AFS
13:09	7[5]	SEC 3 OR BUS 2 FROM ADR 2	EFCS 2	EFCS 1
13:10	6	DMC 1: NO ADC 3 DATA	EIS 1	EIS 3
13:15	6	NO ADR 1 DATA	CFDS	Various systems
13:19	6	DMC 1: NO FAC 1 DATA	EIS 1	EIS 3
13:19	6	ATC1 (1SHID) / TCAS (1SG)	TCAS	
13:19	6	DMC 2: NO TCAS DATA	EIS 2	EIS 1 EIS 3
13:24	6	NO DATA FROM ADIRS	TEMP CTL	
13:25	6	DMC 3: NO ADC1 DATA	EIS 3	EIS 1

Table 2

Table 1 Footnotes

1 Flight phase 2 - On the ground, first engine to achieve takeoff power.
2 Flight phase 5 - Takeoff and climb to 1,500 ft.
3 Flight phase 6 - End of phase 5 until aircraft descends below 800 ft.
4 Flight phase 8 - Touchdown to 80 ft.

Table 2 Footnotes

5 Flight phase 7 - Below 800 ft to touchdown.

It comprises a Centralized Fault Display Interface Unit (CFDIU), which receives data from other aircraft systems BITE. The CFDIU is accessed from two Multipurpose Control and Display Units (MCDU) located in the cockpit, which can be used to initiate tests and to call up other reports such as the Post-Flight Report (PFR).

Air Data and Inertial Reference System

The Air Data and Inertial Reference System (ADIRS) supplies temperature, anemometric, barometric and inertial parameters to the PFD and ND as well as various other systems. The ADIRS includes three identical Air Data and Inertial Reference Units (ADIRU) each of which has two parts: the Air Data Reference (ADR) and the Inertial Reference (IR). The ADR supplies barometric altitude, airspeed, mach, angle of attack, temperature and overspeed warnings. An ADIRS panel, located in the cockpit, allows the crew to select the mode for each ADIRU and provides information on the status of the IR and ADR systems. The normal procedure is for all three ADIRU to be selected on during flight with ADIRU 1 providing information to the Captain's[9] (Capt) instruments, ADIRU 2 providing information to the First Officer's[10] (F/O) instruments. In the event of a failure of ADIRU 1 or 2, ADIRU 3 can be selected to provide information to either the Capt or the F/O instruments. In normal operation, all three ADIRU constantly provide air data to a number of systems including flight guidance, autoflight and autothrust.

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

Probe heat computers

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

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

Flight control laws

The fly-by wire flying control system can operate in Normal Law, Alternate Law or Direct Law. In Normal Law the system automatically protects the aircraft throughout the flight envelope for load factor limitation,

Footnotes

9 In Airbus documentation the Captain refers to the left side.
10 In Airbus documentation the First Officer refers to the right side.

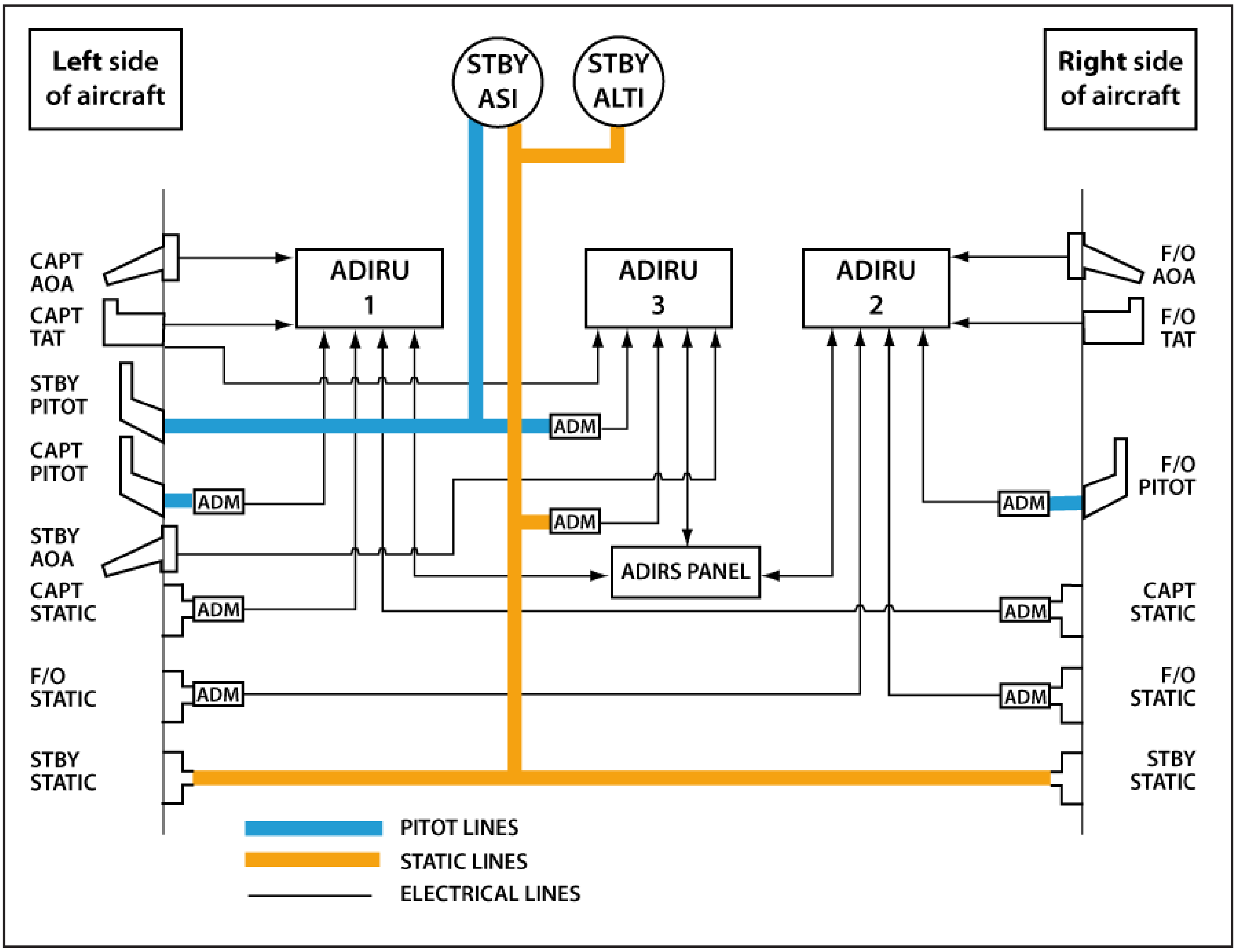

Figure 1

Air data system

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

Cabin pressure control and monitoring system

The Cabin Pressure Control and Monitoring System (CPCS) controls the pressure within the fuselage either automatically or manually by the flight crew. The system has two, independent and automatic systems that contain a Cabin Pressure Controller (CPC), which controls the cabin pressure through an outflow valve. With the CPCS in automatic mode, the FMGS provides the destination QNH and the landing elevation to the CPC, while the ADIRU provides the pressure altitude. During any flight, one CPC is in active mode and the other is in standby mode. When CPC 1 is active it uses data from the ADIRS in the priority ADIRU 1, ADIRU 2 and ADIRU 3. If the active CPC detects a fault it switches to standby and the remaining CPC takes over active control. A warning is then sent to the ECAM EW/D via the SDAC and FWC. The BITE message is retained in the CPC and can be viewed on

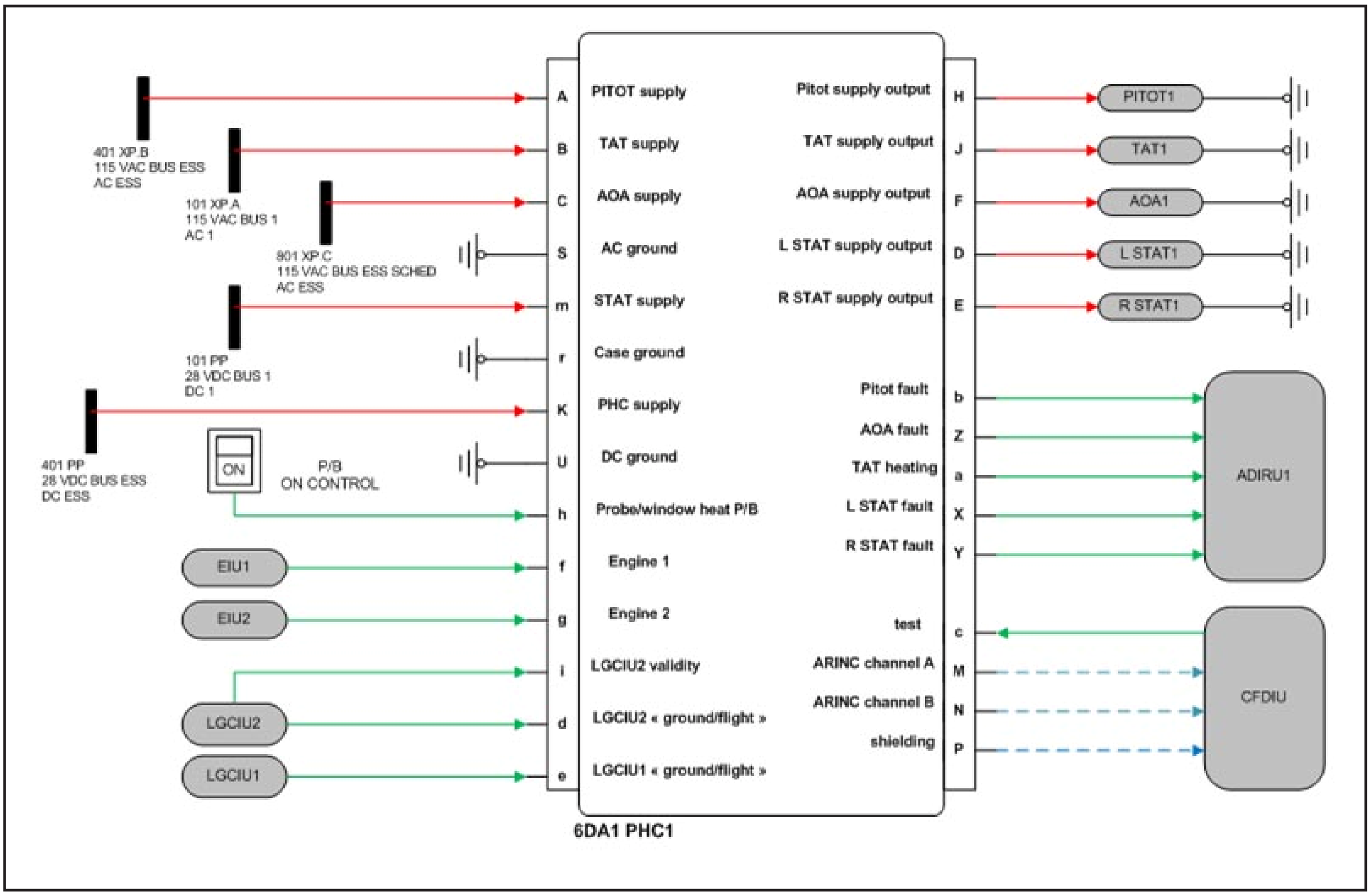

Figure 2

PHC, input and output signals

the MCDU via the CFDIU. The failure message PRESS CONTR 1 means that that there is a fault in CPC 1.

Flight recorders

Introduction

The aircraft was equipped with a 25-hour duration Digital Flight Data Recorder (DFDR), a 120-minute Cockpit Voice Recorder (CVR)[11] and a Digital AIDS Recorder (DAR). The DAR is part of the Aircraft Integrated Data System (AIDS), and had been configured by the operator to record airspeed and altitude parameters from ADIRU 1, ADIRU 2 and ADIRU 3 (the DFDR records airspeed and altitude from only one ADIRU source at any one time). The CVR records four channels of audio and is located at the rear of the aircraft. On G-EUPO, three of the audio channels are connected to the audio management system, for the recording of radio transmissions, cabin announcements and audio from the commander's and first officer's microphones. The fourth audio channel is connected to a Cockpit Area Microphone (CAM), which is located at the front of the overhead panel. The CAM signal is pre-amplified before being provided to the CVR, with the pre-amplifier located above and to the right of the overhead panel. All four channels are provided to the CVR as analogue signals, which are electrically routed the length of the aircraft.

DFDR and DAR data was available for the entire incident flight, with the CVR record commencing at

Footnote

[11] Honeywell manufactured solid state memory CVR, part number 980-6022-001.

1214 hrs and ending shortly after the aircraft had been shut down at Luton Airport. Salient parameters during the approach into London Heathrow and the landing at Luton are contained in Figure 3.

Abnormal sound pulses on CVR Cockpit Area Microphone (CAM) channel

The CVR CAM record was found to contain four periods where brief[12], abnormal sound pulses had been recorded. The same sounds were not present on the other channels, and the flight crew had not referred to hearing any unusual sounds during the flight. The pulses occurred at varying rates, from between five times per second to just less than once every three seconds, and were consistent in generating high amplitude broadband sound pulses. The CVR manufacturer was consulted regarding the serviceability of the unit; no defects were identified.

The sound pulses first occurred at 1255:21 hrs. Thirty four seconds later, at 1255:55 hrs, the ECAM message ANTI ICE CAPT TAT and ANTI ICE CAPT R STAT appeared. Within the minute of 1255 hrs, the CFDS failure message NO PHC 1 DATA was also recorded. The pulses then ended at 1256:40 hrs. The second occurrence started at 1258:17 hrs and ended at 1258:29 hrs, during which the wing anti-ice was selected ON. At 1258:50 hrs the sound re-occurred over a period of two seconds before the fourth and final occurrence which commenced at 1300:20 hrs and ended at 1302:16 hrs. During this period, the CFDS failure message NO PHC 3 DATA was recorded at 1301 hrs, and at 1302:05 hrs, an ECAM message ANTI ICE STBY R STAT appeared. Almost immediately before the ECAM message appeared, the flight crew selected the wing anti-ice to OFF.

The AAIB had not observed a sound having the same characteristics before. To aid in its identification, a sample audio clip was provided to the aircraft manufacturer, Bureau d'Enquetes et d'Analyses Pour la Securité de l'Aviation Civile (BEA) and the CVR manufacturer.

The aircraft manufacturer advised that it had not previously heard such a sound before. The BEA compared the sounds with CVR records from other aircraft, which had experienced atmospheric static discharges. However, the characteristics of the pulses were found to be different, with sounds induced onto the CVR being much more variable in amplitude.

The CVR manufacturer advised that it had recently been notified of a "popping" sound appearing on the CAM channel of a CVR equipped to a different aircraft type. The CVR manufacturer had tested both the same model of CVR equipped to G-EUPO and its latest CVR model. Under laboratory conditions, it was confirmed that this CVR's CAM microphone and associated control panel, which contained the CAM pre-amplifier, were all working correctly. However, by applying an Electrostatic Discharge (ESD) to the connector of the CAM control panel, the "popping" sound could be replicated on the CVR. The CVR manufacturer applied similar discharges to the wiring harness, but were unable to replicate the sound. Specific details were not available, although a faulty unit, which was located near to the CAM on the other aircraft type, was found to have been causing electrical interference. The CVR manufacturer's opinion was that the sounds produced on G-EUPO's CAM channel during the incident flight were a consequence of electrical interference.

In November 2011, the operator performed a download of the CVR equipped to G-EUPO. The record was checked and no abnormal sounds were identified.

The source, or sources, of the sound pulses during the incident flight could not be identified.

Footnote

12 The sound pulse duration was less than 50 milliseconds.

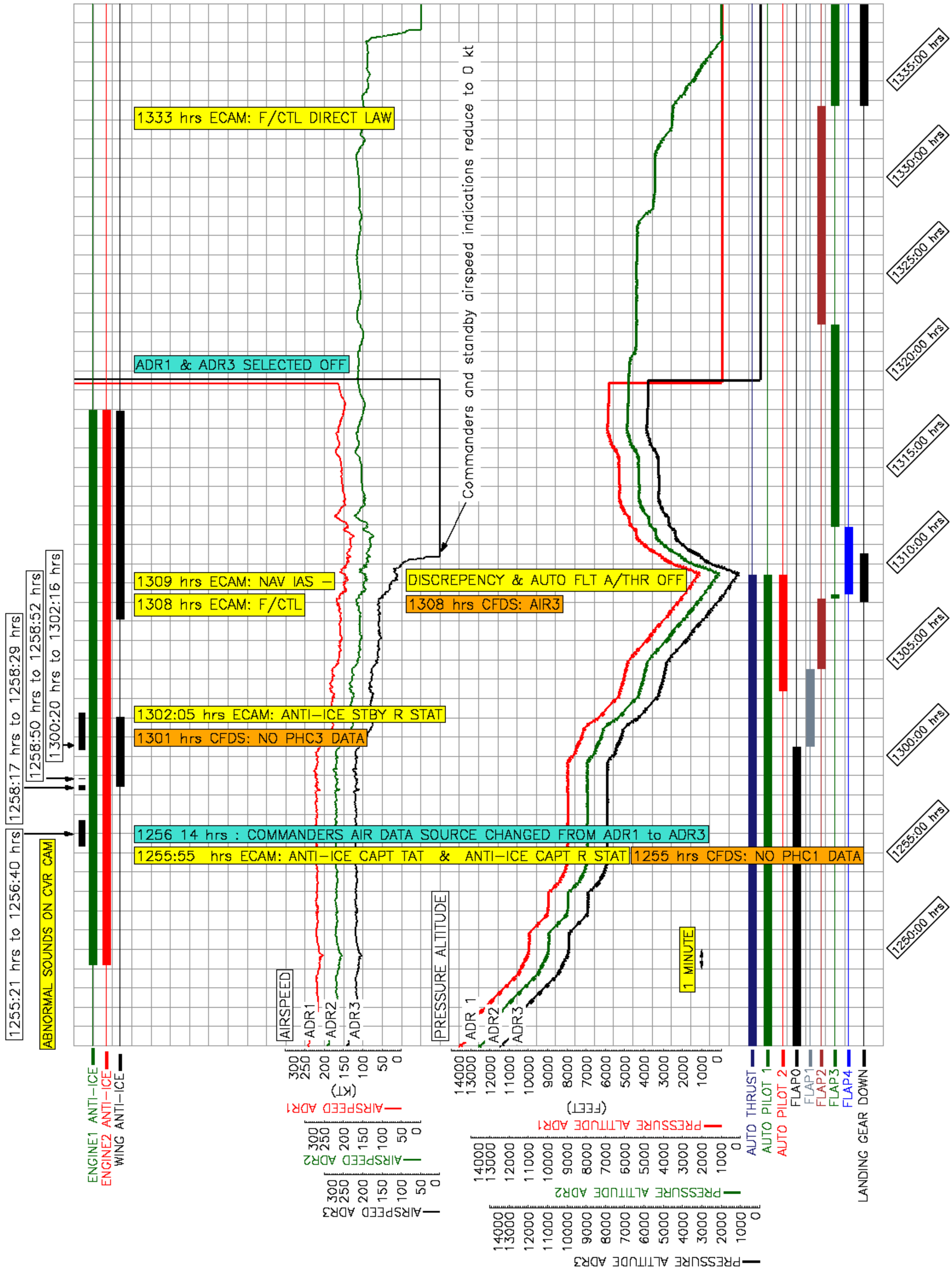

Figure 3

Approach to London Heathrow and landing at Luton Airport

Maintenance actions

Following the incident, the operator, in consultation with the aircraft manufacturer, undertook an extensive examination and testing of the air data system that included the following:

- A BITE test was run, from the CFDS, on CPC 1 prior to resetting it by operating the power supply CB. No BITE messages were present and no faults were identified.
- A BITE test was run from the CFDS on ADR1. No BITE messages were present and no faults were identified.
- The BITE messages on PHC 1 and PHC 3 were checked from the CFDS prior to a BITE test being run. There were no BITE messages on either PHC, and no faults were detected during the test nor any difficulties experienced with the communication between the PHCs and the CFDIU. All these checks were carried out prior to any change of the status of the LGCIU.
- All the probe and AOA sensors were visually inspected which found to be serviceable. All the drain holes were found to be clear of any restrictions.
- A pressure leak test was carried out on the stby pitot probe which was found to be within limits. The stby pitot probe was then replaced.
- The power supply to PHC 1 was tested and found to be within limits.
- Electrical resistance checks were carried out between PHC 1 / PHC 3 and the right stby and the Capt pitot probe.
- The stby airspeed indicator was replaced.

