AAIB Bulletin 10/2014

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

01252 512299

Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hants GU11 2HH

Tel: 01252 510300
Fax: 01252 376999
Press enquiries: 0207 944 3118/4292
http://www.aaib.gov.uk

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

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

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

AAIB Bulletins and Reports are available on the Internet
http://www.aaib.gov.uk

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

Extracts may be published without specific permission providing that the source is duly acknowledged, the material is reproduced accurately and it is not used in a derogatory manner or in a misleading context.

Published 9 October 2014

Cover picture courtesy of Stephen R Lynn
(www.srlynnphotography.co.uk)

© Crown copyright 2014

ISSN 0309-4278

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

CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

AAIB FIELD INVESTIGATIONS

AAIB CORRESPONDENCE INVESTIGATIONS

© Crown copyright 2014

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

GENERAL AVIATION Cont

SPORT AVIATION / BALLOONS

MISCELLANEOUS

ADDENDA and CORRECTIONS

(ALL TIMES IN THIS BULLETIN ARE UTC)

© Crown copyright 2014

AAIB Special Bulletins / Interim Reports

AAIB Special Bulletins and Interim Reports

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

© Crown copyright 2014

Farnborough House
Berkshire Copse Road
Aldershot, Hants GU11 2HH

Tel: 01252 510300
Fax: 01252 376999
www.aaib.gov.uk

AAIB
Air Accidents Investigation Branch

AAIB Bulletin S5/2014
SPECIAL

ACCIDENT

Aircraft Type and Registration:	BAE Systems Jetstream 31, G-GAVA
No & Type of Engines:	2 Garrett Airesearch TPE331-10UGR-516H turboprop engines
Year of Manufacture:	1987 (Serial no: 785)
Location:	Doncaster Sheffield Airport, Yorkshire
Date & Time (UTC):	15 August 2014 at 1836 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left main landing gear, left propeller, fuselage and wing
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	8,740 hours (of which 3,263 were on type) Last 90 days - 147 hours Last 24 hours - 6 hours
Information Source:	AAIB Field Investigation

The investigation

The Air Accidents Investigation Branch was notified of the accident at 1840 hrs on Friday 15 August 2014. An investigation was commenced under the provisions of EU Regulation 996/2010 and the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996; the operator, aircraft manufacturer, UK Civil Aviation Authority (CAA) and the European Aviation Safety Authority (EASA) are participating. This Special Bulletin is published to provide details of the initial facts and discussion surrounding the accident;

This Special Bulletin contains facts which have been determined up to the time of issue. It is published to inform the aviation industry and the public of the general circumstances of accidents and serious incidents and should be regarded as tentative and subject to alteration or correction if additional evidence becomes available.

© Crown copyright 2014

it includes information gathered from witness statements, the cockpit voice and flight data recorders, and a preliminary inspection of the aircraft and the accident site. The investigation is ongoing and a final report will be published in due course.

Synopsis

The aircraft's left main landing gear failed shortly after it landed on Runway 20 at Doncaster Sheffield Airport. The left main landing gear detached from its mounts and the aircraft slid along the runway on its remaining landing gear, left wingtip and luggage pannier before veering off the runway and coming to rest on the adjacent grass. The single passenger and the flight crew vacated the aircraft without injury. Preliminary findings indicate that the failure was initiated as a result of stress corrosion cracking in the forward yoke pintle at the top of the left landing gear leg. Further analysis is required to determine the precise details of the failure, however, the preliminary findings are of significance because the same aircraft, operating under a different registration, was involved in a similar accident in 2012[1] during which the right main landing gear failed. The subsequent investigation identified intergranular corrosion / stress corrosion cracking of the forward yoke pintle at the top of the main landing gear leg as the cause of that failure.

Two Safety Recommendations are made.

History of the flight

G-GAVA took off from Belfast City Airport at 1745 hrs operating a scheduled air service to Doncaster Sheffield Airport with one passenger and a crew of two pilots on board. The commander was the Pilot Flying (PF) and the co-pilot was the Pilot Monitoring (PM).

The departure, cruise and approach to Doncaster Sheffield Airport were uneventful. The 1820 hrs ATIS for the airport stated that the wind was from 260º at 5 kt, varying between 220º and 280º. Visibility was greater than 10 km, there were few clouds at 3,000 ft aal, the temperature was 17ºC and the QNH was 1,019 hPa. Although Runway 02 was the active runway, the crew requested radar vectors for a visual final approach to Runway 20, a request which was approved by ATC. The loadsheet recorded that the aircraft's mass at landing was expected to be 5,059 kg which required a target threshold indicated airspeed (IAS) of 101 kt.

The aircraft touched down at 1836 hrs with an IAS of 102 kt and a peak normal acceleration of 1.3 g, and the commander moved the power levers aft to GROUND IDLE followed by REVERSE. As the aircraft decelerated, the commander moved the power levers forward to GROUND IDLE and asked the co-pilot to move the rpm levers to TAXI. At an IAS of 65 kt, eight seconds after touchdown, the left wing dropped suddenly, the aircraft began to yaw to the left and the commander was unable to maintain directional control with either the rudder or the nosewheel steering tiller. The aircraft ran off the left side of the runway and stopped on the grass having turned through approximately 90º. The left landing gear had collapsed and the aircraft had come to a halt resting on its belly, right landing gear and left wing (Figure 1).

Footnote

[1] G-CCPW at Isle of Man Airport on 8 March 2012, report EW/C2012/03/03, published in AAIB Bulletin 10/2012.

© Crown copyright 2014

Figure 1
The aircraft as it came to rest

The commander pulled both FEATHER levers, to ensure that both engines were shut down, and switched the electrics master switch to EMERGENCY OFF. The co-pilot transmitted "TOWER...... [CALLSIGN]" and the controller replied "[CALLSIGN] COPIED, EMERGENCY SERVICES ON THEIR WAY". The commander instructed the co-pilot to evacuate the aircraft. The co-pilot entered the main cabin where he found that the passenger appeared to be uninjured. The co-pilot considered evacuating the aircraft through the emergency exit on the starboard side of the cabin but judged that the main exit on the port side at the rear of the cabin would be the best option. The cabin door released normally but would not open completely because the sill of the doorway was at ground level (Figure 1). Nevertheless, all occupants were able to evacuate the aircraft through the main exit.

Recorded information

The aircraft was fitted with a Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR); both recorders captured the landing at Doncaster Sheffield Airport. The FDR only recorded five parameters which were pressure altitude, heading, airspeed, normal acceleration and a VHF transmission discrete. Additionally, a Terrain Awareness and Warning System (TAWS) was installed in the aircraft, recording 30 separate parameters including aircraft rate of descent, radio altitude and pressure altitude at a higher sampling rate than the FDR. This data is currently being decoded by the TAWS manufacturer.

A review of the previous 82 landings recorded on the FDR has not identified any of concern but it was noted that a peak normal acceleration of 1.72g was recorded during the eighteenth landing prior to the accident. However, this was within the landing gear limit load defined for a touchdown which is a rate of descent of 10 ft/sec at a maximum landing weight of 14,900 lb (6,758 kg).

© Crown copyright 2014

Runway marks and debris

The aircraft left a number of marks on the runway starting approximately 370 m from the start of the runway threshold markings. The first marks were made by the top of the left landing gear cylinder, after it had folded under the wing, followed immediately by the left engine propeller striking the runway surface.

Aircraft damage

The left landing gear had broken away from its trunnions as a result of the failure of the forward yoke pintle housing; two sections of the pintle housing stayed attached to the pintle spigot (Figure 2). However, the landing gear remained attached to the aircraft by the radius arm (retraction jack) and hydraulic pipelines.