PHC 1 and 3 were replaced and tested by both the PHC manufacturer and the aircraft manufacturer. The tests identified no faults on either unit.

Despite the extensive engineering investigation, the faults that generated the ECAM messages could not be reproduced and all the tests and inspections indicated that the aircraft system and components were serviceable.

Review of fault history

A review of the aircraft fault history revealed that G-EUPO had experienced a number of faults over a number of flights, which might have been related to those observed during the incident flight.

On 14 December 2010, 30 December 2010, 1 January 2011 and 2 January 2011 the ECAM warning CAB PR SYS 1 was displayed during the early phase of the flight. In all cases CPC 1 identified a fault with PRESS CONTR 1. Subsequent BITE tests were satisfactory indicating a serviceable system. On 7 January 2011 the crew reported a CAB PR SYS 1 ECAM message on both flights that day. The operator replaced CPC 1 and there have been no further reports of this ECAM message.

6 January 2011. The stby ASI was reported as under-reading by 8 kt. The stby ASI was replaced. The aircraft manufacturer advised the investigation that the under-reading was within tolerance.

7 January 2011. The crew reported that the captain's right static port failed in descent whilst passing FL 350, with anti-ice selected ON. The PFR contained the following warnings and messages:

- CAB PR SYS 1 FAULT
- ANTI-ICE CAPT R STAT
- ANTI-ICE CAPT TAT
- NAV ALT DISCREPANCY
- AUTO FLIGHT A/THR OFF
- NO PHC 1 DATA (source CFDS)
- PRESS CONTR 1 (source CPC 1)

During the subsequent engineering investigation, the operator's engineers were unable to interrogate PHC1 through the CFDS until they had reset the CB for PHC. When the BITE was run, the PHC was found to be serviceable. ADIRU 1 and 3 were interchanged and the PFR message changed to ANTI ICE STBY and no PHC 3 DATA. PHC 1 and PHC 3 were interchanged and the aircraft released for further flight. ADIRU 3 was subsequently replaced on 22 January 2011 when spares became available and returned to the operators overhaul facility for further testing. The testing found the unit to be serviceable and it was subsequently fitted to another aircraft on 6 February 2011 and has since operated satisfactorily.

15 January 2011. While there was no tech log entry for any ECAM messages occurring during the flight, the following PFR messages were generated:

- ANTI ICE STBY PITOT
- ANTI ICE STBY AOA
- ANTI ICE STANDBY L STAT
- NO PHC 3 DATA (source CFDS)

The operator advised that as no tech log entry had been raised, no work had been carried out to determine why the PFR responses had been generated.

28 June 2011. A Capt TAT ECAM warning appeared during the flight. The associated PFR message was CHECK TAT PHC1 SUPPLY (source PHC 1). The operator undertook a probe heat test and, as the current was within limits, took no further action.

4 July 2011. The crew reported that an ANTI ICE CAPT PROBES ECAM warning appeared after the aircraft landed. There was no associated PFR fault message. The operator undertook a BITE test of PHC 1, through the CFDS, which identified no faults in the system. No further action was taken.

16 July 2011. The crew reported that an ANTI ICE F/O R STAT ECAM message appeared on power transfer after engine start and a F/O TAT ECAM message appeared after takeoff. The relevant warnings and fault messages recorded on the PFR were:

- ANT ICE F/O TAT
- MAINTENANCE STATUS F/CTL
- ADR2
- ADIRU2 (1FP2) (source ADR and ident EIS 2, AFS)
- NO BSCU 1 DATA (INTM) (source CFDS)
- NO PHC2 DATA (source CFDS)
- SEC2 OR BUS 2 FROM ADR2 (source EFCS 2 ident EFCS 1)
- AFS:ADIRU 1/2/3 DISAGREE (source AFS)
- SEC3 OR BUS2 FROM ADR3 (source EFCS 2 ident EFCS 1)
- AFS: ADIRU2 (source AFS)
- ADM2 (19FP2) (source ADR 2)

The aircraft manufacturer advised the investigation that the number of probe heating faults that occurred on G-EUPO over this time period was significantly higher than seen on other the A319/A320/A321 aircraft.

Analysis

Event flight

The crew's account of the sequence of events was consistent with the data recorded on the PFR, the DFDR and the DAR.

At the time of the incident, the aircraft manufacturer was undertaking a technical investigation (TFU 21.25.34.003) into the generation of a spurious ECAM warning, VENT AVNCS SYS FAULT, on A318, A319, A320 and A321 aircraft. This fault was assessed by the aircraft manufacturer as being unrelated to the ECAM warnings concerning the air data that occurred on G-EUPO.

The CAB PR SYS 1 FAULT that occurred in the initial part of the climb also occurred at this stage of flight on other occasions. The replacement of CPC 1 on 7 January 2011 appeared to have cleared this fault.

According to the PFR, the ECAM cautions ANTI ICE CAPT TAT and ANTI ICE CAPT R STAT were both associated with the failure message NO PHC 1 DATA that was generated by the CFDS. This message only indicated that the CFDS was not receiving any data from PHC 1 and was not an indication of the serviceability state of the PHC. Post-flight testing of PHC 1 did not identify any BITE messages or faults that could have resulted in these warnings.

In response to the initial anti-ice ECAM cautions, the crew moved the air data selector switch to Capt 3, which meant that the Captain's PFD was now supplied with air data from ADIRU 3. However, from the DFDR it could be seen that when these messages were generated, the airspeed outputs from ADIRU 1, ADIRU 2 and ADIRU 3, were all within two knots of each other. This indicates that the Capt air data sensors, ADMs and communication paths to ADIRU 1 were serviceable with no evidence of ice collecting on the probes.

Approximately seven minutes later, the ECAM caution ANTI ICE STBY R STAT was displayed and, according to the PFR, was associated with the failure message NO PHC3 DATA, generated by the CFDS. This also indicated that the CFDS was not receiving any data from PHC 3. Post-flight testing of PHC 3 did not identify any BITE messages or faults that could have resulted in this warning. At this time, there was no degradation of the airspeed outputs from ADIRU 1, ADIRU 2 and ADIRU 3 recorded on the DAR, indicating that there was no ice accumulation on the probes and the air data system was serviceable.

Approximately six minutes later, the PFR shows the ECAM message MAINTENANCE STATUS F/CTL, the associated failure message ADR 3 was generated by EFCS 2 and confirmed by EFCS 1 and the AFS. This message indicated that EFCS 1, EFCS 2 and the AFS had identified that there was a discrepancy between the airspeed outputs from ADIRU 1, ADIRU 2 and ADIRU 3. Data from the DFDR showed the airspeed output of ADIRU 3 reducing, with the airspeed output from ADIRU 1 and ADIRU 2 remaining within two knots of each other at about 140 kt. A NAV IAS DISCREPANCY warning was generated by the FWC which indicated that there was a discrepancy between the airspeed displayed on the Capt and F/O PFDs. At the same time the crew reported that the speed displayed on the Capt PFD decayed to around 50 to 60 KIAS and the stby ASI fell simultaneously to 0 KIAS. Less than two minutes had elapsed between the initial discrepancy being detected and the airspeed output from ADIRU 3 decaying to 0 kt. About the same time the PFR records the failure message DMC 1: NO ADC3 DATA; this would have been generated as a result of the air speed data from ADIRU 3 dropping below 30 kt. The stby ASI and ADIRU 3, which was now supplying the Capt PFD, were both using air pressure information from the stby pitot and static probes. The recording on the DAR and the indications reported on the Capt PFD and stby ASI were consistent with possible icing of the stby pitot probe.

The crew determined, using the UNRELIABLE SPEED INDIC/ADR CHEC procedure from the QRH, that ADR 2 was the only reliable source of air data and, therefore, turned ADR 1 and ADR 3 OFF. In fact, the data from ADR1 was still reliable but the earlier ANTI ICE CAPT R STAT and ANTI ICE CAPT TAT caution messages and associated ECAM actions had meant that the commander had selected CAPT 3, so ADR1 data was no longer being presented to the crew. Therefore, they were not able to determine its serviceability without reversing the previous ECAM actions.

Switching off the ADR1 and ADR3 resulted in the following ECAM messages shown below in Table 3 and the reconfiguration of the flying control protection into Alternate and then Direct Law.

The post-flight testing and the data from the flight all indicate that the aircraft experienced two independent faults during the approach to Heathrow airport: icing of the stby pitot probe and loss of data communication, over a 6 minute period, between PHC 1, PHC 3 and the CFDIU. PHC 1 and 3 were powered from different electrical busbars and had separate communication links that did not pass through the same connectors. The aircraft manufacturer advised the investigation that they were unaware of any other occurrences of the loss of communication between two of the PHCs and the CFDIU during one flight.

At the time that both PHC1 and PHC3 had stopped communicating with the CFDIU, sounds identified as being induced by electrical interference were recorded on the CVR CAM channel. Analysis of the sounds indicated that the interference was most probably internal to the aircraft, and although it cannot be ruled out that the interference was generated elsewhere within the aircraft, it is possible that the interference was associated with the loss of the PHC1 and PHC3 communications with the CFDIU.

F/CTL ALTN LAW	As a result of switching off ADR 1, and the loss of ADR 3, there was only one source of air data from ADR 2.
NAV ADR 1 FAULT	A result of turning off ADR 1.
AUTO RUD TRV LIM	A result of turning off ADR 1, the Flight Control Computer no longer had a reliable source of data and therefore stopped computing the rudder travel limit.
MAINTENANCE STATUS SFCS	This message is generated after the aircraft has landed and is associated with the ADR fault message.
NAV ADR 1 + 3 FAULT	A result of turning off ADR 1 and ADR 3.
F/CTL DIRECT LAW	The FCS automatically goes into Direct Law when the landing gear is lowered and the FCS is already operating in Alternate Law.
F/CTL ALTERNATE LAW	The FCS automatically reverts back to Alternate Law once the aircraft lands.

Table 3

ECAM messages

Other occurrences

There are similarities between the event flight and the other occurrences on G-EUPO. The air data probe and static port warnings are generally accompanied with a fault message that there is a loss of data from one of the three PHCs. Yet BITE tests of the ADIRU and PHC following the occurrences could find no faults within the systems. The three PHC are all independent, using different power supplies and data buses to communicate with the CFDS which appears to be the only common system in all the occurrences.

Comment

The faults arising indicated that there was an intermittent communication fault between the PHCs and the CFDIU. In the majority of occasions these were dealt with by maintenance action which showed the systems to be serviceable. However, during the event flight it would appear that this intermittent fault occurred at the same time as the icing of the stby pitot probe. This then resulted in the loss of airspeed information on the commander's and standby flight instruments at a late stage of an instrument approach under demanding weather conditions. This led to an increased crew workload and a declaration of a MAYDAY by the commander. The ECAM and QRH procedures, as carried out, also resulted in a reconfiguration of the flight controls system during the diversion.

The safe flight path of the aircraft was maintained at all times under challenging circumstances and a diversion and uneventful landing were carried out at the alternate airport.

Safety action

Flight Crew Operating Manual

During the investigation the aircraft manufacturer identified that the manufacturer's Flight Crew Operating Manual (FCOM) entry, regarding the loss of deicing to the pitot associated with ADR1 when ADR 3 is selected on the captain's side, was incorrect (Figure 4). This did not affect the crews handling of the emergency and was, therefore not a causal factor in this incident. An amendment to the FCOM has been issued by the manufacturer.

Safety Recommendation

During the investigation the crew reported an anomaly with the UNRELIABLE SPEED INDIC/ADR CHECK in the QRH. Although this did not affect the safe conduct of the flight it could have an influence on the outcome of future similar events.

A318/A319/A320/A321 FLIGHT CREW OPERATING MANUAL	ABNORMAL AND EMERGENCY ICE AND RAIN PROTECTION	3.02.30 P 2 SEQ 105 REV 39

ANTI ICE CAPT PITOT or L (R) STAT or AOA

Failure of probe heating.

– AIR DATA SWTG .... CAPT 3

ADR 3 supplies data to PFD 1 and ND 1.
When ADR 3 is selected on the captain's side, deicing of the pitot associated with ADR 1 is lost.

Figure 4

The procedure is presented over five pages of the QRH (Figure 5). The first page contains the memory items, which are required to be carried out if the safe conduct of the flight is affected, to establish the aircraft in a climb. It then provides the pitch/thrust settings for the initial level off. However, this procedure did not contain information for configuration FULL, the configuration that the aircraft was in at the time of the go-around. Thus, when the crew attempted to carry out the initial level off using the QRH, there was no guidance. Therefore, the following Safety Recommendation is made:

Safety Recommendation 2011-099

It is recommended that Airbus amend the UNRELIABLE SPEED INDIC/ADR CHECK procedure in the A320 Quick Reference Handbook and the Flight Crew Operating Manual to ensure that it meets the requirements for all phases of flight.

The aircraft manufacturer has advised that they:

'will clarify the go-around procedure handling if the unreliable airspeed condition appears in final approach and this will be made available to operators in April 2012.'

UNRELIABLE SPEED INDICATION/ADR CHECK PROC

● **If the safe conduct of the flight is impacted :**

MEMORY ITEMS

- AP/FD .... OFF
- A/THR .... OFF
- PITCH/THRUST :
  - Below THRUST RED ALT .... 15°/TOGA
  - Above THRUST RED ALT and Below FL 100 ..... 10°/CLB
  - Above THRUST RED ALT and Above FL 100 ...... 5°/CLB
- FLAPS .... Maintain current CONFIG
- SPEEDBRAKES .... Check retracted
- L/G .... UP

● **When at, or above MSA or Circuit Altitude :**

- Level off for troubleshooting

- GPS ALTITUDE .... Display on MCDU

● **To level off for troubleshooting :**

- AP/FD .... OFF
- A/THR .... OFF

NOTE : Check the actual slat/flap configuration on ECAM, since flap auto-retraction may occur.

PITCH / THRUST FOR INITIAL LEVEL OFF

SLATS / FLAPS EXTENDED				
		Above 66 t	66 t – 56 t	Below 56 t
CONF	Speed	Pitch (°) / Thrust (% N1)		
3	F	7.0 / 62.0	7.0 / 57.9	7.0 / 52.6
2	F	8.5 / 61.8	8.5 / 57.6	8.5 / 52.3
1+F	S	3.5 / 60.6	3.5 / 56.4	4.0 / 51.5
1	S	7.5 / 60.1	7.0 / 55.7	7.0 / 50.9
CLEAN				
FL	Speed	Pitch (°) / Thrust (% N1)		
Below FL 200	250 kts	4.0 / 64.3	3.0 / 62.0	2.0 / 60.2
FL 200 – FL 320	275 kts	2.5 / 78.0	2.0 / 76.3	1.5 / 74.8
Above FL 320	M 0.76	3.0 / 84.2	2.5 / 82.6	2.0 / 80.4

Figure 5

Further action

The aircraft manufacturer has arranged for further laboratory tests to be conducted on a PHC and CFDIU. They will also continue to monitor the A320 family of aircraft for any similar occurrences of ANTI ICE warnings being associated with the fault message NO PHC DATA. In addition the aircraft manufacturer and operator will continue to monitor for further occurrences of ANTI-ICE ECAM warnings associated with NO PHC DATA.

ACCIDENT

Aircraft Type and Registration:	Airbus A380, VH-OQD
No & Type of Engines:	4 Rolls Royce RB211 Trent 972-84 turbofan engines
Year of Manufacture:	2009
Date & Time (UTC):	14 January 2012 at 1045 hrs
Location:	London Heathrow Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 25 Passengers - 453
Injuries:	Crew - None Passengers - None
Nature of Damage:	Engine cowl penetrated
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	19,558 hours (of which 1,632 were on type) Last 90 days - 97 hours Last 28 days - 22 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and reports from the airport authority and ground handling company

The aircraft was being prepared for departure from Stand 301 at London Heathrow Airport's Terminal 3. Weather conditions were dry and clear. A baggage tug, towing baggage containers loaded onto four purpose-built trailers, approached the aircraft's front hold. As it did so, a partly loaded container on the third trolley made contact with the aircraft's number three engine cowling, penetrating the cowling and also damaging the container.

The ground handling company conducted an investigation. No technical deficiencies were found with the baggage tug, the trailer or the container itself. The investigation determined that the accident arose because the vehicle driver had not followed existing procedures regarding the approach route to the aircraft's forward baggage hold door. No changes to procedures were deemed necessary, but steps were taken to remind ramp staff of the required procedures and to ensure these were being followed through a system of ramp checks.

SERIOUS INCIDENT

Aircraft Type and Registration:	Bombardier DHC-8-402 Dash 8, G-ECOF
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2008
Date & Time (UTC):	21 July 2011 at 1036 hrs
Location:	Approximately 25 nm south-west of Carlisle at FL240
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 47
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	8,010 hours (of which 1,960 were on type) Last 90 days - 141 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

In the cruise at FL240, the aircraft generated a spurious SMOKE warning from the forward baggage compartment. The crew assumed the warning was valid and carried out checklist actions designed to tackle fire or smoke from an unknown source. This resulted in power being removed from the co-pilot's flight displays, the autopilot, the Instrument Landing System (ILS), the transponder, the CVR and FDR, and caused the aircraft to begin to depressurise. The aircraft landed safely at Edinburgh following a Surveillance Radar Approach (SRA), vacated the runway and the passengers were evacuated onto a taxiway.

The investigation indicated that the spurious warning was probably caused by an intermittent short-circuit in a smoke detector connector as a result of moisture ingress.

History of the flight

G-ECOF was operating a commercial air transport flight from Newquay Airport to Edinburgh Airport and was cruising at FL240. At 1036 hrs, the aircraft was approximately 25 miles south-west of Carlisle when a MASTER WARNING light and an aural warning were triggered, and a SMOKE warning light illuminated on the Caution and Warning Panel (CWP) indicating that there was smoke in either the forward or aft baggage compartment. The crew confirmed from information on the overhead panel that the smoke warning was generated from the forward compartment.

The pilots put on their oxygen masks and smoke goggles, which were the first actions of the '*SMOKE (Warning light)'* drill in the Abnormal and Emergency Checklist. While they were doing so, the SMOKE warning light extinguished briefly before illuminating again accompanied by the MASTER WARNING light and the aural warning[1]. The crew carried out the remaining memory items of the checklist, which included pressing the SMOKE/EXTG switch for the forward compartment. This discharged fire suppressant into the compartment and, after the switch was pressed, the aural warning sounded, the CHECK FIRE DET warning light illuminated[2] and the SMOKE warning light extinguished.

The co-pilot asked the senior cabin crew member (SCCM) to look for smoke in "THE FORWARD BAGGAGE" and then declared a PAN to ATC who informed him that the aircraft was 90 nm from touchdown at Edinburgh airport. The pilots then took off their oxygen masks and smoke goggles because there were no signs of fire or smoke in the flight deck. The SCCM reported on the interphone that she could not smell any smoke. The commander told her that "WE HAD TO FIGHT THE FIRE" and that they would be making an emergency descent into Edinburgh. He instructed her to secure the cabin and said he would decide later whether or not an evacuation would be required after landing. The commander told the co-pilot that no smoke had been seen but they agreed that the situation would have to be treated "AS REAL".

The crew consulted the '*FUSELAGE FIRE or SMOKE*' checklist and decided to carry out actions associated with a fuselage fire or smoke from an unknown source[3]. The checklist required the pilots to degrade the aircraft electrical systems by turning off the DC and AC generators, and the Main, Auxiliary and Standby batteries. After they had finished their checklist actions, the commander was required to fly the aircraft from the left seat because power had been removed from the co-pilot's flight displays. Power had also been removed from, amongst other systems, the autopilot, Instrument Landing System (ILS), transponder, CVR and FDR, and the aircraft had begun to depressurise.

At 1047 hrs ATC informed the pilots that the aircraft was 55 nm from touchdown and, two minutes later, estimated it would be about seven minutes until touchdown. The controller tried to calculate a more accurate estimate based on the aircraft's groundspeed but groundspeed information was not available from the de-powered transponder.

The co-pilot called the cabin crew on the interphone to give them a 'NITS' brief[4]. The cabin crew asked for confirmation when told there was to be an evacuation rather than a precautionary rapid disembarkation[5] and the co-pilot, having consulted with the commander, confirmed that it would be an evacuation. He said that the time until landing was expected to be seven minutes and asked whether this would be sufficient for the cabin crew to complete their passenger briefings; the SCCM said that it would not be. The co-pilot then gave an emergency PA to the passengers during which he told them to expect to evacuate the aircraft after landing.

The crew informed ATC that the aircraft would vacate the runway after landing and the passengers would be evacuated onto the taxiway. Following an uneventful

Footnotes

[1] Figure 8 shows the intermittent nature of the smoke warning at the start of this incident.

[2] See later section: Description of the aircraft.

[3] See later section: Aircraft Abnormal and Emergency Checklist.

[4] A formal emergency briefing to the cabin crew consisting of: Nature of the emergency; Intentions: Time to landing; Special considerations.

[5] See later section: Rapid Precautionary Disembarkation or Evacuation.

Surveillance Radar Approach (SRA), the aircraft landed at 1104 hrs and, as it touched down, power was restored to the CVR and FDR. The aircraft was taxied from the runway onto Taxiway L, brought to a halt near the fire vehicles and shut down, following which the commander ordered the passengers to evacuate. The fire service found no signs of fire or smoke.

The evacuation

There were 47 passengers and 4 crew members on board and they exited the aircraft through the four cabin doors, two at the front and two at the back. Passengers used steps at the front left door but the remaining doors had neither steps nor slides. A number of passengers tried to put on coats and take belongings with them, and the rate at which passengers left the rear of the aircraft was slowed by passengers reluctant to jump down from the door sills, which were 1.6 m above the ground. One passenger refused to jump and was eventually helped down by a member of the rescue services. Although the paramedics examined one person who fell onto her hip when she jumped from the rear left door, there were no injuries.

Once clear of the aircraft, the cabin crew members ensured that the passengers gathered at the airport operations vehicle until a coach arrived. They were then required to get onto the coach with the passengers and, approximately one hour later, were taken to the airline's business lounge at the airport. They were able to leave the lounge approximately three hours after the evacuation.

Information from the pilots

The crew decided to continue to their destination, rather than divert to an alternative airport[6], because they had already briefed for the arrival at Edinburgh and to continue seemed the most expeditious solution.

After the SMOKE/EXTG switch was pressed, the smoke warning light went out, which suggested to the pilots that there had been smoke in the compartment. When the smoke warning light subsequently illuminated permanently, the pilots considered that the fire might have re-ignited through an electrical loom, or that the smoke detectors might have been wired incorrectly meaning that the source was actually in the rear cargo compartment. The commander did not want to "do nothing" and decided to look in the '*FUSELAGE FIRE or SMOKE*' checklist even though he knew the checklist was designed to remove smoke from the aircraft and that none had been reported. If there was a fire, the pilots thought it probably had an electrical source and so they began the checklist at the section that dealt with electrical systems. The commander was not prepared to assume that the warning was spurious.

The pilots discussed whether they should evacuate the aircraft or command a rapid disembarkation and decided that, because "fire was in the equation", an evacuation would be required "just in case".

On a recent flight to Edinburgh, the commander had participated in an airport emergency training exercise during which it was assumed that his aircraft had smoke in the cabin. On that occasion he taxied clear of the runway after landing and stopped near the fire vehicles. During the subject incident, he taxied clear of the runway believing it would help the emergency services.

Both crew members stated that they had been told during simulator training that it was good practice to vacate the runway if possible before evacuating the aircraft to allow the airport to continue operations.

Footnote

[6] Edinburgh was approximately 90 nm away and Newcastle, Durham Tees Valley and Isle of Man airports were approximately 60 to 65 nm away.

Information from the cabin crew

The SCCM, when asked to look for smoke, did not hear the reference to the forward baggage compartment and thought that the source of the smoke was simply towards the front of the cabin. Neither cabin crew member knew the supposed source of the smoke until the NITS brief was given to them, which was also the first time they realised the urgency of the situation.

Seven minutes would not have been enough time for the cabin crew to carry out all the duties required of them prior to an emergency landing. However, it actually took 15 minutes to land and they could have made better use of the time had they been given a more accurate estimate. Some passengers expressed concern that there were no slides at the rear exits.

The cabin crew expected to be segregated from the passengers following the evacuation. They felt unprepared to attend to the needs of the passengers once they had left the aircraft, a role for which they had not been trained.

Information from the operator's Ground Services Operations Manager

The operator's Ground Services Operations Manager at the airport expected the passengers to be moved to the gate identified in the airport's emergency response plan for use as a passenger reception centre. When he asked the Airport Duty Manager (ADM) to make this area available his request was refused because the scale of the incident did not warrant it. The ADM agreed that the passengers could be taken to the operator's business lounge.

Description of the aircraft

The aircraft was a Bombardier DHC-8-402, also known as the Q400 version of the Dash 8 (Figure 1). It had accumulated 6,067 flying hours and 6,568 cycles at the time of the incident.

Smoke detection and warning

The aircraft was equipped with a forward and an aft baggage compartment. The aft baggage compartment was fitted with two smoke detectors and was only

Figure 1
Incident aircraft

accessible from an external door at the rear of the aircraft. The smaller forward baggage compartment, located opposite the forward main entrance door, was accessible via an internal door and an external door – this compartment was fitted with one smoke detector (Figure 2).

A placard on the forward baggage compartment door stated: 'NO ACCESS DURING TAXI AND FLIGHT'. The aircraft manufacturer stated that this was a strict requirement in all situations, because if a fire were present then opening the door would make the fire extinguisher ineffective and would allow smoke and extinguishant to enter the cabin and potentially into the cockpit.

When a baggage compartment smoke detector senses smoke, an alarm signal is produced causing a SMOKE light to illuminate on the CWP in the flight deck. This is accompanied by an aural warning and a flashing Master Warning light on the main instrument panel. If smoke is detected by the forward baggage compartment smoke detector, a red SMOKE light illuminates on the 'BAGGAGE FWD' part of the Fire Protection Panel located on the overhead console (Figure 3). The forward fire extinguisher bottle EXTG light will also illuminate indicating that the bottle is armed for activation. A forward baggage compartment test button is located on the same panel for testing the forward baggage compartment smoke detector system.

Figure 2

Forward baggage compartment with its internal door closed (left) and door open (right)

Figure 3

Fire Protection Panel on overhead console

The smoke signal from a baggage compartment smoke detector feeds into a Fire Control Amplifier, which arms the appropriate fire extinguisher bottle and triggers the flight deck warnings. Once the extinguishers have been armed, pressing the EXTG (extinguish) button on the Fire Protection Panel activates the appropriate fire extinguishers. When the fire extinguishers have been depleted the CHECK FIRE DET light illuminates on the CWP to indicate that the levels are low.

The forward baggage compartment smoke detector is mounted above the external door and is protected by a wire cage (Figures 2 and 4). The smoke detector contains a photo-electric sensor which detects a change in light beam intensity when smoke passes through it.

Aircraft exits

The aircraft is equipped with four exit doors. The main door at the front left side of the aircraft has an integrated air stair which lowers with the door. The right front door is made of two parts and consists of an upper removable hatch and a lower hinged door. The two doors at the rear of the aircraft are normal hinged doors and there is a stowable set of stairs aft of the rear left door which can be extended manually after opening the door. The steps are not designed to be used in the event of an evacuation but are intended for use in a

Figure 4

Forward baggage compartment smoke detector rapid disembarkation[7]. There are no evacuation slides fitted to any of the doors. The distance to the ground from the base of the rear doors is 1.60 m (Figure 5) and it is 1.28 m from the right front door. The EASA certification requirements relevant to this aircraft type state than an emergency slide is required if the distance from the exit to the ground is greater than 1.80 m (Certification Specification CS 25.810).

Aircraft examination

No evidence of fire or smoke was found inside the forward baggage compartment or in any other part of the aircraft. The forward baggage compartment contained a step ladder, a tool box and a bag belonging to one of the cabin crew and there were no items in either the tool box or in the bag that could have generated smoke or other airborne particulate. The investigation therefore focussed on trying to determine the cause of a false and intermittent smoke warning.

An operational test of both the forward and aft baggage compartment smoke detectors was carried out by depressing the test switches on the Fire Protection Panel and these tests were passed. Insulation and resistance wiring checks were carried out between all the components of the baggage compartment smoke detection system but no faults were found. Some deposits were found on pin B (Figure 6) of the smoke detector plug and on socket B of the female connector. The female connector socket was also found to be missing blanking pins in unused holes. The smoke detector, fire control amplifier and smoke detector connector socket were removed for further examination. There were no further reports of false smoke warnings on G-ECOF between the time these components were removed and the completion of this report in November 2011.

The fire control amplifier and smoke detector were sent to the component manufacturer in the USA, where they

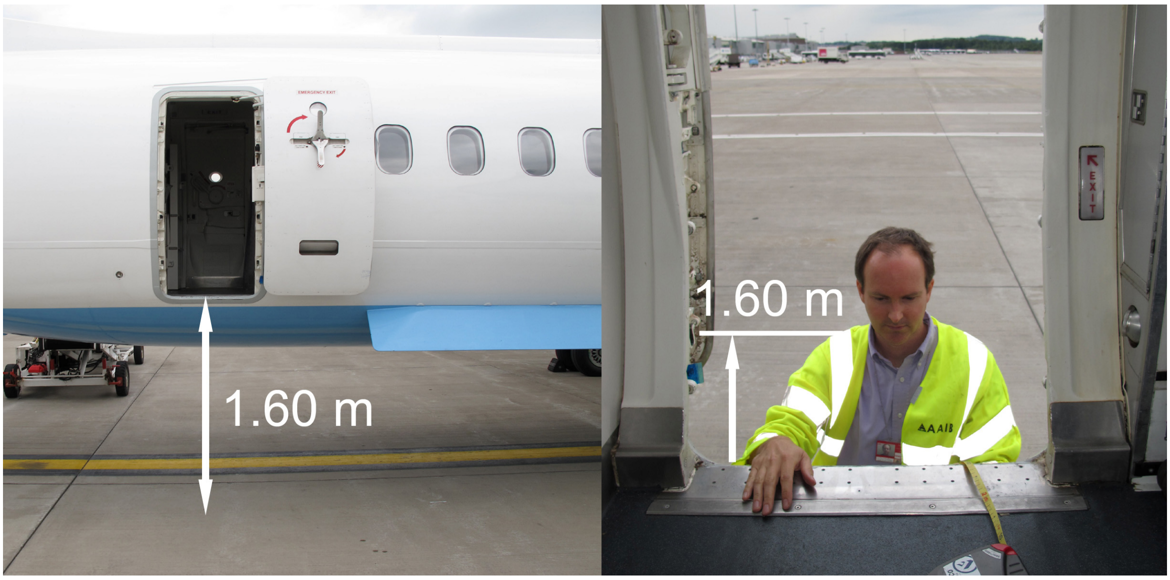

Figure 5

Height of rear exit doors

Footnote

[7] See later section: Precautionary rapid disembarkation or evacuation.

were tested and then strip-examined under the supervision of an investigator from the US National Transportation Safety Board.

Fire control amplifier examination

The fire control amplifier was connected to the manufacturer's test set and passed 15 of the 17 test items: the two failures were resistance checks which were slightly out of tolerance. The amplifier was disassembled and inspected but no anomalies were found. During temperature stress testing, it was found that cooling certain parts of the circuit board with a cooling spray, followed by heating them with the heat gun, generated a CHECK FIRE DET warning and occasionally a SMOKE warning. The manufacturer stated that the false warnings were abnormal and had been triggered only after the circuit board had been subjected to more moisture than would normally be encountered in service. The amplifier functioned normally and did not trigger any warnings in an environmental chamber where the temperature was cycled between -40°C and +85°C.

Smoke detector examination

Before function testing the smoke detector the manufacturer measured the resistance from pin B, where the foreign deposits were located, to the connector shell; the resistance was found to be normal (open circuit). The detector was then connected to the manufacturer's test set and function tested – all tests were passed. The detector was then subjected to the same thermal cycling as the amplifier and all tests were passed. No warnings were generated at any point.

The manufacturer stated that if the deposits surrounding pin B were products of corrosion then this would indicate that moisture had been present, and if moisture caused a short circuit between pin B and the connector shell it would trigger a self-test. This would create the same effect as pressing the forward test button on the Fire Protection Panel, and would trigger the smoke warnings and arm the extinguishers.

The smoke detector was taken to an independent company specialising in electrical failure investigation. Using a scanning electron microscope with elemental x-ray analysis they determined that the deposits surrounding pin B on the smoke detector and on the corresponding hole B of the socket were products of corrosion. There was also evidence of corrosion deposits in several of the other socket holes.

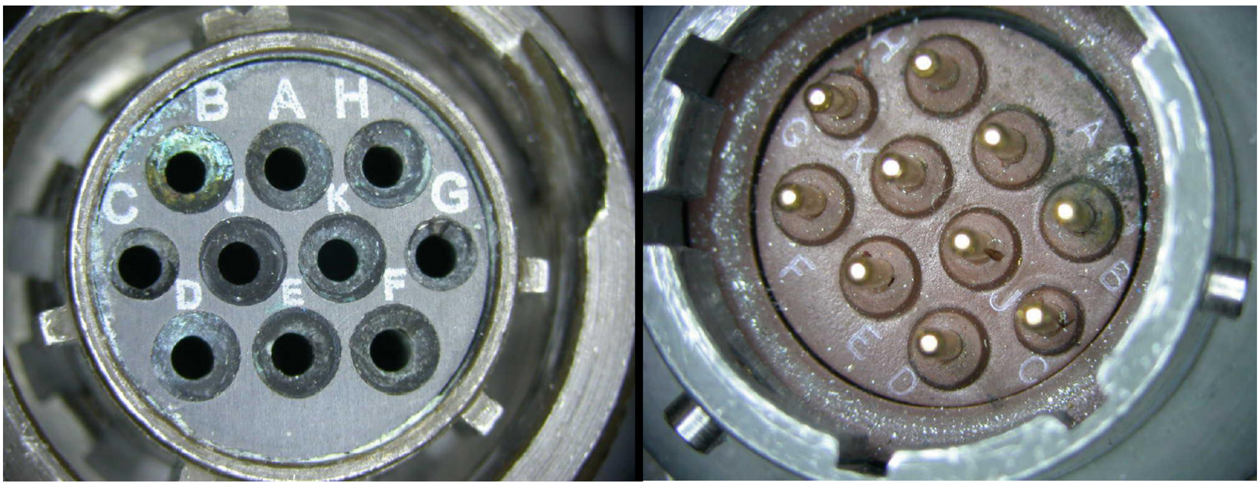

Figure 6

Smoke detector socket (left) and plug (right) – corrosion deposits visible at hole B and pin B

Using a sensitive high-resistance meter, the resistance between pin B and the connector shell was measured while blowing humid air at it, allowing it to dry and then repeating. The initial resistance was measured at 400,000 MΩ, but it reduced to as low as 4 MΩ after blowing humid air at it. For reference, pin A was measured at 200,000 MΩ and this value did not change with humidity.

The smoke detector connector is a MIL-standard connector, designed to MIL-C-26482 which, if used correctly, has a high degree of environmental resistance. However, this only applies if all holes in the socket are filled with either a wire or a blanking pin. The blanking pins were found to be missing from the socket connected to the forward smoke detector on G-ECOF. Figure 7 shows the back of another socket revealing the four wires and red plastic blanking pins fitted in the unused holes. With open holes airborne moisture would have been able to enter the socket and reach the pins. The forward smoke detector is installed upside down at about a 45° angle which results in pin B being located at the bottom where any moisture is likely to collect.

Inspections for missing blanking pins

The aircraft manufacturer stated that blanking pins are inserted in all unused sockets of electrical connectors fitted to their aircraft. According to the aircraft operator's records the forward smoke detector socket on G-ECOF had not been replaced and was therefore probably the one fitted during manufacture in 2008. The aircraft manufacturer carried out a 'line check' of seven aircraft at their manufacturing facility and all the smoke detector sockets were found to contain blanking pins. The aircraft operator also inspected three aircraft at its base maintenance facility and blanking pins were found to be in place.

Maintenance history

An inspection of G-ECOF's maintenance records revealed nine other smoke detector related problems since the aircraft entered service in July 2008. However, all these problems concerned faults that were found on the ground and usually during the smoke detector self-test prior to the first flight of the day. The forward smoke detector on G-ECOF

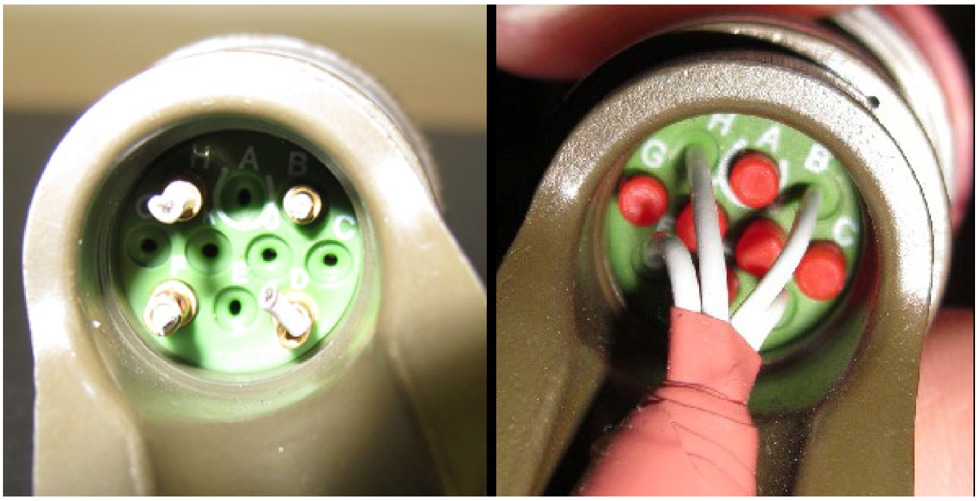

Figure 7

G-ECOF smoke detector socket (left) with blanking pins missing;
another socket (right) showing installation of red blanking pins

was a refurbished unit and had been installed on 7 June 2011; the aircraft had flown 278 hours since it was fitted.

The smoke detector was of a new type that was not affected by interference from mobile phones[8].

Flight recorders

The aircraft was fitted with a Flight Data Recorder (FDR) and a Cockpit Voice recorder (CVR), which were successfully downloaded.

System power

In this aircraft the FDR and CVR were powered from the main DC busbars. During the incident flight on 21 July the crew procedurally switched off the DC and AC generators, leaving the aircraft in what the Maintenance Manual refers to as an '*Emergency Mode*' electrical state, powered only by the batteries through the Essential DC busbars. The emergency mode maximises the time that battery power will be available for essential equipment but also results in the FDR and CVR being de-powered. While airborne, the emergency mode state is achieved by disconnecting the batteries from the main DC busbars. On the ground, the lack of active generators does not require the aircraft to be in an emergency mode electrical state. Consequently, the auxiliary and main batteries are allowed to power the left and right main DC busbars respectively unless the AUX BATT and MAIN BATT, or the BATTERY MASTER switches have been selected OFF by the crew on the overhead DC control panel.

The FDR and CVR recordings stopped at 1045 hrs when the crew procedurally switched off the generators. The fact that the recordings restarted at 1104 hrs, as the aircraft came out of the '*Emergency Mode'* condition on touchdown, indicated that the AUX BATT and MAIN BATT switches on the DC control panel were ON at that stage.