The blades on the left engine propeller had been badly damaged. The left aileron balance horn separated from the aircraft after it left the runway, becoming lodged in the soft ground. The left wingtip had sustained abrasion damage, resulting in a fuel leak from this area. The baggage pannier and anti-collision beacon on the underside of the fuselage also sustained considerable abrasion damage.

Landing gear

The Jetstream 31 main landing gear cylinder is manufactured from DTD 5094 aluminium alloy, which is known to be susceptible to stress corrosion cracking (SCC). In particular, SCC in the forward yoke pintle can be caused by the front face of the pintle housing rotating against the spigot bearing during extension and retraction of the landing gear. The resulting abrasion causes degradation of the protective surface treatment on the pintle housing, which can allow corrosion pits to form and ultimately lead to cracking. The Jetstream 32 main landing gear cylinder and later versions of the Jetstream 31 main landing gear cylinder are manufactured from L161 alloy and are not as susceptible to SCC.

Figure 2

Left main landing gear yoke forward pintle

The landing gear is attached to the airframe by trunnions that fit into steel spigots that are bolted to the inside of the yoke pintles. The upper surfaces of the pintles are machined flat to introduce a weak link that, in the event of the landing gear being subjected to a force outside of its design limits, will fail without damaging the fuel tanks. During the accident, the forward yoke pintle failed along this machined flat (Figure 3).

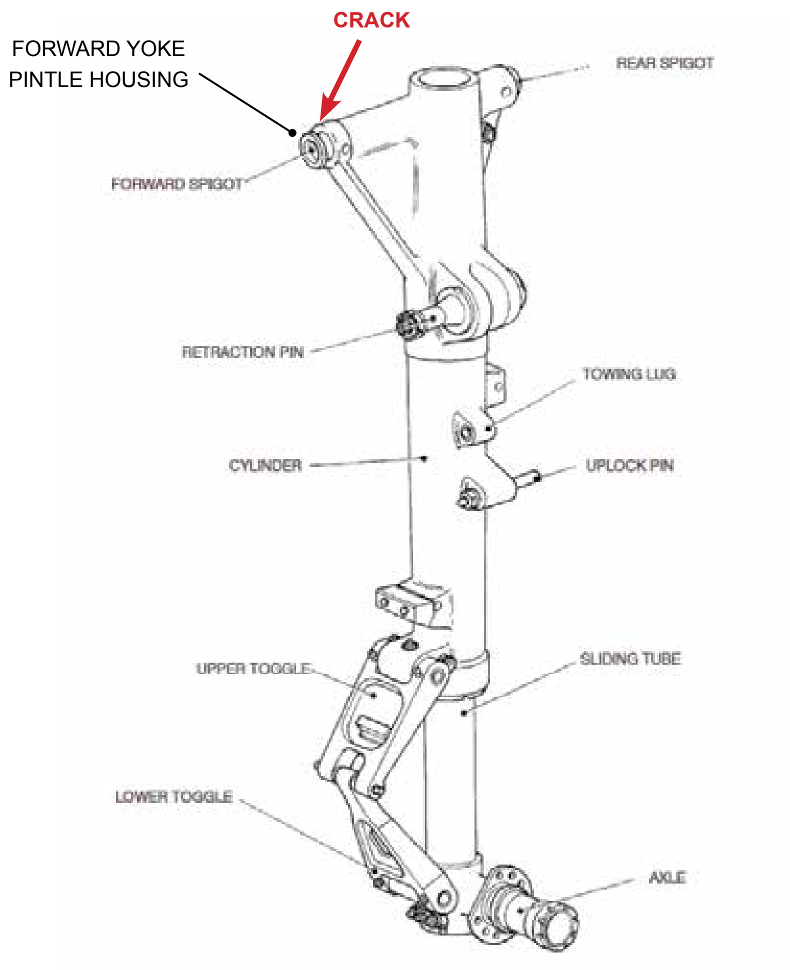


Figure 3

Jetstream 31 main landing gear leg

Previous occurrences

On 8 March 2012, the same aircraft, albeit operating under the registration G-CCPW, suffered a failure to its right main landing gear as it landed at Isle of Man Airport. The subsequent investigation identified intergranular corrosion / stress corrosion cracking of the forward yoke pintle at the top of the main landing gear cylinder as the cause of the failure. The issue of SCC in this area of the Jetstream 31 main landing gear cylinder had previously been identified in 1985 and the AAIB Report into the G-CCPW accident documents the history of the issue. At the time of the G-CCPW accident UK CAA Airworthiness Directive (AD) G-003-01-86 and Mandatory Service Bulletin (SB) 32-A-JA851226, Revision 4 were in force, to require regular high-frequency eddy current and visual inspections of this area. The

© Crown copyright 2014

eddy current inspection was required to be performed every 1,200 cycles or one calendar year, whichever occurred sooner; the visual inspection was required every 300 cycles or three calendar months.

The G-CCPW investigation determined that the existing eddy current and visual inspections had not detected the presence of cracks before failure occurred. In particular, the report raised concerns about the limitations of the eddy current technique in detecting cracks caused by SCC in the forward yoke pintle housing, due to edge effects, minimum detectable crack length and sensitivity of the technique in the presence of corrosion. As a result the investigation made the following Safety Recommendation:

Safety Recommendation 2012-008

It is recommended that the European Aviation Safety Agency review the effectiveness of Airworthiness Directive G-003-01-86 in identifying cracks in the yoke pintle housing on landing gears fitted to Jetstream 31 aircraft.

Safety actions arising from previous occurrences

On 19 June 2013 EASA responded to Safety Recommendation 2012-008 as follows:

'EASA, together with the Type Certificate Holder, is reviewing the effectiveness of the Airworthiness Directive G-003-01-86, and hence the service bulletin, in identifying cracks in the yoke pintle housing. It is agreed that the current service bulletin is not adequate and it is under the process of revision. A revised service bulletin will be produced which will be mandated by an Airworthiness Directive.'

SB 32-A-JA851226 was subsequently revised and Revision 6 was published on 18 December 2013, and was mandated by EASA AD 2013-0208, which superseded AD G-003-01-86. The changes to SB 32-A-JA851226 included revised access instructions, revised instructions for re-protecting the landing gear yoke pintle following the eddy current inspections and various administrative updates. There were no changes to the high-frequency eddy current technique, equipment or inspection intervals.

Following the G-CCPW accident, the aircraft manufacturer decided to place increased emphasis on 'prevention' rather than 'detection' of stress corrosion cracking and so published modification service bulletin SB 32-JM7862, dated May 2013, to introduce a new design solution. This requires installation of a 'special washer' to protect the forward face of the yoke pintle housing from rubbing against the spigot bearing during retraction and extension of the landing gear, and thus prevent initiation of stress corrosion cracking. SB 32-JM7862 requires the washer to be attached to the forward and top faces of the yoke pintle housing using an anaerobically curing, low adhesion, liquid gasket. The washer has a preformed 90º rectangular tab at the top, which is designed to fit against the machined flat on top of the yoke pintle housing, to prevent rotation of the washer. To accommodate the thickness of the washer, a new spigot bearing with reduced flange thickness was also introduced. Although not affected by stress corrosion cracking, this SB is also applicable to Jetstream 31 landing

© Crown copyright 2014

gear made from L161 and Jetstream 32 landing gear. SB 32-JM7862 was mandated by EASA AD 2013-0206.

On 3 December 2013 EASA issued an updated response to Safety Recommendation 2012-008 as follows:

> *'EASA, together with the Type Certificate (TC) holder, has reviewed the effectiveness of the airworthiness Directive G-003-01-86. A new design solution and a new inspection regime have been introduced which have been mandated by EASA AD 2013-0206 and EASA AD 2013-0208, respectively. Furthermore, a new inspection has been introduced in the Component Maintenance Manual of the Main Landing Gear.'*

The new inspection referenced in EASA's updated response relates to an inspection introduced to detect corrosion in the yoke pintle bore. Corrosion in this area was a finding of the G-CCPW investigation, although it was not directly related to the failure of the landing gear. Nonetheless this warranted safety action and was the subject of a separate AAIB Safety Recommendation[1].