FDR parameters

The salient FDR parameters (Figure 8) show that the SMOKE light on the CWP illuminated at 1036 hrs and went off approximately 33 seconds later. The light came on and went off again a further three times before coming on and staying on at 1041 hrs. The end of the second period of the SMOKE light being on was marked by the CHECK FIRE DET light illuminating and staying on. The MASTER WARNING light illuminated briefly every time either the SMOKE or CHECK FIRE DET light illuminated. The MASTER CAUTION light illuminated just before the generators were shut down.

The latest build standard for this aircraft uses the essential DC busbars to power the FDR and CVR, which ensures that they will continue recording even with the aircraft in the emergency mode electrical state. The build standard made no change to battery capacity and the aircraft still meets battery endurance requirements with no AC or DC generators on line.

Aircraft Abnormal and Emergency Checklist

The first checklist actions carried out from memory by the crew were from the '*SMOKE (Warning light)'* checklist. The second checklist to which the crew referred was the '*FUSELAGE FIRE or SMOKE'* checklist, which is a systematic method of isolating the source of fire or smoke and minimising any effects. The relevant parts of the checklist are shown below:

Footnote

[8] When the Dash 8 Q400 first entered service in 2000 the aircraft suffered from a number of spurious in-flight smoke warnings, which were attributed to mobile phone interference. The smoke detectors were modified and the problem did not recur. The smoke detectors fitted to G-ECOF were of the newer standard.

'If known source of fire or smoke:

[Checklist items not relevant to this discussion]

If unknown source of fire or smoke:

[Checklist items relating to engine bleed air and air conditioning]

If source of fire or smoke still cannot be identified:

Caution: Following completion of this drill, fly the aircraft from the left-hand seat in order to read active instruments; PFD 1 will be lost so revert MFD 1 to PFD[9]. 45 min battery duration.

Battery.. Confirm ON
DC and AC Gens 1 and 2...OFF
Storm/dome ....ON (if reqd)
Main, Aux and Standby...OFF
Emergency..OFF
Land immediately at the nearest suitable airport

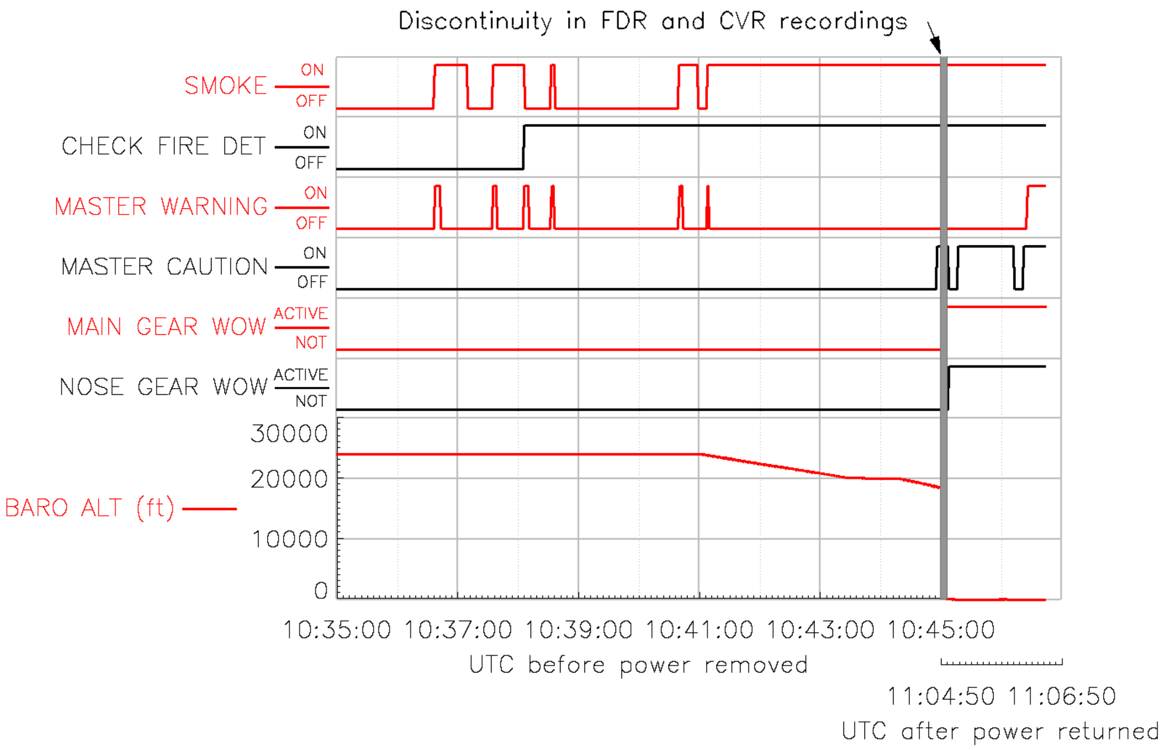

Figure 8

Salient FDR parameters

Footnote 9 PFD is a Primary Flight Display; MFD is a Multifunction Display.

Decisions on 'Precautionary rapid disembarkation' or 'Evacuation'

The operator's procedures include a '*Precautionary rapid disembarkation*' to be used in circumstances that require passengers to vacate the aircraft rapidly but not so rapidly that it justifies an '*Evacuation'* with its attendant risk of injury. A rapid disembarkation requires passengers to leave the aircraft quickly down steps at the front and rear left doors of the aircraft. An evacuation, however, requires passengers to leave the aircraft through any of the four doors, and requires them to jump down from all doors except the front left, which has integral steps.

The operator's Operations Manual gives guidance to aircraft commanders on how to decide which option, evacuation or rapid disembarkation, is appropriate in the circumstances. Figure 9, taken from the Operations Manual, shows how the decision should be made and it is amplified in the manual by the following guidance:

> *'The assessment of the cabin environment can be carried out from the cockpit by visual inspection by either flight crew or interphone contact with the cabin crew. Commanders are to remember that if there is any doubt, a full evacuation should be initiated.'*

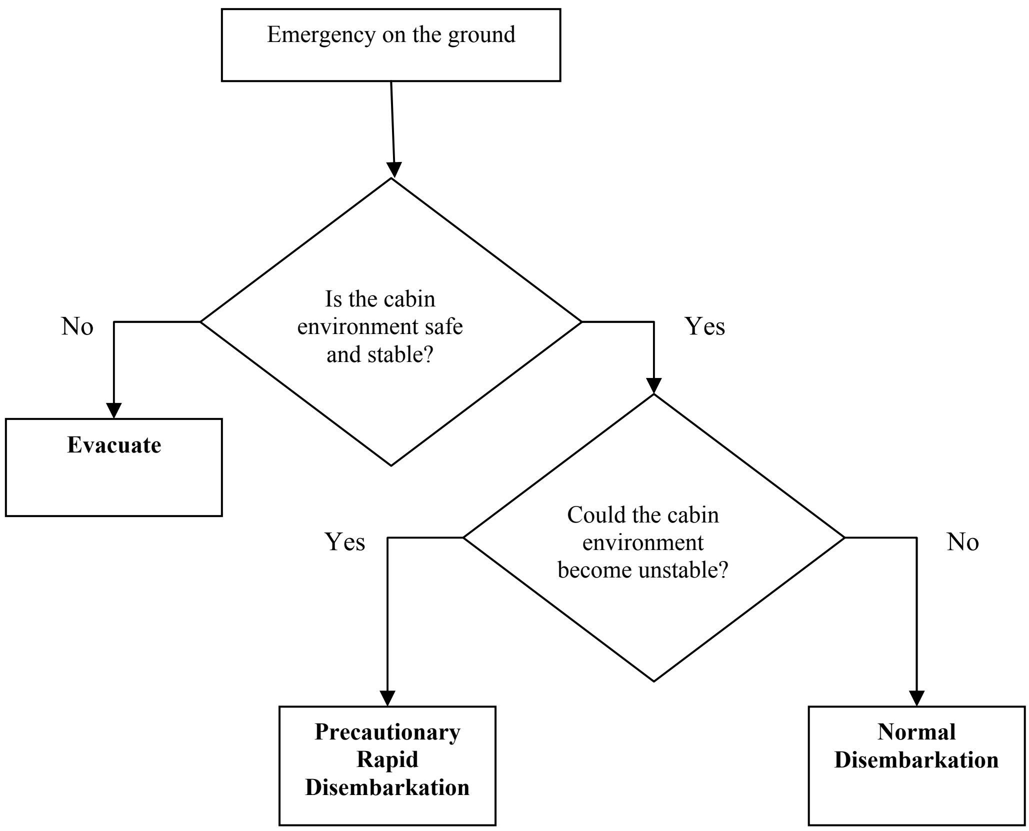

Figure 9

The Operator's decision tree for evacuation or rapid disembarkation

Comments from the aircraft operator

The aircraft operator stated that crews should not be encouraged by ATC or through training to vacate the runway before an evacuation. Airline policy in circumstances where an evacuation is possible after landing is for the aircraft to stop on the runway and, if necessary, for the passengers to be evacuated from the position at which it has stopped.

The operator noted the problems that had been encountered at the rear of the aircraft with passengers refusing to jump to the ground. Passengers are normally loaded onto this type of aircraft with a bias towards the rear for trim purposes although company guidance to handling agents is that passengers with reduced mobility should be seated towards the front of the cabin. However, many such passengers do not advise the airline of their requirements, and passengers are able to choose their own seats during online or self-service check-in.

Although the cabin crew were separated from the pilots for a considerable time after the evacuation, the operator did not wish to impose a requirement for all crew to remain together or for cabin crew to be segregated from the passengers. Rather, the operator expected each situation to be managed by the commander and SCCM according to the circumstances.

Review of the incident by the airport authority

The airport authority carried out a review into the incident and identified the following issues:

1. The airport used a Passenger Evacuation Management System (PEMS) mounted on a vehicle, which included lights and a recorded message to marshal passengers. The speaker system was unserviceable during this evacuation and a loudhailer was used instead. The airport authority considered the system suitable in this incident but decided that additional resources would be required to supplement its use in the event of a larger scale event.
2. The coach used to pick up the passengers was summoned by radio using a codeword that was not recognised and a phone call had to be made instead. This did not delay the bus significantly.
3. When he received the request to use the passenger reception centre, the ADM turned it down as he did not believe that the situation was serious enough.
4. There was a possible misunderstanding as to where or when responsibility for passenger welfare should pass between the emergency services, the airline or handling agent and the airport authority.
5. There should be a method of segregating crew from passengers following an evacuation.

Civil Aviation Publication (CAP) 168 – '*Licensing of Aerodromes*'

CAP 168 details the licensing requirements that must be met by aerodrome authorities. Chapter 9 considers emergency planning and paragraph 8.5 states:

> *'The post-accident arrangements for any survivors who are not injured…..is a joint responsibility between the aerodrome, the airline and/or its agents, and Category 1 Responders and should be set out in the Emergency Plan.'*

CAA Safety Notice: SN-2011/013 *'Rescue and Fire Fighting Service Response to Smoke/Fumes Incidents'*

In its introduction to Safety Notice SN-2011/013, dated 26 September 2011 (but not written in response to this incident), the CAA stated:

> *'There have recently been instances where the response of the aerodrome Rescue and Fire Fighting Service (RFFS) to reported incidents of smoke or fumes has resulted in evacuations or de-planing of passengers in inappropriate locations.'*

The notice commented that, if smoke or fumes are inside the aircraft, the flight crew are best placed to determine the course of action and recommended that:

> *'The RFFS should review its procedures for responding to such incidents to assure effective communication with the flight crew so that the need for any action is agreed and co-ordinated.'*

Analysis

Engineering analysis

The aircraft suffered a false and intermittent forward baggage compartment smoke warning. No faults with the aircraft wiring system were found and, after removal of the forward smoke detector and the fire control amplifier, there were no further reports of false smoke warnings on the aircraft. It is probable, therefore, that either the smoke detector or the amplifier generated the false warning. The amplifier could generate a false smoke warning but only when exposed to high levels of moisture not representative of normal operating conditions. It is therefore more likely that the spurious warning was caused by a short circuit at the smoke detector connector between pin B and the connector shell. The evidence of corrosion in this area indicated that moisture had been present, and sufficient moisture would have provided a conductive path from the pin to the shell. Grounding pin B triggers a self-test, which would have given the flight crew indications of a smoke warning and would have armed the fire extinguishers.

The type of connector used on the smoke detector is normally resistant to moisture ingress but the lack of blanking pins in the unused sockets meant that moisture in the air could reach the pins. The fact that the corrosion was primarily present at pin B, the pin at the lowest point, was consistent with the theory that moisture had collected there.

Safety Action

At the end of this investigation the aircraft operator initiated an inspection programme of the forward and aft baggage compartment smoke detector connectors on all their Q400 aircraft to ensure that blanking pins were in place. As part of the inspection the condition of the connector pins would be assessed. The operator expected to have all aircraft inspected by mid-February 2012. A routine task to check for blanking pins would also be added to the aircraft's base maintenance 'C' check.

Operational analysis

The crew was presented with a smoke warning but there were no corroborating signs of smoke or fumes. The pilots were not prepared to proceed on the basis that the warning was spurious and assumed that it was valid. Subsequently, the continuing absence of corroborating evidence did not alter this assumption, and the crew proceeded on the basis that the continuous smoke warning meant that smoke or fumes were present somewhere in the aircraft caused by an unknown electrical problem.

Having made their assumption, the pilots carried out checklist actions designed to remove smoke from the aircraft. The actions degraded the operational capability of the aircraft significantly because it depressurised, the commander had to fly manually (which reduced his ability to do other tasks) and the co-pilot's monitoring task was made more difficult because his flight displays were blank. Consequently, the crew's workload increased, which would have made managing the overall situation more difficult. In addition, the loss of its ILS system would have reduced the aircraft's approach capability in poor weather, although in this incident the weather was good and safety was not adversely affected.

The pilots made an early decision to evacuate the aircraft rather than use a rapid disembarkation because, with the possibility of a fire on board, they thought it was the safest course of action. By the time of the evacuation, 28 minutes had passed since the original warning during which there had been no reports of smoke within the cabin. Had the pilots assessed the cabin environment from the cockpit before commanding the evacuation, it is possible that the advice given in the Operations Manual would have led them to carry out a rapid disembarkation instead. However, that same advice recommends that commanders should evacuate an aircraft if they are in any doubt as to its safety, which was the course of action followed.

When the commander was asked to simulate having smoke in the cabin for a previous training exercise at the airport, he taxied clear of the runway to meet the emergency response vehicles. The CAA Safety Notice SN-2011/013 reinforces the fact that, if smoke or fumes are within the cabin, the commander is best placed to decide where any evacuation will take place but it is quite likely to be on the runway. An airport authority will not wish to close a runway for the purpose of an exercise but there is potential for negative learning if RFFS responders expect an aircraft in such circumstances to vacate the runway and evacuate passengers onto a taxiway. This negative learning probably extended to the commander who, in this incident, vacated the runway partly because he thought it would help the emergency services.

A number of passengers refused to jump from the rear doors, presumably because they thought they might injure themselves on landing. Had there actually been smoke or fire in the cabin, it is likely that the urgency of the situation would have convinced them that jumping involved a lower risk to their safety than remaining on board.

Safety Action by the aircraft operator

The operator reviewed its training of pilots for circumstances where an evacuation was possible after landing to ensure that the training was in accordance with its policy.

Safety Action by the airport authority

Following its review into the evacuation, the airport authority decided to:

1. Change its procedures for summoning a coach to ensure that the use of discrete radio codes would be effective in a future incident.

2. Update its ATC procedures to ensure that they were aligned with the airport's emergency orders on reportable incidents.

3. Brief all ADMs that the designated passenger reception area was to be used for all future evacuation incidents.

4. Discuss with airlines using the airport the division of responsibilities for passenger welfare following an evacuation.

5. Amend its procedures to ensure that crew would be segregated from passengers following an evacuation.

The RFFS at the airport reviewed its procedures in accordance with CAA Safety Notice SN-2011/013.

Summary

The aircraft generated a spurious smoke warning from the forward baggage compartment, which was probably caused by a short circuit in the smoke detector connector. The pilots decided to treat the warning as valid even though there was no evidence of smoke or fumes. The pilots decided that, with the possibility of a fire on board, an evacuation was required and, after landing, the aircraft vacated the runway and the passengers were evacuated onto a taxiway.

Safety action was taken by the aircraft operator to prevent a similar short circuit in other smoke detector connectors, and to ensure pilots received training with respect to aircraft evacuation that reflected company policy. Safety action was taken by the airport authority to address issues that arose during and after the evacuation.

INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-ECOK
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2008 (Serial No: 4230)
Date & Time (UTC):	16 Nov 2011 at 1300 hrs
Location:	8 nm north-east of Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 46
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	7,000 hours (of which 1,600 were on type) Last 90 days - 130 hours Last 28 days - 50 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, operator's Safety Investigation Report and recorded flight data

Synopsis

During an ILS approach at Manchester, the aircraft descended on the glidepath without being correctly established on the localiser. With the aircraft displaced more than two dots right of the localiser centreline and at about 800 ft aal, a go-around was initiated on ATC instruction.

History of the flight

The two flight crew, each qualified Commanders, reported for duty at their Manchester base between 0610 and 0615 hrs and learned of a change to their planned rosters. The revision was for a four-sector duty: a return flight to Norwich, followed by a return flight to Knock, in Ireland (the right-hand seat pilot was originally to fly this sector, but as Commander). The aircraft departed ahead of schedule but was unable to land at Norwich due to poor visibility, so returned to Manchester before operating the flight to Knock. The incident occurred on the return flight from Knock, during the approach to Runway 23R at Manchester Airport.

The aircraft was being flown by the right-hand seat pilot; he was a Training Captain but was operating as acting First Officer following the roster change. His brief for the ILS/DME approach included his intention to fly the aircraft manually, with the flight director, for practice.

The reported visibility at Manchester was 3,900 m in haze, with a light and variable wind and scattered cloud at 800 ft aal.

The aircraft was vectored by Manchester ATC onto an intercept heading for the localiser (ILS QDM was 234°) and descended to 2,500 ft. The acting First Officer recalled[1] that the flight guidance approach mode had been armed and that, as the course deviation indicator (showing localiser deviation) started to move from full-scale deflection, the flight guidance localiser and glideslope capture modes engaged automatically. The acting First Officer followed the 'turn right' flight guidance indications, and commenced descent to follow the glideslope.

With the localiser deviation indicator giving a 'fly left' indication, the crew were aware that the aircraft was actually to the right of the localiser centreline. Suspecting a false localiser capture, the crew selected heading and vertical speed guidance modes, whilst descent continued on the glidepath. The acting First Officer steered the aircraft left to recapture the localiser and again armed 'approach' mode. He thought he saw conflicting localiser deviation indications at about this point, with his side indications showing 'fly right' and the Commander's side showing 'fly left'. With the Multi-Function Display navigation page to assist, it was determined that the aircraft was still to the right of the actual localiser centreline.

The acting First Officer stated that they would execute a go-around at 1,000 ft aal if the aircraft was not correctly established on the localiser by that stage. With the aircraft at about 1,300 ft, Manchester ATC asked the crew if they were visual with the approach lights. The crew were not, although they did have visual contact with the ground and were able to recognise significant features in the approach area. They advised ATC and were instructed to go around.

As the aircraft was vectored for a further ILS approach, the crew noticed a discrepancy between the left and right side localiser inbound courses as selected on the flight guidance control panel: the left side was set to 265° and the right side was set to 234°[2]. The left side was set to the correct value of 234° and the second ILS approach was completed, using the autopilot, without incident.

Operating company's investigation

The AAIB was provided with a report on the operating company's own investigation. It was judged that the two pilots worked together effectively to resolve the problem they were faced with, although there existed a relatively unusual situation whereby the acting First Officer was senior to the aircraft Commander by virtue of his Training Captain status.

The crew retained sufficient situational awareness to determine that the aircraft was not on the correct track, although this would probably not have been aided by the miss-set course on the Commander's side. It was also noted that the crew's capacity to deal with the problem may have been enhanced if the autopilot had been engaged.

Although the crew maintained an overall awareness of their situation and were endeavouring to correct it, it

Footnote

[1] The AAIB was notified one month after the incident occurred and the operator's own investigation was similarly delayed. Due to the elapsed time, the flight crew considered that their recollection may not be entirely accurate.

Footnote

[2] The ILS at Knock has a localiser QDM of 265°, so it is likely the left side course had remained unchanged since the aircraft's approach there.

was established that they had begun to deviate from standard operating procedures in allowing the aircraft to continue to descend without it being correctly established on the localiser.

The operator conducted a simulator exercise to explore the effect of the discrepancy in selected inbound courses. The results suggested that, while localiser deviation indications should not be affected, it may have caused the flight director to function inefficiently at the point of localiser intercept.

The operator reported a number of false localiser capture incidents affecting its Q400 fleet, more than half of which have been at Manchester. Internal investigations were ongoing at the time of this incident, although it was felt that the subject incident was more probably a case of the flight guidance system not following the localiser as expected rather than an actual false localiser event.

Safety actions

The operator's report made three internal safety recommendations. As a result, a Notice to Crew was issued warning against starting final descent before the aircraft was confirmed as being established on the correct localiser. It also stressed the importance of discontinuing an approach if inconsistent localiser indications are observed. As there was some evidence that flight director performance could be impaired with one miss-set selected course, an appropriate cross-check was introduced prior to the localiser intercept point.

Recorded information

Data from the aircraft's quick access recorder (QAR) was available for analysis. This showed the aircraft descending on a steady intercept heading of about 200°(M) when localiser and glideslope capture modes engaged simultaneously. The aircraft was slightly above the glideslope but correcting to it, so descent continued uninterrupted. At the point of localiser capture, localiser deviation was just in excess of two dots (about 2.5°) and reducing. The selected heading was moved to align with the inbound course of 234° but the aircraft continued to turn right (lateral flight guidance was localiser mode) until reaching about 255°. Deviation reduced to one dot 'fly left' before increasing again to full scale deflection as the aircraft started to fly away from the localiser centreline. Figure 1 shows the relationship between localiser deviation and aircraft heading, with the engaged flights guidance modes at each stage of the approach.

The heading slowly reduced from its maximum 255° to a value slightly less than the inbound course, at which point heading and vertical speed modes were selected and a heading of about 210° set. The aircraft was descending through about 2,250 ft altitude (2,000 ft aal) at this point. Localiser and glideslope capture modes re-engaged at about 1,700 ft, followed by an almost identical profile as before, with localiser deviation again reducing to about one dot before increasing again to full-scale deflection. As deviation increased through two dots deflection, the aircraft was descending through 1,400 ft and heading about 250°. When go-around mode engaged, the localiser deviation was full scale 'fly left' and the aircraft was descending through about 1,050 ft altitude (800 ft aal).

Recorded information for the whole approach showed continuous agreement between the localiser deviation values for both left and right ILS receivers. A comparison with recorded radar data showed a good correlation between the aircraft's actual position and the indicated deviation.

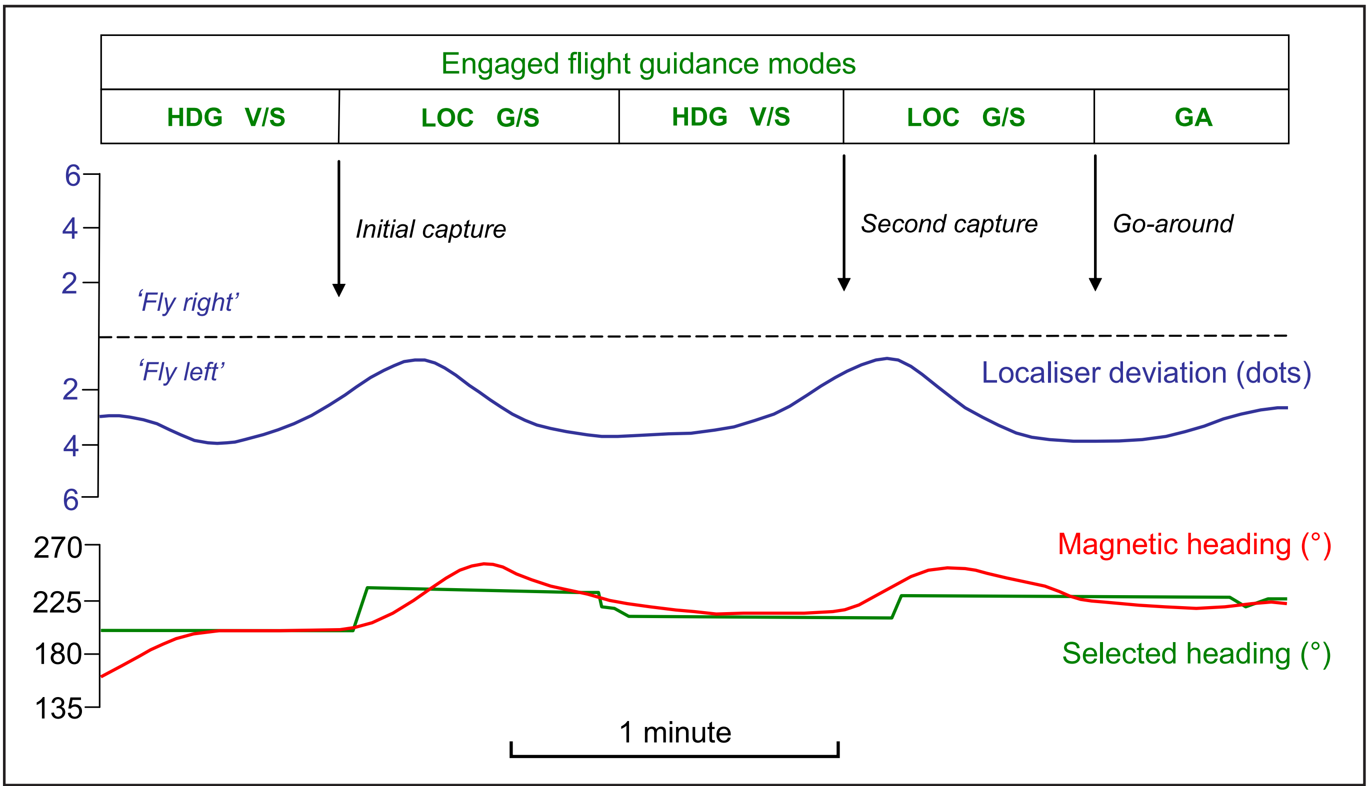

Figure 1

QAR derived information showing the relationship between localiser deviation and aircraft heading, with engaged flight guidance modes

Analysis

As Figure 1 shows, the pattern of each localiser capture and subsequent deviation is remarkably similar. It is reasonable to assume that the handling pilot followed the flight guidance on each occasion (as he reported) in which case the flight guidance system responded in a very similar manner on each occasion too. With both ILS receivers showing consistently accurate deviation and the position and altitude of each intercept being different, it is most likely that the guidance issue arose as a result of the discrepancy between the left and right inbound courses selected on the flight guidance control panel.

SERIOUS INCIDENT

Aircraft Type and Registration:	AS332L2 Super Puma, G-PUMS
No & Type of Engines:	2 Turbomeca Makila 1A2 turboshaft engines
Year of Manufacture:	2000
Date & Time (UTC):	29 July 2011 at 0845 hrs
Location:	Approximately 30 nm east of Aberdeen
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 17
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	40 years
Commander's Flying Experience:	6,542 hours (of which 5,100 were on type) Last 90 days - 83 hours Last 28 days - 38 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The helicopter was cruising in IMC at an altitude of 3,000 feet when the No 2 Automatic Flight Control System (AFCS) disengaged. The pilots reset the No 2 system but, shortly afterwards, the No 1 system disengaged. The pilots reset the No 1 system but, almost immediately afterwards, both systems disengaged, the helicopter yawed significantly to the right and full left yaw pedal input was required to regain balanced flight. The pilots were unable to re-engage either of the AFCS channels and so elected to descend to find VMC below cloud. Once in VMC, the pilots turned the helicopter towards Aberdeen Airport. They were able to reset the AFCS after approximately 10 minutes and the aircraft landed without further incident.

The operator commented that this was the first such occurrence in over 7 years of their operating this equipment. The manufacturer found independent failures in the two AFCS computers: a pin was broken on a circuit board in one computer and the 15 V supply voltage was out of range from a circuit board in the other.

SERIOUS INCIDENT

Aircraft Type and Registration:	AS365N3 Dauphin II, G-REDG
No & Type of Engines:	2 Turbomeca Arriel 2C turboshaft engines
Year of Manufacture:	2010
Date & Time (UTC):	18 April 2011 at 0837 hrs
Location:	Norwich Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 5
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	37 years
Commander's Flying Experience:	2,300 hours (of which 1,300 were on type) Last 90 days - 73 hours Last 28 days - 20 hours
Information Source:	AAIB Field Investigation

Synopsis

Following a normal despatch and engine start for a routine offshore flight, the ground engineer monitoring the helicopter's departure noticed flames emanating from the No 1 engine. As there was no dedicated means for ground staff to inform ATC of the incident, in order to alert the crew, the ground engineer chased the helicopter along the taxiway to attract the crew's attention and communicate with them using hand signals. The crew shutdown the helicopter and the passengers were evacuated. The ground engineer extinguished a small oil-fed fire in the engine bay with a handheld fire extinguisher from the cockpit. Two Safety Recommendations have been made.

History of the flight

The crew had been tasked with a routine flight to convey passengers and freight to the Pickerill B oil platform, situated 52 nm offshore from Norwich Airport. The flight had been delayed by poor weather, but the helicopter was eventually towed from its hangar and placed on the 'pick up point' (Figure 1) facing east. The 0819 hrs actual weather report for the airport showed a 5 kt wind from 070°, with 3 km visibility.

The crew arrived at the helicopter and the co-pilot occupied his normal left seat in the cockpit. He was acting as the handling pilot. The commander occupied the right seat and was the non-handling pilot. After the crew had started the rotors, the commander vacated the helicopter, to assist the passengers, leaving the co-pilot

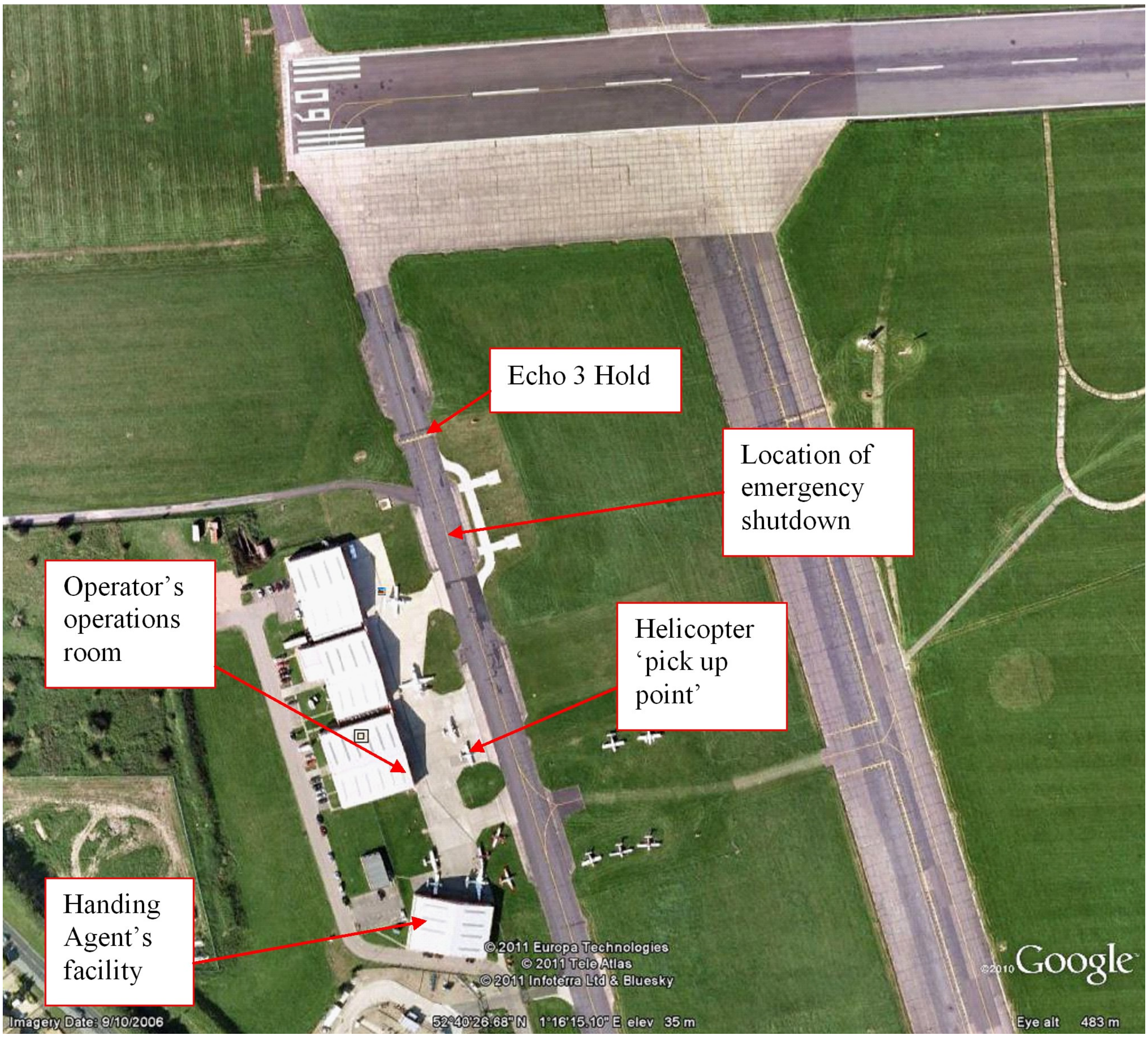

Figure 1

Location of the incident

to complete the final pre-flight checks, which included validating communication frequencies, navigation aids and inserting the route into the navigation system. The co-pilot reported that he then detected a smell in the cockpit similar to that following a chemical wash of the engines, so he opened his window. After completing his checks, he awaited the arrival of the passengers.

The operator's ground engineer, monitoring the engine start, stated there had been no indication of any problem with the helicopter. On completion of the start, he positioned himself on the right side of the helicopter to assist with passenger loading and securing of the helicopter prior to departure. Passenger doors were available on both sides of the helicopter. The commander led the passengers to the helicopter, where they boarded through the right side door. The commander also noticed a smell in the cabin that he attributed to either a cleaning agent or a recent chemical wash of the engines. However, he did not detect the presence of the smell in the cockpit. After the passengers were strapped in, the engineer secured the door, removed the chocks, and then withdrew to the operations room in the hangar where he could monitor the helicopter during departure through the window (Figure 1 and 2).

The engineer reported that as the helicopter taxied away, he observed flames coming from the 7 to 11 o'clock position on the No 1 (left) engine, between the engine and the engine cowling (Figure 2). He did not recollect seeing any smoke at this time. The engineer informed the operator's base manager, who was also in the operations room, to contact the flight crew by radio and tell them to shut the engines down. The base manager attempted to contact the crew but was unsuccessful.

The Duty Air Traffic Control Officer (DATCO) had cleared the helicopter for taxi and so it was ground taxiing northwards along Taxiway Echo to stop at holding point Echo 3 prior to taking off on Runway 09 (Figure 1). At the same time, an employee of the handling agent saw the helicopter from the handling agent's facility. He stated that whilst he had not noticed any smoke when the helicopter was on the 'pick up spot', as it taxied away, he saw blue/black smoke emanating from the exhaust of the No 1 engine, but no flames. He had also tried to contact the crew on the company frequency but with no success.

After leaving the operations room, the engineer ran after the helicopter in an attempt to alert the crew to the fire, which was now evidenced by smoke emanating from the engine compartment. The crew were unaware of the engineer until the passenger behind the co-pilot informed them. Having attracted the crew's attention,

Figure 2

View of the helicopter from the operations room (helicopter pointing east) the engineer gave the hand signal for 'shutdown', which caused confusion, as the crew were unsure of the nature of the problem. The commander gesticulated downwards with his fingers in an attempt to identify if the engineer wanted them to shut down where they were. The engineer nodded and again gave the 'shutdown' signal; he then pointed at the No 1 engine and gave the hand signal for 'fire'. At 0838 hrs, the co-pilot reported to ATC that he had received instructions from the operator to shutdown in his present position. The DATCO asked if they required any assistance, but this was declined.

The engineer approached the helicopter, re-affirmed the requirement to shutdown in-situ, before vacating the area of the rotor disc until the shutdown was complete. The co-pilot admitted he had not recognised the hand signal for 'fire', but understood the shutdown requirement and referenced the abbreviated checklist to commence the normal procedure. The commander, who had recognised the 'fire' signal, actioned the emergency checklist drill for an engine bay fire on ground. The commander partially removed his headset and turned round to the passengers to brief them to remain in the helicopter until the rotors had stopped. There was no internal indication to the pilots of the fire by the aircraft fire warning system. Additionally, the pilots did not observe any abnormal engine indications.

At 0839 hrs, the crew contacted the DATCO and informed him that the helicopter had an engine fire. The Duty Air Traffic Services Assistant (DATSA) contacted the Rescue and Fire Fighting Service (RFFS) and put them on 'local standby'. One minute later the DATCO upgraded the incident to an Aircraft Ground Incident (AGI) and deployed the RFFS. Local procedures state that, in the event of an AGI, ATC should alert the Duty Airfield Operations Officer (DAOO) to the incident. The DAOO is responsible for marshalling the 'passengers and safely transferring them to the airport terminal'. This DAOO was not informed of the incident and at the time he was assisting in the recovery of a broken-down vehicle on the airfield.

When the rotors stopped, the engineer approached the left side of the helicopter, opened the side sliding door and cockpit door, and directed the passengers to evacuate the helicopter and move to a safe distance. The engineer stated that he used the left door to allow him to evacuate the passengers whilst continuing to monitor the status of the engine.

The engineer then opened the No 1 engine cowling and reported seeing a large plume of smoke and a single flame about 6 to 8 inches long on the underside of the engine, with oil dripping from the flange between the gas-generator turbine and power turbine modules onto the transmission tube (Figure 3).

The commander joined the engineer at the open cowling and passed him a handheld fire extinguisher from the cockpit which was used to extinguish the flames. The RFFS, having been dispatched by the DATCO, arrived at the scene at 0843 hrs by which time the fire had been extinguished and all the passengers had returned to the handling agent's facility. The RFFS was stood down at 0845 hrs and the helicopter was recovered to the hangar.