Subsequently, in April 2014, the aircraft manufacturer became aware of an integration issue on some aircraft during embodiment of SB 32-JM7862 that caused the bearing locking pins in the spigot bearing cap to protrude from the (reduced thickness) bearing flange and foul on the special washer. Consequently, Revision 2 of SB 32-JM7862 was issued on 13 June 2014, with an instruction to rotate the spigot bearing cap by 180º so that the bearing locking pins did not foul against the washer. The compliance instructions for aircraft which already had Revision 1 of SB 32-JM7862 embodied, were to reverse the orientation of the spigot bearing cap *'at the next convenient maintenance input (e.g. when the aircraft is jacked)'*.

Metallurgy

Preliminary metallurgical examination of the fracture faces on G-GAVA's left landing gear has established that the failure initiated at the top outer edge of the forward yoke pintle and that the crack propagated axially along the top of the pintle, before final overload failure occurred. The presence of corrosion has been identified at the crack initiation site. The forward face of the yoke pintle housing exhibits rotational wear marks and corrosion pitting. There is also evidence of rotational wear marks on both the forward and aft faces of the special washer; further work is required to fully understand the origin of these marks. There was no visual evidence of the presence of gasket material on either of the mating faces of the washer or pintle housing although some gasket material was present on the top machined flat of the housing. Additionally the fracture faces exhibit considerable similarities to those from the G-CCPW accident. This provides strong evidence that the crack initiated due to stress corrosion cracking.

Footnote

[1] AAIB Safety Recommendation 2012-024.

© Crown copyright 2014

Maintenance history

The Jetstream 31 landing gears are required to be overhauled every 10,000 cycles or six calendar years and both main landing gears had last been overhauled in December 2012 and fitted to G-GAVA later that month[1]. At the time of the accident they had accumulated 955 cycles. The last eddy current inspection was carried out on both landing gear legs on 10 December 2013, 803 cycles prior to the accident, with nil findings. During the same maintenance input, SB-32-JM-7862 Revision 1 was embodied to install the protective washer on the forward face of the landing gear yoke pintle of both landing gear legs.

The technical records indicate that while conducting a detailed visual inspection of the landing gear during a subsequent maintenance input in March 2014, the protective washers on both landing gears were observed to have rotated out of position; the documented rectification action was *'MLG reinstalled in accordance with SB 32-JM7862 with protective washer'*. During examination of the aircraft after the accident, the special washer on the left landing gear was observed to be in the correct position, although the rectangular tab was not lying flush over the machined flat of the yoke pintle. Instead it was bent up at a slight angle. There was a fresh gouge in the yoke pintle housing near the edge of the special washer tab, which may have been caused by debris during the landing gear collapse. It was therefore not possible to determine whether the special washer tab was displaced prior to the accident, or as a result of the accident sequence. The special washer on the right landing gear had rotated out of position, by about 15º inboard.

The most recent visual inspection was performed on 30 June 2014, 226 cycles before the accident; no defects were noted. The operator also advised the investigation that they had no reports of the aircraft having sustained a hard or heavy landing.

Discussion

The ground marks on the runway from the failed landing gear and the left engine propeller, together with FDR data and audio analysis of the CVR indicate that the left main gear failed eight seconds after touchdown.

While the aircraft's rate of descent rate prior to landing is yet to be confirmed from the TAWS download, the aircraft weight was considerably below the maximum permissible landing weight and there is currently no evidence to suggest that the landing parameters were outside of the design specification for the landing gear. As such the landing gear should not have failed.

Metallurgical analysis has determined that a crack initiated at the top edge of the forward yoke pintle and propagated axially along the top of the pintle housing, ultimately resulting in an overload failure of the pintle yoke. Further analysis is required to understand the specific characteristics of the failure and how long the crack took to grow to failure. However, there is sufficient evidence to indicate that the failure was precipitated by stress corrosion cracking

Footnote

[1] The left main landing gear on G-GAVA was a different unit to that which was installed at the time of the G-CCPW accident.

© Crown copyright 2014

in the forward yoke pintle. Given the similarities of the failure to that which occurred on G-CCPW, it is evident that the inspections of and the modifications to the left main landing gear of G-GAVA were not effective in preventing this accident.

Rotational wear is evident on the mating faces of the forward yoke pintle and the special washer. Further work is being undertaken to determine the origin of this wear and also whether rotational wear on the forward face of the special washer may be related to fouling of the bearing locking pins. There is no visual evidence of gasket material on the mating faces of the yoke pintle and the special washer; however, it is not yet known whether the gasket material was omitted during installation or had been forced out by the rotating washer. Gasket material is evident on the machined flat of the yoke pintle housing, however this area would be expected to be cleaned to facilitate the regular visual inspections in this area.

Due to the known limitations of the eddy current inspection technique, following the G-CCPW accident the aircraft manufacturer decided to place increased emphasis on 'prevention' rather than 'detection' of stress corrosion cracking in the landing gear yoke pintle. They introduced the modification to install a protective washer on the forward face of the yoke pintle. The investigation determined that it is possible for the special washer to migrate / rotate out of position, which could cause it to abrade on the forward face of the landing gear yoke pintle. Prior to this accident, the aircraft manufacturer was unaware that the washer could rotate out of position and had not been made aware of the previous finding of migration of the special washers on G-GAVA. They also noted that SB 32-JM7862 contains instructions only for initial installation of the special washer and not for subsequent reinstallation in the event of a defect being identified. While the investigation has not yet determined whether the rotation of the washer is due to an installation issue (failure or absence of an effective gasket seal) or an integration issue (fouling of the washer on the bearing locking pins), any rotation would not only negate the protective effect of the washer, but may actively degrade the surface protection on the forward face of the yoke pintle housing. For aircraft with DTD 5094 landing gear with Revision 1 of SB 32-JM7862 embodied, the next opportunity to remove the landing gear and thus determine whether the special washer has caused wear on the forward face of the yoke pintle housing, may not arise until the next annual eddy current inspection. The following Safety Recommendation is therefore made:

Safety Recommendation 2014-038

It is recommended that the European Aviation Safety Agency take action to assure the continued airworthiness of those BAE Systems Jetstream 31 main landing gear legs that are manufactured from DTD 5094 aluminium alloy and have SB 32-JM7862 embodied.

Following publication of Safety Recommendation 2012-008, EASA determined that SB-32-A-JA851226 was inadequate, however, despite the subsequent revision to the SB and the publication of EASA AD 2013-0208, no substantive changes have been made to the NDT technique, equipment or inspection intervals nor to the intermediate visual inspections.

© Crown copyright 2014

It is therefore evident that these actions did not result in increasing the effectiveness of the established inspection regime for detecting the presence of cracks in the landing gear forward yoke pintle housing. As embodiment of SB 32-JM7862 in this case may not have achieved the intended level of protection of the forward yoke pintle, an effective inspection regime for early detection of cracks is imperative. The following Safety Recommendation is therefore made:

Safety Recommendation 2014-039

It is recommended that the European Aviation Safety Agency take action to mandate an effective inspection regime for the Jetstream 31 that will detect cracking and prevent failure of the yoke pintle of main landing gear legs manufactured from DTD 5094 aluminium alloy.

Further work

The investigation is ongoing and this Special Bulletin is based on preliminary information which is subject to change. In particular, further detailed metallurgical examination of the left main landing gear is ongoing to characterise the exact nature of the failure. A comparative examination of the right main landing gear, which was subject to the same overhaul and recent component history, will also be undertaken. The investigation will also consider the maintenance history of the failed landing gear in more detail. The AAIB will publish additional Safety Recommendations if further safety action is required.