Radio communications

The operator's normal practice at Norwich Airport was for the helicopter's No 2 VHF radio to be selected to the handling agent's company frequency. On first entering the helicopter, prior to the incident, the commander saw that the No 2 VHF radio was selected to the ATC tower frequency. The commander reported he was aware that

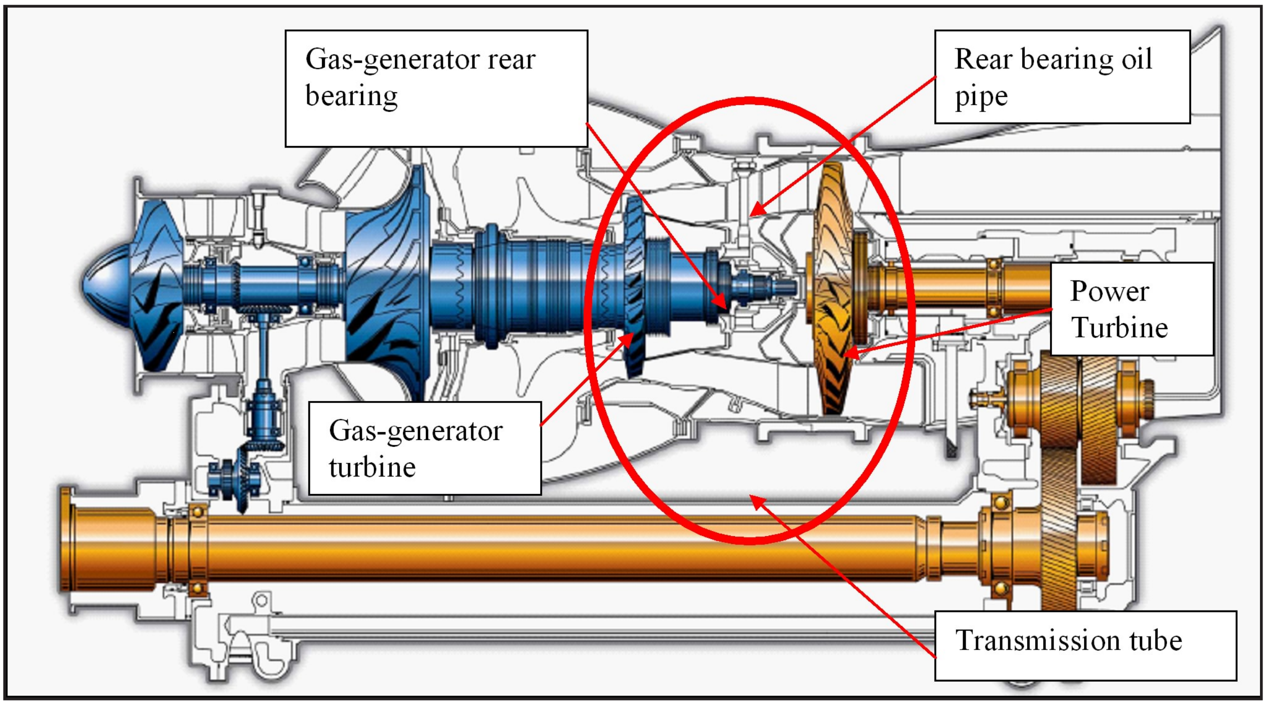

Figure 3

Location of the oil leak and fire

there had been issues with the quality of the audio on the No 1 VHF radio and assumed this was the reason for this selection. Additionally, the crew stated the handling agent's company frequency was frequently busy and, at such times, they tended to deselect it in order to concentrate on ATC communications.

Airport information

The DATCO normally controls aircraft movements from the ATC visual control room, using VHF frequencies. The DATSA answers incoming telephone calls and communicates with airside vehicles on a single UHF frequency. They utilise each form of communication if required, but the normal procedure is for the DATSA to relay communications from the UHF users and telephone to the DATCO. There is a dedicated, direct telephone line between the visual control room and the RFFS control room. However, when RFFS personnel leave the fire station, their only means of communication with ATC is via the UHF radio. This UHF radio frequency is not a dedicated emergency channel and is also used by other airside vehicles. In the event of an incident, radio silence can be imposed on all users except RFFS vehicles, until emergency messages have been passed and acknowledged.

If a member of airport staff witnesses an aircraft incident they can communicate using UHF radio or contact ATC or RFFS via a routine switchboard number.

Aerodrome licensing

CAP 168, chapter 9, paragraph 6.1 states that:

> *'Emergency Orders should be drawn up detailing the lines of communication that will ensure all the agencies (or services) appropriate to the emergency are notified and alerted.'*

Paragraph 6.4 states that:

> *'Each department, section or individual should have on display, or immediately to hand, the Emergency Instructions that apply to their role in each emergency procedure.'*

The Aerodrome Manual contains communications procedures that are to be followed when ATC is aware of an aircraft in distress. The Manual does not contain any procedures for other airport staff to follow to alert key aerodrome personnel, such as ATC or RFFS, should they witness an aircraft emergency.

Maintenance

The helicopter had undergone its first 600 hr maintenance check in the days immediately prior to the incident. During this check, the operator completed maintenance work on both engines to replace the external seals on the gas-generator rear-bearing oil feed, scavenge and breather ducts (Figure 4). Appropriate critical task safeguards had been adhered to including duplicate and independent inspections. Post-maintenance, the helicopter underwent two ground runs and an air test. The first ground run, which lasted approximately seven minutes, identified an oil

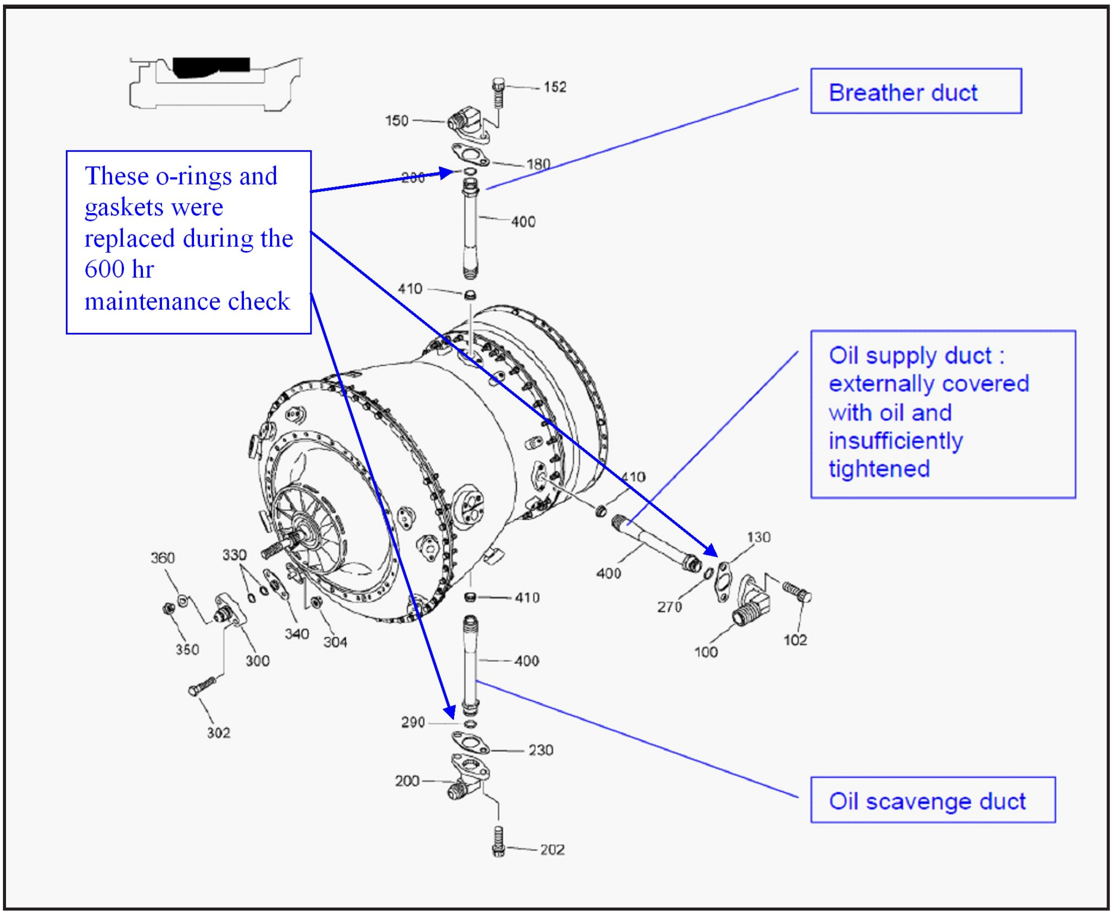

Figure 4

Engine strip findings

leak on the No 2 engine. The oil-feed duct o-ring seal, which had been replaced during maintenance, was again replaced and a second ground run lasting ten minutes was undertaken. During this run, further leak checks and auto-cycle checks were completed[1]. The operator's report stated there had been no evidence of any oil leaks on either engine after this second ground run or after the 15 minute air test, which was to carry out rotor track and balancing on the helicopter.

The operator reported that, during the pre-flight inspection, there was no indication of any fluids leaking onto the helicopter's engine bay decks.

Engine strip findings

The operator removed the engine following the incident and returned it to the manufacturer, who carried out a detailed strip examination. This identified evidence of oil leaking around the split line of the module three and four casings, the lower thermocouple probe ports, and the lower area of the exhaust. Oil contamination was also found in the air cooling system. This indicated that oil was likely to have entered the gas path whilst the engine was operating. During disassembly, the lower connection of the gas-generator rear-bearing oil supply duct was found to have a torque of 10 Nm rather than the required 20 Nm. The outside of the duct was also wet with oil (Figure 4).

The oil ducts have a thread at the lower end, which screws into the bearing housing, with the torque loading sealing the duct against a copper seal. This is achieved by means of a hexagonal collar at the external end of the duct (Figure 5). The right-angle flanged union that caps the duct has a star-shaped fitting, which prevents the duct rotating in service. The flanged union is located by two screws, which screw into a boss on the engine casing. The duct is sealed with the flange by a viton o-ring on the duct and a copper gasket between the flange and the casing. The flange therefore, has to be removed to allow replacement of the o-ring and gasket, which is required every 600 hrs. As a consequence of the star-shaped fitting, if the flanged union is refitted, such that the screw holes do not line up with the casing, the duct has to be rotated clockwise to ensure torque in the lower fitting of the duct is increased rather than reduced. If the duct is rotated anti-clockwise, the torque will be reduced and the duct would no longer seal properly on the copper seal, potentially resulting in an oil leak. The manufacturer advised that there had been no previous experience of a leak caused by loss of torque on the duct. Their experience of oil leaks at the upper connection of the duct immediately after installation, indicated the cause to be damage to the o-ring during its replacement.

The operator considered that the leaking oil from the lower duct connection had pooled in the bottom of the casing, then exited at the split line between the gas-generator and power turbine modules before igniting on the hot engine casing. However, they stated that the torque on the duct had not been changed during the maintenance check. The operator stated that in their opinion the internal oil leak was supplemented by a leak at the o-ring seal (the same o-ring that had been replaced during the maintenance check), as evidenced during the engine strip inspection by oil streak marks on the outer casing, originating from this area. They considered that the o-ring might have been damaged during installation.

Footnote

[1] Auto-cycle checks ensure that the helicopter can function correctly during single engine operation, by reducing each engine to idle in turn and assessing the performance of the higher power engine.

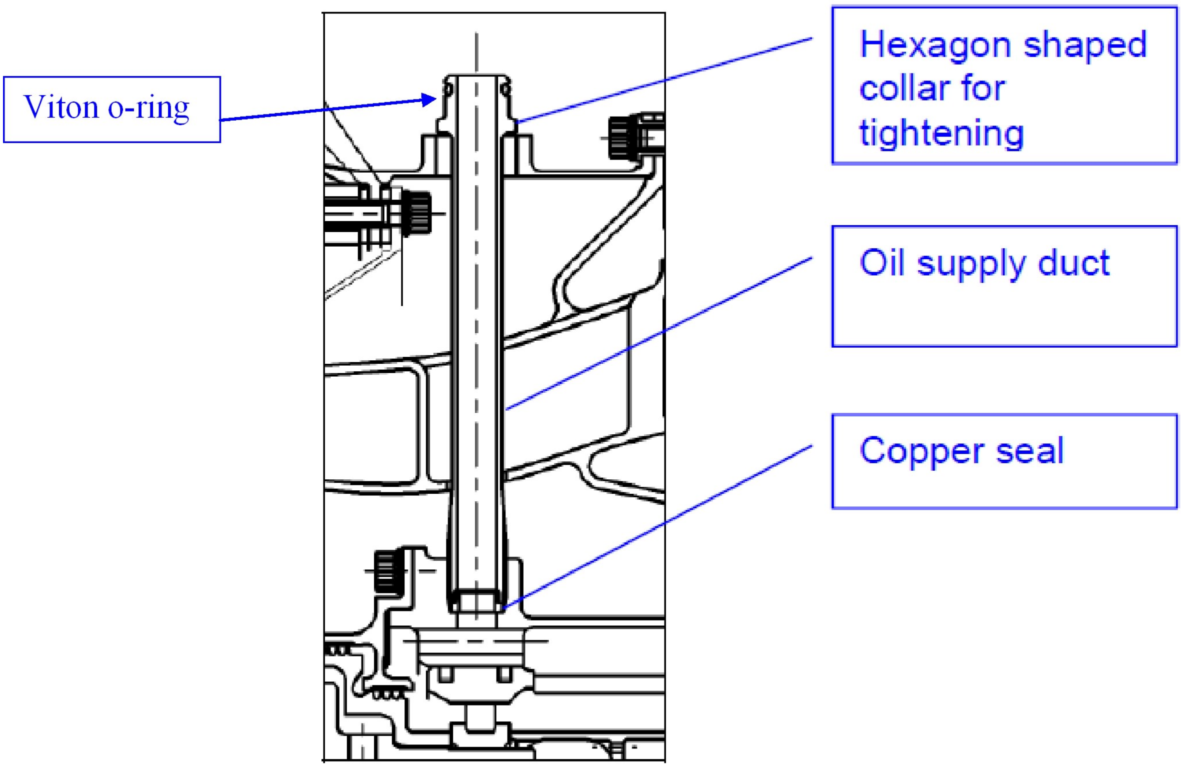

Figure 5

Bearing oil supply duct

Analysis

Emergency reporting and response

The engineer, when he detected the fire in the helicopter and before he left the operations room, requested that his base manager contact the helicopter crew by radio to tell them to shut down. The base manager was unsuccessful in alerting the crew, as the helicopter's radios were not selected to the handling agent's company frequency. He did not call ATC, via the routine switchboard number, at this time. The handling agent employee who witnessed smoke coming from the No 1 engine, also tried to alert the crew using the company frequency but without success.

Having noticed that there was an engine fire, there was a delay in communicating this to the crew. As the helicopter had already departed the pick up point, the engineer took time to reach it. There was an additional delay due to his inability to attract the crew's attention, followed by confusion over the hand signals used. The crew were then made aware of the fire and were able to inform the DATCO. The investigation estimated that over three minutes elapsed between the engineer initially observing the flames and the DATCO alerting the RFFS.

After the helicopter was shut down, the engineer approached and initiated the emergency evacuation of the helicopter, without consultation with the commander. By using the left cabin door to evacuate the passengers, both he and the evacuating passengers were on the same side as the reported fire, despite doors being available on both sides of the helicopter.

Once the passengers were clear of the helicopter, the engineer opened the cowling of the No 1 engine where he had seen signs of the fire. At the time he opened the engine cowl, he was not aware of the extent or origin of the fire. His only means of dealing with the fire was the cockpit fire extinguisher which was provided to him by the commander once he had already opened the cowling.

Whilst the engineer's actions were well intentioned and considered appropriate by him during the incident, had a dedicated system been available for personnel witnessing this incident to rapidly inform ATC, then the DATCO would have received information of the possible fire in the helicopter in a timely manner. The DATCO could have immediately and unambiguously informed the crew of the fire, allowing them to initiate promptly their emergency procedures. Simultaneously, the DATSA could have despatched the RFFS to the scene. This would have negated the perceived need for the engineer to chase after, and approach, the helicopter. When the engineer ran towards the helicopter, he was exposed to unnecessary risk. He was on an active area of the airfield where crews would not expect personnel to be. Additionally, the risk was increased due to his proximity to a helicopter that appeared to be on fire.

Since this incident, the airport has installed a dedicated telephone line, and associated procedures, for airside personnel to use to report anything that could endanger the safety of an aircraft. The investigation found that some other UK regional airports do not have a dedicated emergency system whereby airport staff, on witnessing an aircraft incident, can immediately notify key aerodrome personnel, such as ATC or the RFFS, to the incident. This is now being addressed by the CAA.

The airport emergency plan identifies that in the event of an emergency evacuation of an aircraft on the airfield, the DAOO is responsible for marshalling the evacuated passengers and transferring them to a safe facility. The DAOO was not informed of the incident by ATC and at the time of the incident, he was assisting with the recovery of a broken-down vehicle on the airfield. As a consequence, the emergency plan was not carried out and the passengers were escorted back to the handling agent's departure building by staff from the operator.

As a result of the investigation into this incident, the Airport Operations Director stated that he has reviewed the airport procedures and imposed a requirement that routine procedures will only be conducted when there are at least two AOO staff on duty to ensure that the emergency response capability is maintained at all times.

Engineering analysis

The oil leak from the damaged o-ring on the oil supply duct of the No 2 engine was quickly identified during the first post-maintenance ground run. Given the multiple ground runs and inspections on the No 1 engine, and reports by the operator that there was no evidence of oil leakage at that time, it is unlikely that the o-ring seal on the No 1 engine oil supply duct was the source of the later oil leak. The findings from the engine strip examination identified that the oil leak was from the lower connection of the oil supply duct. If the leaking oil had become entrained in the engine cooling airflow, it is possible that the majority of this oil was expelled from the engine via the gas path during the post-maintenance ground runs. This would have reduced the likelihood of external evidence of a leak and may also explain why the oil leak was not identified during the post-maintenance activity. The presence of oil in the engine airflow is supported by the eyewitness account of blue-black smoke from the engine exhaust observed during the incident, and may have been the cause of the cockpit smell identified by the flight crew prior to the incident. However, if the oil continued to leak overnight, from the lower oil supply duct connection, and pooled in the lower casing of the engine, as the engine was started prior to the incident flight and began to reach operating temperature, a leak path would have developed between the module casings, thus leaking oil onto the transmission tube.

Given that the engine had been operated for 600 hrs without a reported oil leak and the star-shaped fitting prevents rotation of the duct in normal operation, it is unlikely that the low torque on the oil supply duct existed prior to the maintenance input. It is, therefore, possible that the oil supply duct was rotated anti-clockwise during removal or refitting of the flanged union, lowering the torque on the duct from the required 20 Nm to 10 Nm and reducing the contact pressure on the copper seal, thus creating the leak path.

The engine manufacturer advised that they have amended the maintenance manual to include a note identifying the need to rotate the oil ducts in the direction that increases torque on the lower connection rather than reducing it, when aligning the screw holes of the flanged union with the casing. The note states:

> *'Note: If the passage holes of the attaching screws of the flange union and the turbine casing are not aligned, increase duct tightening, refer to task 72-43-10-900-801'*

The note refers to the deliberate action of rotation of the duct during refitting of the flanged union. It does not, however, sufficiently caution against or provide information to highlight, the consequences of reducing the duct torque, and the potential oil leakage if the duct is rotated in the anti-clockwise direction whilst removing or refitting the union. The following Safety Recommendation is made:

Safety Recommendation 2011-095

It is recommended that Turbomeca add a caution to the Arriel 2C Maintenance Manual to highlight the consequences of rotating the gas-generator rear-bearing oil ducts during removal or refitting of the flanged unions and to publish suitable technical advice to operators to raise awareness of this risk.

The manufacturer has advised that they are responding to this recommendation and are in the process of updating their documentation.

The maintenance task of replacing the o-ring on all three oil ducts is scheduled every 600 hrs and was accomplished on both engines during the same maintenance check. In addition, the normal critical maintenance task safeguards, of duplicate inspections and a post-maintenance ground run, did not identify the No 1 engine oil leak. As such, there was little mitigation against the risk of an oil loss leading to engine shutdown or possible fire on both engines during a subsequent flight. The following Safety Recommendation is made:

Safety Recommendation 2011-096

It is recommended that Turbomeca amend the approved maintenance program for Arriel 2C engines, to ensure that the concurrent replacing of the o-rings on the gas-generator rear-bearing oil ducts is not performed on both engines of a helicopter, in order to reduce the risk of an oil loss on both engines during a flight.

Safety Actions

Airport authority

The airport authority advised that they have taken the following action since the incident.

1. The airport authorities have installed a dedicated telephone line, and associated procedures, for airside personnel to use to report direct to ATC anything that could endanger the safety of an aircraft.

2. A review has been conducted into the airport procedures and a requirement has been introduced so that routine AOO procedures will only be conducted when there are at least two AOO staff on duty to ensure that the emergency response capability is maintained at all times.

CAA

The CAA advised that they have taken the following actions since the incident.

1. The CAA issued an Information Notice requesting Aerodrome Licence Holders to review their arrangements for actions to be taken in emergency situations, in particular the alerting procedures.

2. The CAA revised the Aerodrome Inspectors routine inspection checklist to include a check that the aerodrome has an effective system for summoning assistance, which can be used by any person who identifies an aircraft incident or other emergency on the aerodrome.