Published 2 September 2014

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

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

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

Extracts may be published without specific permission providing that the source is duly acknowledged, the material is reproduced accurately and is not used in a derogatory manner or in a misleading context.

© Crown copyright 2014

Summaries of Aircraft Accident Reports

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

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

© Crown copyright 2014

Aircraft Accident Report No: 3/2014

This report was published on 9 September 2014 and is available in full on the AAIB Website www.gov.uk

Report on the accident to
Agusta A109E, G-CRST
near Vauxhall Bridge, Central London
16 January 2013

Registered Owner and Operator:	Owned by Castle Air Ltd; operated by Rotormotion
Aircraft Type:	Agusta A109E
Nationality:	British
Registration:	G-CRST
Place of Accident:	St George Wharf, Vauxhall, London
Date and Time:	16 January 2013 at 0759 hrs

Synopsis

At 0820 hrs on 16 January 2013 the Air Accidents Investigation Branch (AAIB) was notified that a helicopter flying over central London had collided with a crane and crashed into the street near Vauxhall Bridge. A team of AAIB inspectors and support staff arrived on the scene at 1130 hrs.

The helicopter was flying to the east of London Heliport when it struck the jib of a crane, attached to a building development at St George Wharf, at a height of approximately 700 ft amsl in conditions of reduced meteorological visibility. The pilot, who was the sole occupant of the helicopter, and a pedestrian were fatally injured when the helicopter impacted a building and adjacent roadway.

The investigation identified the following causal factors:

1. The pilot turned onto a collision course with the crane attached to the building and was probably unaware of the helicopter's proximity to the building at the beginning of the turn.
2. The pilot did not see the crane or saw it too late to take effective avoiding action.

The investigation identified the following contributory factor:

1. The pilot continued with his intention to land at the London Heliport despite being unable to remain clear of cloud.

Ten Safety Recommendations have been made.

© Crown copyright 2014

Findings

1. The pilot was properly licensed and qualified to conduct the flight.

2. No evidence was identified of a pre-existing technical defect that was causal or contributory to the accident.

3. The pilot was aware that there was freezing fog over London and that there was a possibility that it would be present at Elstree Aerodrome.

4. The weather at Redhill Aerodrome was suitable for the helicopter's departure.

5. The pilot did not land at Elstree Aerodrome because the weather was unsuitable.

6. Unable to land at Elstree Aerodrome, the pilot requested ATC clearance to return to Redhill Aerodrome.

7. The pilot was cleared by ATC to transit the London CTR under VFR or Special VFR at his discretion.

8. While en route to Redhill Aerodrome, the pilot received a text from the client telling him that London Heliport was open and the pilot asked ATC to confirm that this was the case.

9. Having been told that London Heliport was open, it is probable that the pilot's intention was to land there.

10. London Heliport is closed when its reported meteorological conditions are below a visibility of 1,000 m and a cloud ceiling of 600 ft agl.

11. The pilot did not know the current weather conditions at London Heliport at the time the helicopter began its descent towards the River Thames.

12. The pilot was operating under Special VFR from the time the helicopter began its descent towards the River Thames.

13. The helicopter entered restricted area R157 without permission.

14. The pilot was probably unable to remain continuously clear of cloud as the helicopter approached Vauxhall Bridge.

15. The pilot did not adjust his plan to land at London Heliport when he encountered increasingly challenging weather conditions as the helicopter descended towards, and routed onto, helicopter route H4.

16. ATC cleared the pilot to proceed to London Heliport and he began a turn towards the building at St George Wharf. At the time he began the turn, he was probably unaware of the building's proximity.

© Crown copyright 2014

17. The pilot was possibly distracted by the task of changing radio frequency as he entered the turn towards the building.

18. The helicopter struck a crane attached to the building. At the point of impact, the helicopter was approximately 105 ft from the building.

19. The presence of the crane at St George Wharf was notified through the NOTAM system.

20. There is no requirement for Local Planning Authorities to notify the CAA when granting planning permission for obstacles extending above 300 ft agl when those obstacles are outside safeguarded areas.

21. Between the time of construction of the building and implementation of amended ATC procedures, ATC controllers possibly, and inadvertently, issued clearances compliance with which would breach Rule 5 of the Rules of the Air Regulations.

22. Two-way traffic along helicopter route H4 is no longer possible in certain circumstances using current procedures following construction of the building at St George Wharf.

23. The building at St George Wharf was added to the UK DVOF by coincidence rather than through a systematic process.

24. The building at St George Wharf was not included in the helicopter's obstacle databases.

25. There is no effective system in place to anticipate the potential effects of new obstacles on existing airspace arrangements when the obstacles are outside safeguarded areas.

Causal Factors

1. The pilot turned onto a collision course with the crane attached to the building and was probably unaware of the helicopter's proximity to the building at the beginning of the turn.

2. The pilot did not see the crane or saw it too late to take effective avoiding action.

Contributory Factor

1. The pilot continued with his decision to land at the London Heliport despite being unable to remain clear of cloud.

© Crown copyright 2014

Safety Recommendations

Safety Recommendation 2014-025

It is recommended that the Civil Aviation Authority require UK Air Navigation Service Providers to assess the effect of obstacles, notified through the UK Aeronautical Information Regulation and Control cycle, on operational procedures relating to published VFR routes near those obstacles, and modify procedures to enable pilots to comply simultaneously with ATC instructions, and the Air Navigation Order and Commission Implementing Regulation (EU) 923/2012 as applicable.

Safety Recommendation 2014-026

It is recommended that the Civil Aviation Authority require UK Air Navigation Service Providers to assess the effect of obstacles, notified through the UK Aeronautical Information Regulation and Control cycle, on operational procedures for controlling non-IFR flights within the Control Areas and Control Zones surrounding UK airports, and modify procedures to enable pilots to comply simultaneously with ATC instructions, and the Air Navigation Order and Commission Implementing Regulation (EU) 923/2012 as applicable.

Safety Recommendation 2014-027

It is recommended that the Department for Transport implement, as soon as practicable, a mechanism compliant with Regulation (EU) 73/2010 and applicable to the whole of the UK for the formal reporting and management of obstacle data, including a requirement to report data relating to newly permitted developments.

Safety Recommendation 2014-028

It is recommended that the Department for Transport remind all recipients of the Office of the Deputy Prime Minister Circular 01/2003 that they are requested to notify the Civil Aviation Authority:

1. whenever they grant planning permission for developments which include an obstacle
2. about obstacles not previously notified
3. about obstacles previously notified that no longer exist.

© Crown copyright 2014

Safety Recommendation 2014-029

It is recommended that The Scottish Government remind all recipients of Planning Circular 2/2003 that they are requested to notify the Civil Aviation Authority:

1. whenever they grant planning permission for developments which include an obstacle
2. about obstacles not previously notified
3. about obstacles previously notified that no longer exist.

Safety Recommendation 2014-030

It is recommended that the Department for Transport implement measures that enable the Civil Aviation Authority to assess, before planning permission is granted, the potential implications of new en-route obstacles for airspace arrangements and procedures.

Safety Recommendation 2014-031

It is recommended that the Civil Aviation Authority review Federal Aviation Regulations Part 135 Rules 135.615, *VFR Flight Planning,* and 135.617, *Pre-flight Risk Analysis,* to assess whether their implementation would provide safety benefits for those helicopter operations within the UK for which it is the regulatory authority.

Safety Recommendation 2014-032

It is recommended that the European Aviation Safety Agency review Federal Aviation Regulations Part 135 Rules 135.615, *VFR Flight Planning,* and 135.617, *Pre-flight Risk Analysis,* in advance of the scheduled regulatory standardisation programme, to assess whether their immediate implementation would provide safety benefits for helicopter operations within Europe.