Helicopter Operator

The helicopter operator has introduced into their maintenance programme, a visual check, following the disturbance of the rear bearing oil supply, scavenge and breather duct o-rings during the 600 hr inspection. After ground runs and leak checks, following the replacement of the o-rings, a boroscope check via the T4 thermocouple port will be carried out to ensure there is no evidence of oil on the ducts or their lower connections to the bearing.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-BODC
No & Type of Engines:	1 Lycoming O-320-D3G piston engine
Year of Manufacture:	1988 (Serial No: 2816041)
Date & Time (UTC):	27 December 2011 at 1420 hrs
Location:	Micklefield, West Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nose landing gearfolded back, left main landing gear sheared off, extensive damage to left wing and forward fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	388 hours (of which 380 were on type) Last 90 days - 6 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During a local sightseeing flight the engine lost power at about 1,100 feet. The pilot was not able to restore power and made a forced landing in a ploughed field, with extensive damage to the landing gear, forward fuselage and left wing.

History of the flight

The pilot had arranged to take three friends for a recreational flight around the Wetherby area, where they lived. The pilot reports that he was particularly careful in his pre-flight checks as one of the passengers had previous piloting experience and the two others were interested in taking flying lessons.

The engine start, the taxi and run-up checks were normal and the pilot took off from Runway 29, climbing to 1,000 feet and then to 1,500 feet. The pilot remained at this altitude while transiting to Wetherby, about five minutes away, where he reduced the power to 1,700-1,800 rpm and descended towards 1,000 feet for a better view placing the carburettor heat control in HOT.

The pilot reports that at about 1,100 feet he advanced the throttle lever, to bring the speed back to 2,300 rpm, but that each time he tried it the engine made what he described as "a sputtering sound". He proceeded to carry out 'Engine failure' checks as he had been taught but without success and, at about 700 feet with the propeller 'windmilling' he set up for a forced landing, making a MAYDAY call to Leeds, who responded with wind speed and direction, and informing his passengers. The best field available appeared to be about a half-mile ahead and slightly to the right, a ploughed field near to the A1(M), with trees and telegraph wires at the near end. He was just able to reach the field, although the length of glide meant he was unable to deploy any flap, and touched down at high pitch attitude, with the stall warner sounding. He held the nose off as long as possible, to avoid a possible cartwheel on the muddy ground, but after some 70 to 80 yards the nosewheel touched down, bringing the aircraft to a sudden stop and folding back the nose leg. The left main landing gear sheared off and damaged the upper surface of the left wing and there was extensive further damage to the propeller, engine cowlings and forward fuselage. When the aircraft came to a halt all four occupants were able to exit in a calm manner and without injury.

The cause of the engine failure remained obscure when the aircraft was later examined at its maintenance facility, with no apparent mechanical defect. On the possibility that the cause of the power failure was carburettor ice, the pilot was confident that he had applied carburettor heat before reducing power to descend to 1,000 feet. However, he did later comment that in similar circumstances he would climb to, and maintain, a greater altitude (say 3,000 feet), giving him longer to diagnose and remedy any loss of power and to allow more options in the case of a forced landing. He further commented that what he believed had helped him in his emergency landing was that he had often practised this from the circuit, with glide approaches, and that these practice glide approaches had helped his judgement of height and distance in the real emergency.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-RVRF
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978
Date & Time (UTC):	29 July 2011 at 1123 hrs
Location:	Newlands Avenue, Eccles, Greater Manchester
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	426 hours (of which 302 were on type) Last 90 days - 3 hours Last 28 days - 1 hour
Information Source:	AAIB Field Investigation

Synopsis

The aircraft suffered an engine stoppage on takeoff at approximately 200 ft, stalled, rolled more than 60° to the left, crashed into houses and caught fire. Both occupants survived the impact and fire but the pilot succumbed to his injuries later in hospital. The most likely cause of the engine stoppage was stiffness of the fuel selector valve causing it to be in an intermediate position, reducing fuel flow to a level too low to sustain continuous engine operation.

History of the flight

The aircraft was on a local flight and had been privately hired from a flying training school. The pilot was expecting a friend to accompany him on the flight but, when the friend did not arrive, the pilot offered the vacant seat to the passenger. Witnesses who saw the pilot before he went to the aircraft describe him as appearing well, alert and in good spirits.

The pre-flight inspection, start-up and taxi were uneventful. The passenger stated that the pilot had carried out the power checks, including a check of the carburettor heat system, and the engine had behaved normally. He also recalled that the pilot operated the fuel selector prior to takeoff as part of the normal pre-flight procedure but he was unsure when this was done. The flying order book for the flying training school states that the pilot should select the tank containing the least fuel for engine start and the fullest tank before the power check. The aircraft took off at

1119 hrs from Runway 09R. The aircraft was within the CG limits and near to the maximum takeoff weight. The pilot was trained to use the PA-38 'short field, obstacle clearance' takeoff technique at Barton, which involved using one stage of flap, rotating the aircraft at 53 KIAS and flying the initial climb at 61 KIAS until 300 ft aal then accelerating and retracting the flaps. Immediately prior to the engine stoppage, the passenger noticed that the pilot operated a control to the left of the control column with his left hand. Although he was unsure which control the pilot operated, the cockpit layout suggests that it is likely to have been a heater or ventilation control.

At an estimated 200 ft aal, the engine suffered a rapid and significant power loss. The pilot transmitted a MAYDAY call stating that he had an engine failure. The passenger stated that the engine behaved as if the throttle had been closed suddenly. One witness, who was standing on the airfield at Barton, stated that he saw a quantity of blue or black smoke around the forward fuselage area just before the aircraft rolled to the left. He indicated that this was a brief event and that there was no smoke or fire visible during the aircraft's descent. Several witnesses stated that the aircraft's nose remained in the climb attitude until the aircraft rolled to the left to more than 60° of bank. Two witnesses stated that the aircraft appeared to slow noticeably before the wing dropped. The aircraft's nose then dropped and the aircraft entered a steep descent, turning to the left, before it struck two houses and came to rest between them. Two witnesses, who observed the latter stages of the descent, described the aircraft's bank and nose-down pitch attitudes reducing just before impact. The aircraft suffered substantial damage on impact and there was a sustained post-crash fire. Both occupants survived the crash and fire but the pilot succumbed to his injuries later in hospital.

Personnel information

The pilot had held a PPL(A) since 1988 and had flown 426 hours. Before gaining his PPL he had flown 460 launches in gliders. Six weeks before the accident he had flown two flights with an instructor during which he had practised circuits, practice forced landing and emergencies, including engine failures after takeoff (EFATO). The instructor stated that, during these flights, the pilot had demonstrated a safe and conscientious approach to his flying and had carried out the various exercises successfully.

Aircraft information

The PA-38 Tomahawk is a single-engine, two-seat aircraft. It has a low wing with integral fuel tanks and a distinctive 'T-tail' style horizontal stabiliser. It has a side-by-side seating arrangement and 'bubble' canopy, with doors on each side of the fuselage. The FAA granted a type certificate to the design in 1977 and the aircraft was in production until 1982.

Following a fatal accident in 1981, the National Transportation Safety Board (NTSB) issued a safety recommendation to fit additional flow strips to the leading edge of the wing. A modification to add these strips to the wings, to improve the stall characteristics, was introduced in FAA Airworthiness Directive 83-14-08 in 1983. Following investigations into further fatal PA-38 accidents in America and Sweden, the NTSB noted that, where stall/spin was a factor, this aircraft had a higher rate of fatal accidents than other similar aircraft and issued a safety recommendation in 1994 to carry out flight testing to determine if the aircraft's stall characteristics met certification requirements. No modifications relating to the stall/spin characteristics have been made since that time.

Fuel selector

The aircraft fuel selector is a large, red, plastic, pointed handle in the centre of the instrument panel. The OFF position is with the handle pointing to the bottom left quadrant. The handle must be rotated clockwise to the top left quadrant to select the left fuel tank. It can then be rotated clockwise to the top right quadrant to select the right fuel tank. To return to the OFF position, the handle is rotated anti-clockwise. To ensure the fuel selector is not selected OFF inadvertently, a small pawl must be pushed against spring pressure to allow the rear of the handle to pass (see Figure 1).

A long steel shaft connects the bottom of the handle to the stem of the brass selector valve, which is located on the aircraft floor, at the bottom of the cockpit side of the engine firewall. The valve has three pipes attached in an inverted 'T' shape, one either side from each fuel tank and one which passes through the firewall to deliver fuel to the engine. The stem of the valve is attached to a plastic plug with two holes in it, which rotates within the body of the valve. When the valve is in the OFF position the plug blanks off the engine delivery pipe. When the plug is rotated to select the left tank, the holes line up with the pipe from the left tank and the engine delivery pipe to allow the fuel to flow. Similarly when rotated again to select the right tank, the holes line up with the engine delivery pipe and the pipe from the right fuel tank. The top of the plug has four recesses aligned in a cross shape. Above this is a spring-loaded, non-rotating washer with a ridge across its diameter. In each of the defined positions of the valve, the ridge in the washer slots into the recesses on the plug, providing a positive detent to give tactile feedback that the holes in the plug are correctly orientated with the feed and exit pipes (see Figure 2).

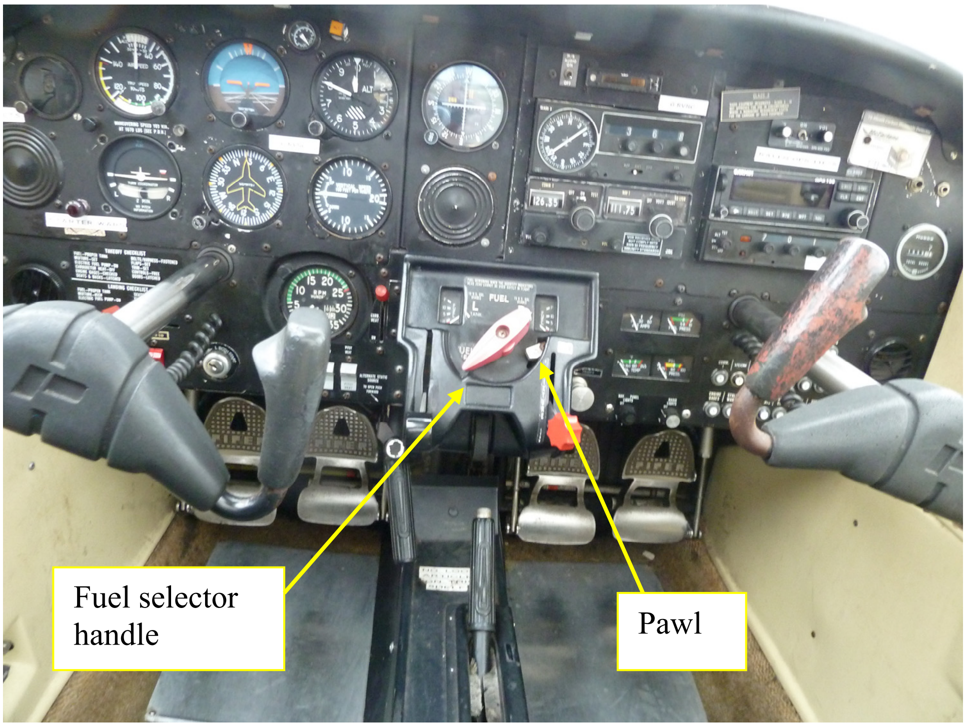

Figure 1

Fuel selector handle in the OFF position

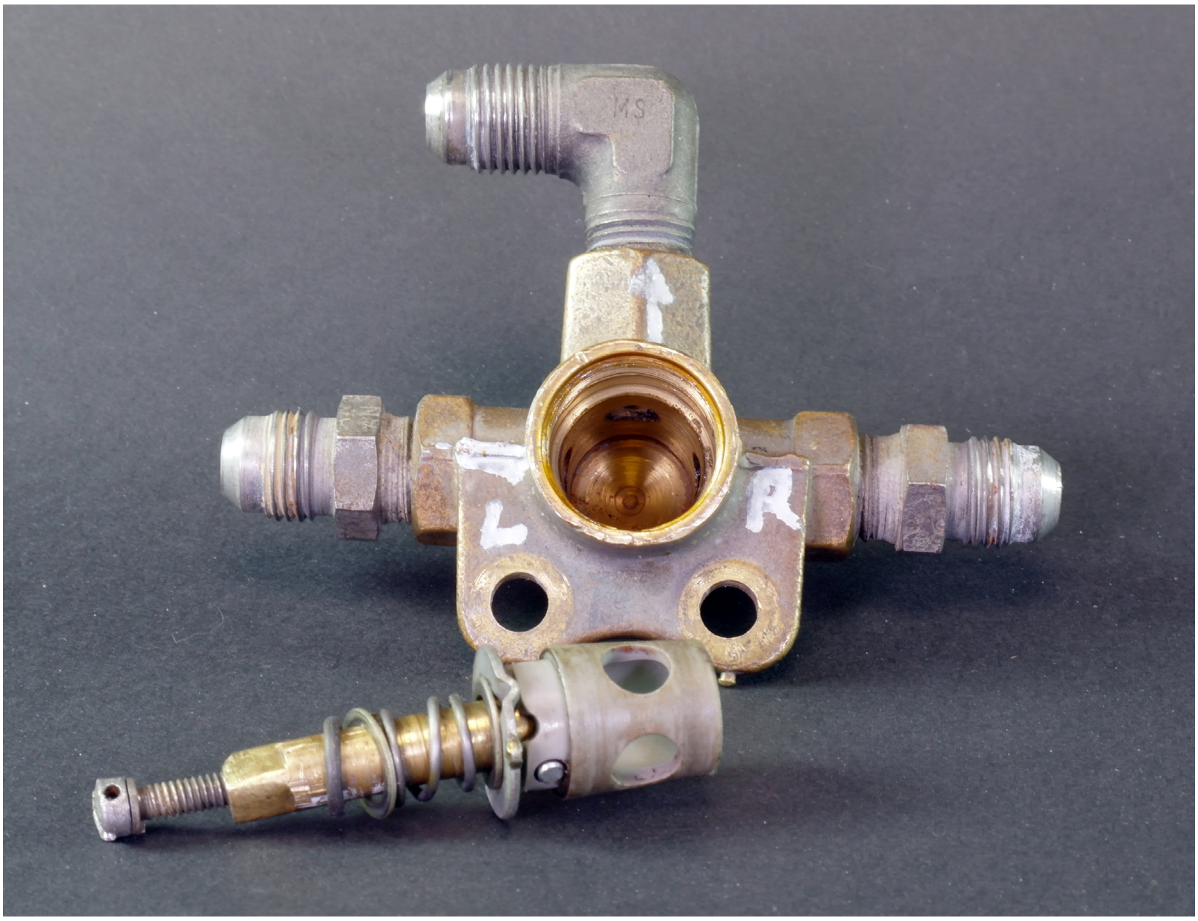

Figure 2

Fuel selector valve (valve cap removed)

Meteorology

The weather conditions at the time of the accident were a surface wind of 070° at 8 kt, visibility greater than 10 km, cloud scattered at 3,000 ft, temperature 16°C, dew point 11°C and QNH of 1025 hPa. These conditions could have produced a moderate risk of carburettor icing[1].

Airport information

Manchester/Barton City Airport is located 5 nm west of Manchester. The airport has four grass runways: the longest (09R/27L) is 621 m in length. Local orders state that practice EFATOs are not permitted on climbout from Runways 09L, 09R and 14. An aerial view of the airfield, the crash site and surrounding area is shown in Figure 3. The open grass area to the southeast of the crash site and to the west of the motorway was, at the time of the accident, a building site with a large stadium in the advanced stages of construction. The area to the north of the housing estate on which the aircraft crashed is a cemetery.

Recorded information

The aircraft taking off from Runway 09 at Barton was captured on a CCTV video system that also recorded sound. The video only captured a small section of the flight and did not include the point at which the engine

Footnote

[1] Civil Aviation Authority - SafetySense Leaflet 14.

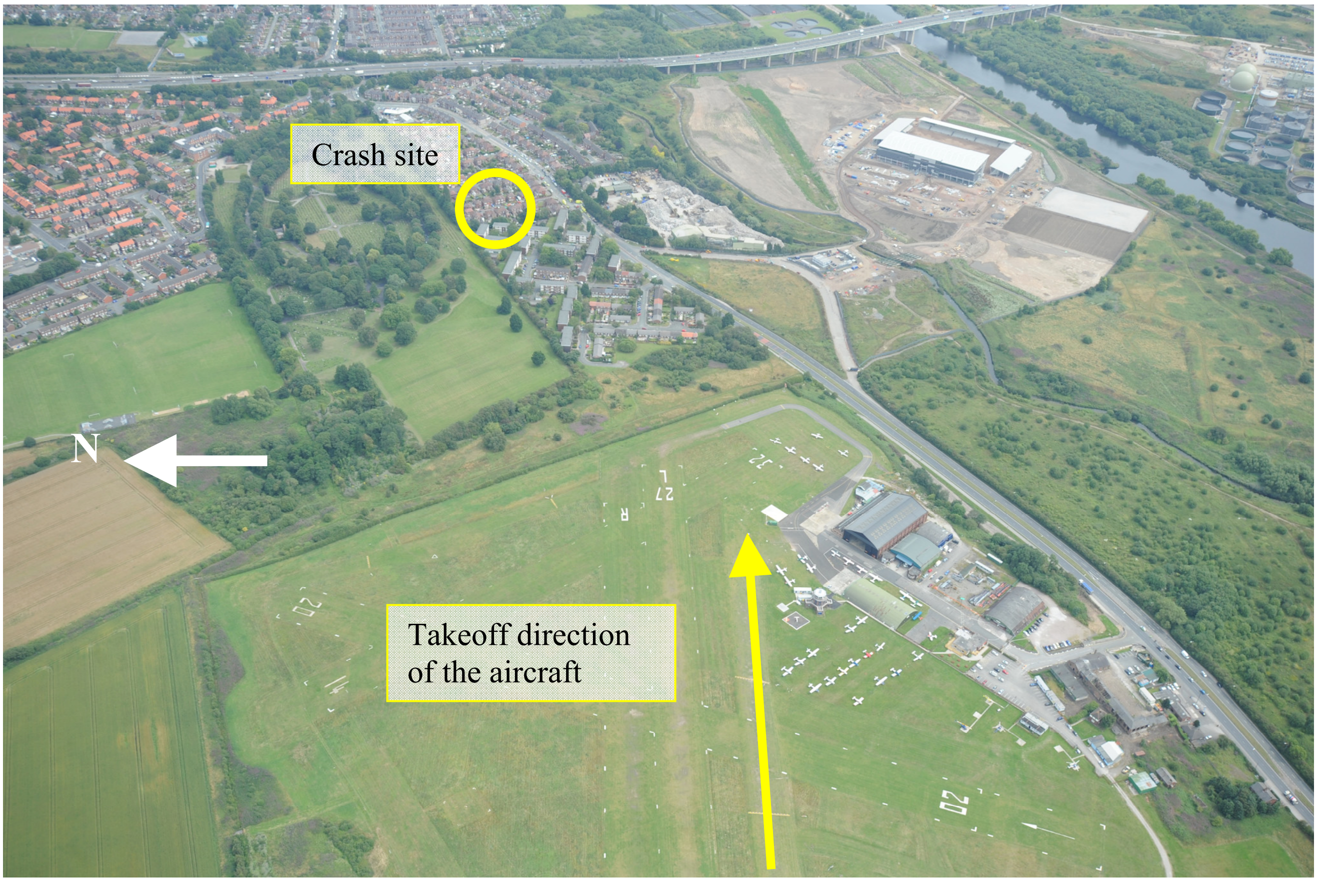

Figure 3

Manchester/Barton Airport

lost power or the start of the takeoff. However, the audio recording captured the sound of the aircraft outside the camera's field of view. Through analysis of this recorded audio, the time between the engine being set to takeoff power and the point at which the engine rpm suddenly reduced was 36 ± 1 seconds.

Accident site

The aircraft came to rest in a driveway between two adjacent houses. The house to the right, when viewed from the back, had a single storey extension to the rear. The roof of this extension had a large number of missing roof tiles and the upper floor window of the house was damaged. The left main landing gear leg and wheel assembly of the aircraft was lodged in the boundary fence to the right of this property. The house to the left of the driveway had a two-storey extension in a mirror image position to the house on the right. The sidewall of this extension, facing the driveway, had a large hole at upper floor level through to the interior of the house. The adjacent wall and roof section also exhibited severe structural damage (see Figure 4). Both houses had suffered significant heat damage from the fire in the immediate area around the aircraft wreckage.

The aircraft had come to rest where a wooden boundary fence between the two houses had been. The T-tail section was suspended inverted and twisted over an intact fence panel. The main fuselage had separated from the tail section and was lying on its right side, pointing along the driveway, to the left of where the fence line had been. The right wing had almost completely separated from the fuselage and was lying diagonally across the width of the driveway with the wingtip against the wall of the house on the right. A six-inch high concrete gravel board in the fence had punctured the integral fuel tank in the wing. The left wing had been almost entirely consumed by fire having detached from the fuselage at the wing root; what remained was lying on the right side of the driveway in front of the right wing. The cockpit structure had been significantly disrupted during the impact and also by the fire and rescue services to enable extraction of the aircraft occupants. Large areas of the fuselage, cockpit and engine bay had suffered significant fire damage during the post-impact fire, but most of the structure was still present. The starter ring and propeller hub had been damaged in the impact, as had one of the two propeller blades, which had curled significantly at the tip. The other blade was relatively undamaged.

Detailed wreckage examination

Initial inspection of the wreckage on-site showed that the throttle was approximately two-thirds open and the mixture lever was in the FULL RICH position. The carburettor heat lever was in the OFF position and the flap lever position confirmed that first stage flaps had been selected. The fuel selector was in the OFF position, as was the magneto key switch. The primer pump was found unlocked and slightly extended from its stowed position. The officers who attended from the fire and rescue services confirmed that they had not intentionally changed any switch or lever positions during the extraction of the aircraft occupants or to make the aircraft safe.

The aircraft was recovered from the accident site for detailed examination. The engine was removed from

Figure 4

Accident site

the fuselage, stripped, and inspected. No evidence was found of pre-impact mechanical failure in the engine or the accessories. The spark plugs were removed and examined; several of the electrode gaps were larger than the maintenance manual limit and there was evidence of what may have been lead fouling, with two of the plugs found to have debris bridging the gap between the electrodes.

The area around the filter bowl and fuel filter had been significantly fire-damaged. There was no fuel remaining anywhere on the aircraft, so no sample could be taken. The fuel system piping that remained post-fire was inspected and no blockages were found, neither were any anomalies with the carburettor identified. As the air intake on the carburettor had been crushed during the impact and then significantly damaged in the fire, it was not possible to confirm its condition or the selected position and serviceability of the carburettor heat system pre-impact.

The fuel selector handle was found in the OFF position but the ridged washer above the valve plug was not located in the detent for the OFF position on the plug. The valve plug was exceptionally stiff and difficult to rotate and the edges of the recessed detents on the top of the plug were also noticeably worn. The dried lubricant on the valve plug contained small particles of the valve body material released by wear between the plug and the valve. The top of the valve stem, which located in a keyway recess on the end of the connecting rod, was also heavily worn, as was the recess into which it fitted. This allowed a degree of rotational movement of the rod without moving the valve, even with the retaining screw tightened and wire-locked. As the valve and fuel selector handle were not rigidly connected, it was possible for a variation to exist between the actual valve position and the position selected by the handle. No evidence was found to indicate that the valve had been damaged or degraded in the crash or subsequent fire.

Maintenance

The engine had reached the manufacturer's maximum overhaul life of 2,400 hrs on the flight prior to the accident. *CAP 747, Generic Requirement No 24* issued by the CAA, permits up to a 20% life extension for engines operated in accordance with their approved Light Aircraft Maintenance Programme (LAMP), as this engine had been. The engine had last been inspected on 14 July 2011, 10 hrs prior to the accident, during a routine 50 hr maintenance check. The aircraft was certified to continue in service with this engine during the 14 July maintenance check, although the life extension had not been annotated in the engine logbook.

The Technical Logbook for the aircraft recorded two defect entries identifying that the engine had been *'rough running'* with the right magneto selected. Maintenance records showed the defects were cleared at the most recent 50 hr check by servicing the spark plugs and replacing one plug that was damaged.

In 1982, the aircraft manufacturer issued Service Letter 944 to address a problem where fuel selector valves had become difficult to rotate, damaging the valve and preventing switching between fuel tanks. The Service Letter introduced a repetitive 400 hr valve disassembly, inspection and lubrication task. The logbook for the accident aircraft identified that this task was last carried out on 25 July 2010, 109 hours prior to the accident. The lubricant specified by the Service Letter has an operating temperature range of -30°C to +230°C.

Medical and pathological information

The post-mortem identified that the pilot had an undiagnosed pre-existing medical condition. This condition can cause incapacitation.

Fire

Eyewitnesses recalled seeing a single "puff" of black smoke from the engine before the aircraft descended, followed by an initial flash of flames as the aircraft impacted with the house. However, a key witness, who was one of the first on the scene after the aircraft came to rest, reported seeing a pool of fluid spreading from beneath the aircraft and then igniting. The fire then engulfed the wreckage. Attempts were made by the first responders to try to protect the aircraft occupants from the fire using water from garden hoses and containers, but the effect was limited due to the extent of the fire. The fire also impinged on the houses either side of the aircraft, causing significant heat damage. However, the timely intervention of the fire and rescue services prevented the fire from spreading.

Survival aspects

With the exception of burns, both occupants of the aircraft had sustained only minor injuries. Had there not been a post-crash fire it is likely that the accident would have been survivable for both occupants.

Investigation test flight

A test flight was carried out to determine the likely flight path of the aircraft following an EFATO. The aircraft tested was aerodynamically similar to the accident aircraft and was of similar weight and CG. The test flight was conducted at 3,500 ft.

During the test flight, the pilot flew the aircraft in the short field takeoff configuration (full power, one stage of flap and 61 KIAS) and an EFATO was simulated by rapidly closing the throttle to idle. The pitch attitude was held constant. As soon as the pilot closed the throttle the aircraft decelerated rapidly. Within 3 seconds, the aircraft stalled. At the point of the stall there was no significant pitch down but the aircraft rolled to 60° left bank. After it rolled, the nose dropped below the horizon and the aircraft entered a descent during which it lost 350 ft. The rapid deceleration to the stall meant that there was no timely stall warning. This test was repeated. This time the aircraft rolled 90° to the left and lost 400 ft in the subsequent descent. During this descent, the pilot observed a rate of descent of 2,000 ft per minute, which was full-scale deflection on the instrument. On both occasions the aircraft stalled at 49±1 KIAS which is consistent with the data in the Pilots Operating Handbook (POH). The POH states that:

> *'Loss of altitude during stalls can be as great as 320 feet, depending on configuration and power.'*

The test was conducted 3,000 ft higher than the altitude at which the accident occurred. The additional height would result in the engine producing less power than during a climb out from Barton and this would result in the test aircraft exhibiting a shallower climb angle and a slower deceleration to the stall. The test was unable to assess the effect of a complete engine stoppage safely but had this occurred, the time to aircraft stall would have been further reduced. Therefore, the 3 second interval experienced on the test flight between engine throttle back and stall probably represents the maximum interval that would have been experienced during the accident flight.

Engineering tests

A number of tests were carried out to determine the significance of the physical evidence found during investigation of the wreckage.

Primer pump test

An equivalent aircraft to the accident aircraft was ground run at takeoff power with the primer pump in various positions from unlocked but stowed, through to fully extended and then with the pump being operated. Although the effect on engine performance of the additional fuel was detrimental, the effect was only momentary and it was not sufficient to cause a rich cut[2].

Ignition system test

The ignition system from the accident engine, comprising both magnetos, both High Tension (HT) lead assemblies and the sparkplugs, was transposed to a serviceable donor engine. The engine was then installed on a calibrated engine test rig. Initially the engine would not start but this was traced to the condition of the HT lead assemblies, which had been damaged in the post-impact fire. When the damaged leads were replaced with new ones, engine performance was normal, despite the visual appearance of the spark plugs.

Fuel starvation test

This test was also conducted on an equivalent aircraft to the accident aircraft, although at a lower outside air temperature than on the day of the accident. The engine was run at full power, then the fuel selector was moved to the OFF position and the time taken for the engine to stop was recorded. The test was repeated a number of times and the process was repeated on a second representative aircraft. Although some variation was seen between aircraft and between tests on the same aircraft, the results were consistently in the region of 25 to 30 seconds.

Fuel selector valve test

Following an initial inspection of the valve, connecting rod and handle, they were replaced in the aircraft and a test was carried out to assess the actual valve plug position against fuel selector handle position. The test identified that the detent position could not be confirmed when turning the selector handle. The results of the test showed that the holes in the valve plug did not align with the feed and exit pipes of the valve, despite the fuel selector handle visually indicating the correct position.

Previous event

On 12 July 2000, a PA-38-112 registered and operated in the USA, lost engine power and hit the ground whilst conducting a practice go-around at Selma Airport in California. The occupants were not injured and there was no fire. The instructor reported that the fuel tank in use had been changed just after rotation on the final go-around. The NTSB investigation confirmed that the engine was not operating at impact. They later identified that although the instructor had selected the fuel selector handle to the OFF position prior to evacuating the aircraft, the fuel selector valve could not be moved, and the valve plug openings were found to be positioned between the left and right port openings. The connecting rod was confirmed to be slipping within its connection in the handle, allowing movement of the handle without movement of the valve.

Footnote

2 Engine stoppage due to the mixture of air and fuel vapour containing too much fuel to support combustion.

Analysis

Operational aspects

The pilot's pre-flight preparation appears to have been normal with all appropriate pre-flight checks carried out. The takeoff and initial climb also appear to have been normal until the aircraft reached an estimated height of 200 ft. At this point the engine suffered a rapid and significant power loss. In the event of a power loss during initial climb out from an airfield, a priority action for a pilot is to lower the nose of the aircraft to prevent it stalling. On this occasion, the pilot does not appear to have lowered the nose after the power loss and the aircraft continued in a climbing attitude and decelerated until it stalled with the aircraft rolling to the left.

The suddenness of the engine stopping meant that the pilot may not have been mentally prepared to carry out the actions required during an EFATO and, although he transmitted an emergency call, he appears to have omitted to lower the nose before the aircraft stalled. The investigation test flight showed that, when using an initial climb speed of 61 KIAS for a 'short field, obstacle clearance' takeoff, a maximum of 3 seconds were available for the pilot to react to an engine stoppage before the aircraft stalled.

The pilot's pre-existing medical condition could have caused incapacitation. However, this is highly unlikely to have been the case as he had adjusted a heater or ventilation control immediately prior to the engine stoppage, transmitted a MAYDAY call immediately after the engine stopped and spoken to the passenger during the descent.

On the investigation test flight a height loss of 350 ft was experienced when the testing pilot was expecting to carry out the recovery manoeuvre. The estimated height of the accident aircraft when it stalled was 200 ft and therefore it is highly unlikely that the pilot could have recovered the aircraft from the descent in the height available. The flight path experienced during the investigation test flight was consistent with the observed flight path of the accident aircraft.

Technical investigation

Accident sequence

During the final moments of the flight, it is likely the aircraft's right wing contacted the extension roof of the first house, which pivoted the aircraft around such that the underside of the aircraft impacted the sidewall of the neighbouring house. The left wing, main gear leg and nosewheel detached during the collision. The aircraft then dropped towards the ground striking the boundary fence, almost completely detaching the right wing, which folded underneath the fuselage. The aircraft came to rest lying on its right side, with the left wing lying over the top and with the tail section hung over the fence panel to the rear. The propeller was not rotating at impact, and had stopped in an approximately vertical position. The lower blade damage was most likely to have occurred as it struck the wall, which also caused damage to the propeller hub and starter ring. The upper blade remained relatively undamaged.

No evidence was found to corroborate the witness report of smoke from the aircraft in-flight. This smoke may have been caused by an attempt to restart the engine by the pilot, although the passenger did not recall the pilot taking any recovery actions after the engine stopped. It is likely that the flames seen by the witnesses following the initial impact were caused by the ignition and flashover of an amount of atomised fuel released by the disruption of the left wing fuel tank during the aircraft's impact with the house. However, the pooling fluid and subsequent sustained fire were most likely due to continued release of the remaining fuel from the left wing tank and, more significantly, leakage of the entire contents of the right wing fuel tank from the hole caused by the impact with the concrete gravel board. Multiple ignition sources were present including hot engine components and the aircraft's damaged electrical system.

Causal factors of the engine stoppage

The account of the passenger and the findings from the investigation support a fuel supply problem as being the most likely cause of the engine stoppage. Analysis of the audio track recovered from the CCTV recording of the accident flight, identified that the engine stopped approximately 36 seconds after it was set to full power at the start of the takeoff roll. The fuel starvation tests showed that the engine would run at high power for a period just less than this on the fuel remaining between the fuel selector valve and the engine.

Based on the passenger's statement, the pilot changed the fuel tank in use while the aircraft was on the ground. Had the pilot inadvertently selected the OFF position on the fuel selector valve then this would have resulted in the engine stopping approximately 30 seconds later. However, given that the recorded data indicates a period at high engine power of greater than 30 seconds and that the spring-loaded pawl preventing inadvertent rotation of the handle to the OFF position was found to be fully serviceable, this scenario is considered unlikely. In addition, although the handle was found in the OFF position post-accident, the magneto key switch was also switched OFF. Selecting these items off is part of the standard emergency actions for an EFATO. As such, these selections were more likely to have been a deliberate action taken by the pilot either just prior to or immediately after impact, or by another unidentified individual attempting to make the aircraft safe immediately after the event.

The balance of evidence from the findings relating to the stiffness of the valve, the relative movement between the valve and the selector handle and the results of the tests carried out, support a more likely cause. When the pilot changed tanks prior to takeoff, he may have turned the handle sufficiently for a correct selection to appear to have been made. However, the stiffness of the valve and the free movement between it and the connecting rod, may have resulted in the plug within the valve not rotating sufficiently to line up the holes with the fuel tank and engine supply pipes fully. The pilot might not have been aware of this as he may not have been able to feel the detent and there was no other means of determining the actual valve position. This would have reduced the supply of fuel to the engine sufficiently that the mixture eventually became too lean to support combustion and the engine stopped. This would also account for the discrepancy between the time identified on the CCTV footage for the engine to stop and the time to engine stop identified during the fuel starvation tests. Although the possibility of some degradation of the valve lubricant due to heat from the post-impact fire can not be ruled out, the lubricant was designed to tolerate temperatures up to 230°C and the valve did not exhibit evidence of impact damage, sooting or heat damage. There was also evidence of progressive wear in the body of the valve. The extent of the wear to the valve stem and the connecting rod also indicate that the valve may have become stiff on a number of previous occasions, despite the repetitive lubrication task being performed. Although the problems relating to lubrication of the valve identified by the NTSB investigation of the accident at Selma Airport had reached a more advanced stage on that aircraft, the basic findings matched those of this investigation, providing further evidence to support this as a potential cause.

Although considered unlikely based on the evidence that was available, a number of other possible causes for the engine stoppage could not be eliminated from the investigation, due to the destruction of evidence by the post-impact fire. These included:

- Carburettor icing
- Fuel contamination or water in the fuel tanks
- Blockage of the fuel system in a section that was destroyed by the post-impact fire.

Conclusion

Although other potential causes for the engine stoppage could not be eliminated from the investigation, the most likely cause, based on the available evidence, was that stiffness of the fuel selector valve and wear on the rod connecting it to the selector handle may have resulted in the valve being in an intermediate position during the takeoff. This would have reduced the fuel flow to a level too low to sustain continuous engine operation. The suddenness of the engine stopping and the limited time available to react to it probably resulted in the pilot omitting to lower the nose before the aircraft stalled. Once the aircraft stalled, it is highly unlikely that he could have recovered the aircraft in the height available.

ACCIDENT

Aircraft Type and Registration:	Vans RV-8, G-XSEA
No & Type of Engines:	1 Superior XP-IO-360-B1AA2 piston engine
Year of Manufacture:	2005
Date & Time (UTC):	14 January 2012 at 1430 hrs
Location:	North Weald Airfield, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tailwheel
Commander's Licence:	Private Pilot's Licence
Commander's Age:	78 years
Commander's Flying Experience:	2,759 hours (of which 113 were on type) Last 90 days - 9 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft landed on Runway 20 at North Weald. At the end of the landing roll the aircraft ground looped, causing damage to the tailwheel. The pilot considered that the limitations in forward view in his tailwheel aircraft together with the glare from the low sun in front of him had caused him to lose his sense of direction temporarily.

BULLETIN CORRECTION

Aircraft type and registration:	Piper PA-178-150 Super Cub, G-BIDK
Date & TIME (UTC):	1 September 2011 at 1420 hrs
Location:	Cranfield Airport, Bedfordshire
Information source:	Air Accident Report Form submitted by the pilot

AAIB Bulletin No 2/2012, page 70 refers

The report erroneously refers to the handling pilot being in the left seat when he was actually occupying the front seat. Therefore, the second sentence should now read:

> The handling pilot, who was in the ***front*** seat, was under instruction and was making an approach to Runway 21 with an 8 kt crosswind from the left.

This was corrected in the online version of the report on 20 February 2012.

BULLETIN CORRECTION

AAIB Bulletin No 2/2012, page 81 refers

Following receipt of an Aircraft Accident Report Form from the pilot of the second aircraft involved, the report published in Bulletin 2/2012 has been updated to clarify the movements of both aircraft prior to the ground collision. The updated report is reproduced below. The online version of the report was updated on 21 February 2012.

ACCIDENT

Aircraft Type and Registration:	1) Zlin Z.526F Trener Master, G-PCDP 2) Ikarus C42 FB80, G-CDVI
No & Type of Engines:	1) 1 Walter M137A piston engine 2) 1 Rotax 912-UL pistion engine
Year of Manufacture:	1) 1971 2) 2006
Date & Time (UTC):	13 November 2011 at 1200 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	1) Private 2) Private
Persons on Board:	1) Crew - 1 Passengers - None 2) Crew - 1 Passengers - 1
Injuries:	1) Crew - None Passengers - N/A 2) Crew - None Passengers - None
Nature of Damage:	1) Propeller and left wing 2) Right wing and tail
Commander's Licence:	1) Private Pilot's Licence 2) National Private Pilot's Licence
Commander's Age:	1) 60 years 2) 59 years
Commander's Flying Experience:	1) 760 hours (of which 397 were on type) Last 90 days - 15 hours Last 28 days - 1 hour 2) 195 hours (of which 195 were on type) Last 90 days - 12 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Forms submitted by both pilots

Synopsis

A ground collision occurred on a taxiway between an Ikarus C42, which had just landed, and a Zlin Trener Master which had taxied from its parking position.

History of the flight

Having landed on Runway 08, G-CDVI began a 180° left turn onto the parallel taxiway. The pilot of G-CDVI reported in his statement that he had observed G-PCDP and that it was stationary on its parking position to the north of the taxiway with its propeller turning. He stated that G-PCDP was still stationary as he completed the turn onto the taxiway before losing it from view.

The pilot of G-PCDP (a monoplane with a conventional tailwheel undercarriage) taxied his aircraft from its parking position to join the taxiway, which was located several metres in front of the aircraft. He stated that he had noticed G-CDVI, which was converging from the left, but he continued to taxi ahead as he expected the other aircraft to give way to him. He also stated that, when taxiing, the forward view from the cockpit was limited and that on the day his view was further impaired by the relative position of the sun. As he turned right to join the taxiway, the pilot saw that G-CDVI was almost directly in front of him. Unable to stop in time, the propeller struck the right wing of G-CDVI. G-PCDP then yawed to the right and its left wing struck the tail of the other aircraft.

FORMAL AIRCRAFT ACCIDENT REPORTS
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2010

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

Published February 2010.

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

Published May 2010.

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

Published May 2010.

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

2011

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.

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