Safety Recommendation 2014-033

It is recommended that the Civil Aviation Authority assess whether mandating the use of Helicopter Terrain Awareness and Warning Systems compliant with Technical Standard Order C194 or European Technical Standard Order C194 would provide safety benefits for helicopter operations within the UK for which it is the regulatory authority.

© Crown copyright 2014

Safety Recommendation 2014-034

It is recommended that the European Aviation Safety Agency assess whether mandating the use of Helicopter Terrain Awareness and Warning Systems compliant with Technical Standard Order C194 or European Technical Standard Order C194 would provide safety benefits for helicopter operations within Europe.

© Crown copyright 2014

AAIB Field Investigation reports

ACCIDENT

Aircraft Type and Registration:	BD-700-1A10 Global 6000, EC-LTF	
No & Type of Engines:	2 Rolls Royce BR710A2-20 turbofan engines	
Year of Manufacture:	2011	
Date & Time (UTC):	6 March 2014 at 1858 hrs	
Location:	Prestwick Airport, Scotland	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 4	Passengers - 2
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to right wingtip, aileron, flap track fairing and slat	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	46	
Commander's Flying Experience:	8,000 hours (of which 1,400 were on type) Last 90 days - 30 hours (all on type) Last 28 days - 20 hours (all on type)	
Information Source:	AAIB Field Investigation	

Synopsis

The right wing touched the runway while landing at night in a crosswind. The technique employed during the landing was different from that recommended in training material published by the manufacturer. Furthermore, the information in the training material about crosswind landings, and data on reduced wingtip clearance with increasing pitch attitude, had not been incorporated into the Airplane Flight Manual (AFM) or the Flight Crew Operating Manual (FCOM).

The pilot flying (PF) was looking through a Head-Up Display (HUD) and his view of the runway may have been impeded because the symbols on the HUD screen were set too bright.

While the investigation was underway, another operator's Global 6000 (CS-GLB) struck a wingtip during a night-time, crosswind landing at Luton Airport. The landing technique employed on CS-GLB shared certain similarities with EC-LTF.

Following these two accidents several safety actions were taken, including amendment of the FCOM to include the Manufacturer's recommended technique when landing with a crosswind.

© Crown copyright 2014

History of the flight

The crew of EC-LTF, consisting of a commander and co-pilot, reported for duty at Barajas Airport, Madrid at 1515 hrs for a flight to Prestwick Airport. A training captain, conducting annual line checks on the pilots, occupied the jump seat.

The co-pilot obtained the ATIS information for Prestwick at 1849 hrs. It reported a surface wind from 190º at 16 kt, 10 km visibility in slight rain, scattered cloud at 1,000 ft aal, broken cloud at 2,000 ft aal, temperature 10ºC, dew point 9ºC, and QNH 1009 hPa. Runway 12, with an LDA of 2,743 m, was reported to be wet.

The flight proceeded without incident until the commander, who was PF, started the approach at night to Runway 12 at Prestwick. The localiser was captured at a range of 7 nm while at an altitude of 2,000 ft amsl. Prior to glideslope capture, the crew observed that the wind calculated by the onboard systems was 90º from the right at 35 kt. The autothrottle was engaged throughout the approach and the autopilot was used until the commander disengaged it at 400 ft agl[1]. There was a HUD fitted above the left glareshield and this was used by the commander, in accordance with standard practice on all approaches.

The V_{REF} for the FLAP 30 landing was 112 KIAS and, with no gusts reported, was used as the target speed for the approach. When cleared to land, the aircraft was passed a wind from 190º at 12 kt which gave a crosswind component of approximately 11 kt. No further wind reports were passed during the approach and the wind speed shown on the aircraft's instruments decreased as the aircraft descended. Passing 1,000 ft agl, the indicated crosswind had reduced to 25 kt and the pilots then had visual contact with the runway. At about the same time, the airspeed reduced to 107 KIAS (V_{REF} minus 5 KIAS), and the commander briefly increased the target airspeed by 3 KIAS to 115 KIAS before resetting it to 112 KIAS (V_{REF}). The autopilot was disengaged at 400 ft agl and the commander continued to compensate for the crosswind by pointing the aircraft's nose to the right of centreline.

At approximately 100 ft agl a nose-down control column input caused the rate of descent to increase and the aircraft deviated below the glideslope. A right wing-down attitude began to develop and, at 85 ft agl, when the aircraft was about 330 m from the displaced threshold, left rudder was applied. In response the aircraft's nose started to align towards the runway centreline and the aircraft rolled quickly left. The commander reacted to what he believed to be a gust of wind by making a control wheel input to the right. He briefly centred the rudder pedals before re-applying left rudder. At the same time, passing 50 ft agl, he commenced a flare by pitching to about 7.5º nose-up. The wings were then held in a near level attitude which required an average control wheel input of 35º to the right but with the rudder pedals almost neutral. This attitude was maintained for approximately 4 seconds and the nose of the aircraft began to yaw to the right. At 6 ft agl, the airspeed had decayed to 106 KIAS (V_{REF} minus 6 KIAS).

Footnote

1 For the purposes of this report the term agl refers to altitude above the reference ground level at the touchdown point.

© Crown copyright 2014

The commander increased the flare by pitching the nose quickly from about 7.5º to about 11.7º. The aircraft then started to roll right rapidly, so the commander reacted by moving the control wheel to about 50º to the left but the aircraft continued rolling right, reaching 11.8º before responding. In this nose-high attitude, the right wing contacted the runway, although the crew were unaware of the wing strike. Shortly afterwards the right main gear compressed with the right wing 7º down, at an airspeed of 99 KIAS (V_{REF} minus 13 KIAS). The aircraft then rolled left before rolling right again and landed left of centreline with about 3.5º right wing down.

The pilots taxied the aircraft to the terminal where the passengers disembarked. The training captain then sat in the cabin while the aircraft was taxied to an overnight parking position and the two operating pilots discussed the landing and the use of the HUD.

A tug driver, working on another aircraft, reported that he had seen sparks from the vicinity of the aircraft when it landed. A subsequent check of the runway revealed two parallel grey marks on the surface of the tarmac, to the right of the centreline and between the displaced threshold and the usual touchdown point. An inspection of the aircraft revealed damage on the right wing.

FDR data was available for the entire flight, with the CVR audio record commencing prior to the approach and ending as the aircraft was shutdown at its overnight parking position. Salient parameters from the FDR, shown in Figure 1, included radio altitude, airspeed, pitch and roll[2] attitude, control wheel[3], control column and rudder pedal position[4].

Aircraft description and damage

The aircraft is a long range business jet designed to carry up to 16 passengers and is a later variant of the Global Express. It is 30.3 m long and has a wingspan of 28.7 m. It can operate at M 0.89 and has a 35° swept wing. The aircraft has a digital glass cockpit design, with four large LCD displays. Data taken from the commander's flight instruments are displayed on a HUD, which is rotated down from its stowed position in the ceiling panel above the left windscreen for use. The co-pilot's position is not fitted with a HUD.

During the accident the aircraft suffered damage consistent with the right wing touching the runway surface at various points across its structure. The composite wingtip had been abraded in three positions, the heaviest contact having worn through the skin exposing the aluminium wing structure beneath. The damage to the rear of the wingtip extended onto the corner of the wing trailing edge. As the flaps and slats had been extended at touch down, the corner of the leading edge slat had been planed flat, as had the rear tip of the outboard flap track fairing. There was also damage to the outboard trailing edge of the aileron and static wick mounts, along with the loss of the two furthest outboard static

Footnote

2 Roll was recorded four times per second.
3 Control wheel was recorded sixteen times per second and the maximum control wheel movement left and right was about 77°.
4 Rudder pedals were recorded at 16 times per second.

© Crown copyright 2014

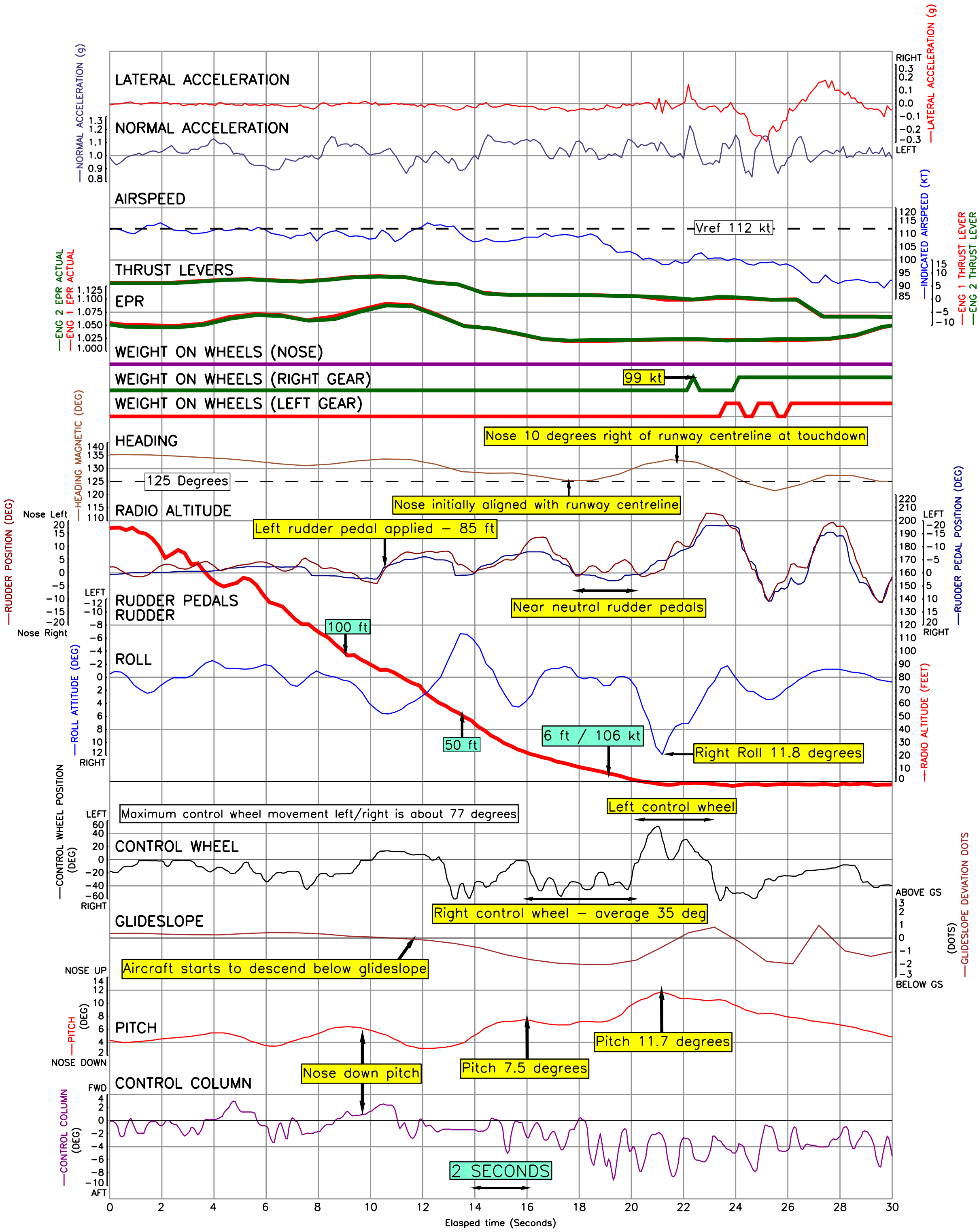


Figure 1

FDR Salient parameters of the approach starting at 200 ft agl wicks fitted to the aileron. No pre-impact technical issues were identified that may have affected the aircraft's handling.

Figure 2
Damage to EC-LTF

Crew comments

The commander of EC-LTF stated that during the approach he believed that he had "straightened" the aircraft to align with the runway when crossing the threshold at V_{REF}. He thought that there had been a strong gust of wind which caused the aircraft to roll left. He had counteracted this with a rapid control column input to the right and that as a result the aircraft rolled right. He said the touchdown was affected by the wind with a further roll to the right but he did not think the bank angle was excessive. Although the touchdown was "unusual", he did not think that damage had occurred.

The co-pilot stated that he always checked the crosswind indicated on the displays after he completed the 'Before Landing' checks. If necessary he would request a wind check but on this occasion he did not believe that the wind was gusting and did not ask for such a check. He was conscious of the roll to the right before touchdown and felt it was "a little bit more than usual" but he was not aware of wing contact with the ground.

Observing from the jump seat, the training captain felt that the commander flew the correct crosswind technique but that the aircraft was affected by a sudden gust prior to touchdown. He saw the commander make a very quick control input in the last 10 ft which appeared to be in reaction to a gust. Like the other pilots, he was not aware that the wing had touched the runway during the landing.

All three pilots commented on what they considered as the standard crosswind landing technique. They stated that the aircraft should be crabbed towards the wind until just before

© Crown copyright 2014

touchdown. The rudder would then be used to align the aircraft with the runway, while an aileron input would be needed to keep the wings level.

While the aircraft was taxied to the overnight parking position, the commander commented about the HUD screen, in that it produced a bright green glow which had disorientated him. He said that the screen acted a bit like a mirror and had impeded his view of the runway and that in future he would not use the HUD at night in windy conditions.

Later he stated that he was comfortable using the HUD but that at night, in good weather conditions, it may become difficult to see some of the symbols on the HUD when there are bright lights in the vicinity of the runway. If the HUD brightness is turned up to counteract this, the effect can be to flood the screen with green light from the symbology. It may then be difficult to discern the runway and its immediate surroundings through the screen.

Prestwick surface wind

The surface wind (from 190º at 16 kt), quoted on the Prestwick ATIS was derived from an anemometer positioned on the eastern side of the airfield, in the vicinity of the touchdown zone for Runway 30. When the landing clearance was given, the crew were informed that the wind was from 190º at 12 kt. This information came from another anemometer, positioned on the western side of the airfield, close to the touchdown zone for Runway 12. An unofficial observation made by ATC personnel was that the wind velocity indicated from the western side of the airfield was usually a few knots less than that from the eastern side with a southerly wind direction.

During the aircraft's approach the indications available to ATC were that the wind velocity remained steady, hence no additional wind checks were given on the radio.

EC-LTF operator's manuals

The AFM stated that the maximum demonstrated crosswind component for takeoff and landing was 29 kt. This was not considered to be limiting when landing and there was no specific crosswind limit relating to use of the HUD for a Category 1 ILS approach.

The FCOM stated that the final approach speed should be V_{REF} for the flap setting, plus half of any gust factor up to a maximum of 10 kt. However, the Operations Manual (OM) Part B stated that the approach speed should be V_{REF} + 5 kt, plus any gust factor. No guidance concerning the crosswind landing technique was provided in the AFM, the FCOM or the OM.

The HUD, for use by the pilot in the left seat only, had been installed in EC-LTF since delivery. The AFM indicated that the HUD could be used for approaches, go-arounds and landings by day or night in VMC and IMC. The OM Part B, which was mostly written in Spanish, had not been updated to reflect the aircraft's entry to service. It included a note that operational approval for the HUD was '*pending*'. A technical description of the HUD was provided in the FCOM but no advice was offered as to how this equipment might be best used by pilots.

© Crown copyright 2014

Manufacturer's guidance and comments

The manufacturer produced an Operations Reference Manual (ORM) and a Pilot Training Guide for the Global 6000. These amplified the information provided in the AFM and the FCOM but they did not form part of the operator's documentation. The crew had online access to the ORM and the Pilot Training Guide and they were expected to refer to them for recurrent simulator training.

The ORM stated: *'Increased airspeeds above V_{REF} may be required upon encountering turbulence, strong crosswinds or gusts,'* and the manual then mentioned the same procedure that was given in the FCOM for adjusting V_{REF} *'if the reported wind contains a gust'*. The manufacturer subsequently stated that the information in the ORM was not correct and the speed increments above V_{REF} were only required in the event of gusts. The manufacturer clarified that the ORM was not an 'approved airplane manual'[5] and was never intended to be used as a flight manual. Unlike the AFM and the FCOM, the ORM is not updated regularly so copies held by flight crew could become out of date.

The manufacturer also explained that for the Global aircraft the V_{REF} is calculated based on V_{SMIN}[6] methodology rather than V_{SR}[7]. For aircraft that adopt fully reduced reference speeds based on V_{SR} methodology, V_{REF} would normally equate to 1.23 x V_{SR} and a significant portion of the certification programme for the Global Express (from which the Global 6000 was developed), was flown with a V_{REF} equating to 1.23 x V_{SR}. However, in agreement with Transport Canada, the manufacturer subsequently reverted to the more conservative V_{SMIN} methodology for defining operating speeds and V_{REF} was calculated as 1.326 x V_{SMIN}. Consequently the V_{REF} used for Global aircraft is between 6 and 8 KIAS greater than it would be if it had been calculated using the 1.23 x V_{SR} formula.

The manufacturer also provided clarification on the effect of speed decay of V_{REF} minus 13 KIAS prior to touchdown. For operational landings[8], the speed decay after the initiation of the landing flare is not expected to exceed 4% of V_{REF}. (With a V_{REF} of 112 KIAS this would equate to 107.5 KIAS.) As far as roll control was concerned, the manufacturer stated that because the dynamic pressure at 99 KIAS is some 20% lower than at 112 KIAS, roll control power would diminish by about 6% at a control wheel angle of 50º but this would not compromise the ability to control the aircraft in roll. During certification tests an aircraft that was heavier than EC-LTF showed good lateral controllability at 100 KIAS in a full rudder sideslip.

Performance calculations for the Global aircraft were based on thrust being reduced to idle as the aircraft passed over the threshold at 50 ft with an airspeed of V_{REF} and on the correct glide path. The instructions in the FCOM for a normal landing was that the thrust levers should move to IDLE at or below 50 ft agl and that aircraft attitude should be maintained until '*close to the runway*' when the pilot should '*Perform partial flare, and touchdown without*

Footnote

5 See *Safety actions.*
6 V_{SMIN} is the non g-corrected stick pusher activation speed.
7 V_{SR} is defined as the reference stall speed of an aircraft at 1g and $V_{SR} = V_{S1G}$.
8 Operational landings are those that are not made under test conditions.

© Crown copyright 2014

holding off'. The ORM noted that the flare should normally commence at approximately 30 ft above touchdown. The ORM also provided the following guidance about the technique for a crosswind landing:

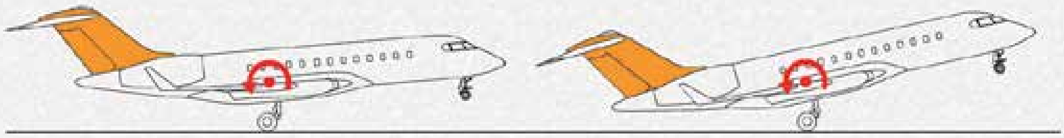
> ***'Crosswind Landing***
>
> ***Wings Level Crab Technique***
>
> *The recommended technique for approach is the wings level crab technique where the aircraft is pointed into the wind to control direction.*
>
> *If a crosswind is present, as the flare is commenced, application of rudder is used to align the fuselage parallel with the runway centreline.*
>
> *As rudder is applied the aircraft will tend to roll in the direction of the rudder input. To counter this, simultaneous input of rudder and opposite aileron is required to keep the wings level. In this wings level condition there will be some sideways drift. A slight into wind, wing down should control the sideways motion.*
>
> *Excessive wing down can cause the wingtip to contact the runway. In order to minimize this possibility, the bank should be limited to less than 3 degrees and the touchdown should occur as soon as the aircraft is aligned with the runway. Prolonging the flare would increase the pitch attitude which brings the wingtip closer to the ground.*
>
> *The aileron input is required throughout the landing roll and the input should be increased as the airspeed decreases.*
>
> *Any lateral motion on final approach should be controlled using aileron inputs. The rudder should not be used to control lateral motion and should only be used in the flare to align the aircraft with the runway.'*

The above guidance was also included in the FCOM for the Global Express (from which the Global 6000 was derived), and for the Global 5000, but was not included in the FCOM for the Global 6000. Additionally, the manufacturer offered a number of online e-learning courses for Global aircraft and these included a module devoted to crosswind takeoffs and landings. Although this was available, the operator of EC-LTF did not require crews to access it. The presentation contained several points that were not mentioned in the manuals, such as a small amount of '*crab'* could be maintained until landing as it would be removed automatically when the mainwheels touched down. It also stressed that pilots should not prolong the flare, as this was likely to lead to a more nose-up attitude which would place the wingtip closer to the ground. Figure 3 shows information presented in this material at the time of the accident. As shown, with an increasing nose-up attitude, the angle of bank that can cause the wingtip to contact the ground during flight decreases:

© Crown copyright 2014

Flare

- Geometry:
  - During the flare, an aircraft will change its pitch attitude around the Center of Pressure (Center of Lift).
  - If the wingtips are aft of this point (as in most swept wing aircraft), as the nose is raised, the wingtips will get closer to the ground.
  - Prolonging the Flare (raising the nose to preserve lift) will reduce the wingtip clearance over the ground.



Landing Flight Planning

- Pitch vs Bank Angle for wing tip contact:
  - Jig column shows the on ground static wing tip contact angle
  - Flight column shows the effect of the lift of the wing increasing the dihedral

PITCH	JIG	FLIGHT
0	10.6	13.5
3	9.6	12.3
6	8.5	11.2
9	7.4	10.1

Figure 3

Manufacturer's slides showing effect of pitch on wingtip clearance

A further slide in the material (Figure 4) discussed use of the HUD during a crosswind landing. It mentioned that a flare cue would appear on the screen at 50 ft agl and if this was followed the aircraft would fly a 1° descent path to touchdown. This would lead to a firm touchdown but would protect against a wing strike. The picture in Figure 4 illustrates how the green symbology of the HUD overlays the external vista at night. The red rectangle is not part of the display but is presented on the picture to highlight the flightpath vector with flare cue symbols above each wingtip. When the flare cue appears the pilot is expected to initiate the flare manoeuvre.

In response to a query about use of the HUD, the manufacturer provided some observations from its senior engineering test pilot. He noted that pilots who were new to HUDs must learn not to fixate on the screen but to "look through" it, otherwise their peripheral view of the outside world could be affected. He said that during this learning process, pilots must find the level of screen brightness with which they were most comfortable and it could take them a few landings to establish this. In his experience, new pilots initially tended to set the

© Crown copyright 2014

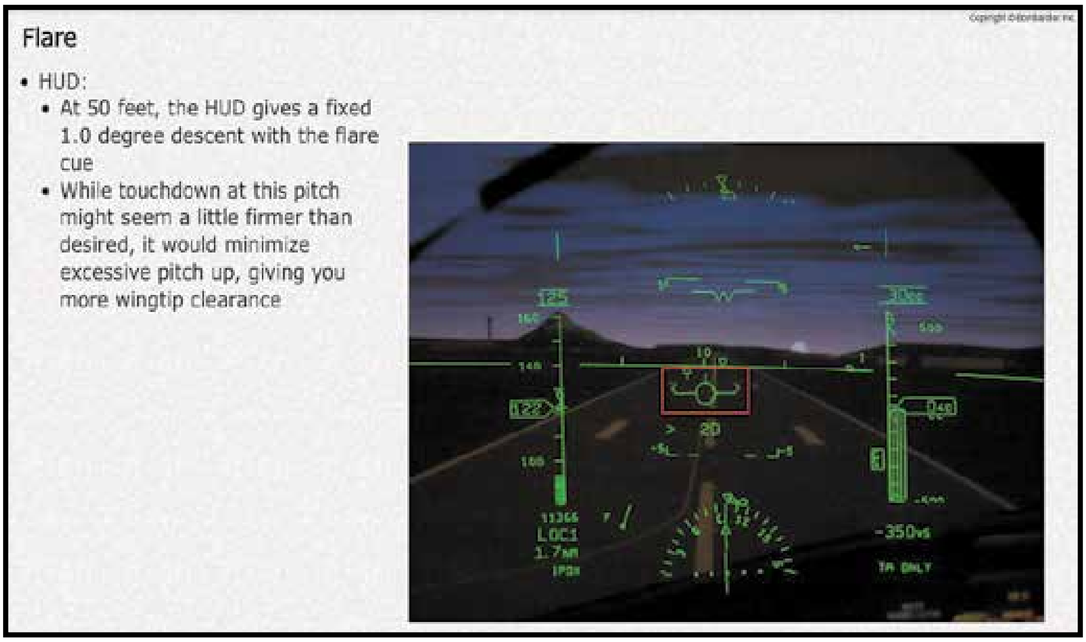


Figure 4

Manufacturer's slide indicating HUD guidance during landing flare

brightness level too high and this could cause the HUD symbology to become distracting. Consequently, during a landing with a significant crosswind, for example, a pilot who has set the brightness too high, may fixate on the screen and not discern all the relevant external cues. To reduce fixation on the screen, pilots should aim to use a HUD all the time when available.

Additionally, the manufacturer passed on an opinion expressed by one of its customer liaison pilots. His personal preference was to turn the HUD off for a crosswind landing, as he found that it "channelized" his visual cues and did not help him to de-crab the aircraft while keeping the wings level.

Flight Data Monitoring (FDM)

EC-LTF was one of 30 aircraft monitored by the operator's FDM programme. Data was processed centrally at the operator's UK headquarters where the readout and initial analysis was performed. Downloads were nominally scheduled at once per month, following which a base-specific report was produced that included an aggregate of the 20 most frequently triggered events[9] for both the month and previous year and the 10 most frequently triggered events by aircraft registration.

Footnote

[9] The core analysis function used within FDM systems is known as 'event' detection, which uses algorithms to identify if parametric data has exceeded pre-defined trigger thresholds. Event algorithms are developed to monitor specific aspects of an aircraft's operation or its systems. To enable operators to categorise the extent to which an operating limit may have been approached or exceeded, varying trigger thresholds are often set for each event.

© Crown copyright 2014

The monthly reports were reviewed by the Spanish AOC holder's Flight Safety Officer (FSO) who would provide feedback to crew and provide the link through which the context of an event could be better understood. If adverse trends were noted, these would be brought to the attention of crew and if necessary, the flight operations department would review the need for changes in training or procedures. The operator advised that it had focused on reviewing and addressing the top 20 aggregated events identified at each base.

The operator's FDM system incorporated three events that monitored for excessive bank angle between 50 ft agl and touchdown (the rollout was also monitored as part of the touchdown event logic). Following the accident the operator reviewed its monthly reports and FDM archive for the 12 months prior to the accident. Due to the relative number of bank angle events, they did not appear in the aggregated list of top 20 events. However, on reviewing the top 10 list of events specific to EC-LTF, the three bank angle events were noted to have been present during a number of reports. A retrospective review of the FDM records by the operator indicated that a precursor to several of the bank angle events was early alignment of the aircraft's nose with the runway centreline during crosswind landings. Among the operator's fleet, EC-LTF was the only Bombardier manufactured Global 6000, although it operated 13 other similar variants from the Global Express family of aircraft. A review of these aircraft did not identify a similar trend of bank angle events or early de-crab manoeuvres.

CS-GLB at Luton Airport

On 17 April 2014, another operator's Bombardier Global 6000, CS-GLB, suffered a left wing tip strike whilst landing at night on Runway 26 at Luton Airport. The approach was made with a crosswind component from the right of about 9 kt and the aircraft was configured at FLAP 30 and flown at a target speed of V_{REF} (112 kt). The HUD was in use but the pilot reported that this did not affect the landing. Analysis of CS-GLB's FDR identified similarities with the final approach of EC-LTF. Left rudder pedal was applied at about 90 ft agl to align the aircraft nose with the runway and there was a gradual increase in pitch attitude to just less than 10° that resulted in a prolonged flare and a reduction of airspeed to V_{REF} minus 7 KIAS at touchdown.

Unlike the landing of EC-LTF, CS-GLB landed firmly with a high lateral acceleration of 0.4g and with the control wheel in a wings level attitude. The aircraft then bounced whilst rolling rapidly to 8.8° left wing down. Right control wheel was applied but this did not prevent the left wingtip contacting the runway. The manufacturer and the operator of CS-GLB are continuing a joint exploration of the aerodynamics and pilot/aircraft flight control interactions during the event in order to gain a more in-depth understanding of the event and, if necessary, take additional safety action.

The crew of CS-GLB were not aware that the left wing had contacted the runway until the damage was identified during the post-landing inspection. The PF believed that the crosswind landing was made in accordance with the technique laid down in his operator's OM, which was for touchdown to occur as soon as the aircraft was aligned with the runway and with a bank angle of no more than 3º. The operator of CS-GLB stated that it was not aware of the advice and guidance provided by the manufacturer, other than that in the AFM and FCOM. In particular, the operator was not aware of the table illustrating the effect of pitch attitude on wingtip clearance.

© Crown copyright 2014

Analysis

EC-LTF

During the approach there was a strong crosswind from the right that reduced as the aircraft descended. The reported crosswind component of 11 kt at the touchdown point was below the maximum demonstrated crosswind and the crew understood that the aircraft should be crabbed into wind until just before touchdown. The manufacturer's training guidance was that de-crabbing should be initiated at the start of the flare, but this was not promulgated to the crew in the OM, the AFM or the FCOM. The FCOM had no guidance for crosswind landings but for a normal landing it stated that below 50 ft agl, when close to the runway, a partial flare should be commenced and that touchdown should take place '*without holding off*'.

The commander believed that he commenced the de-crab manoeuvre as the aircraft passed over the runway threshold, but the data indicated that rudder was applied to start to align the aircraft with the centreline at 85 ft agl, some 330 m before the displaced threshold. This was well before the point recommended in the manufacturer's training material for a de-crab manoeuvre to be initiated. The aircraft then became de-stabilised in roll and the pilots believed that this was due to a gust of wind.

At around 50 ft agl, a flare was initiated. This was above the height at which the manufacturer recommends a flare to start and was likely to be in response to an increased rate of descent, caused by the pitch-down input made at 100 ft agl. Initially, the nose was pitched up to approximately 7.5º but prior to touchdown the attitude rapidly increased until the nose was 11.7º up. During this prolonged flare the airspeed reduced to 99 KIAS (V_{REF} minus 13 KIAS), and the data indicated that the commander tried to maintain a wings level attitude. In doing this the rudder pedals were moved near to neutral and the aircraft's nose yawed right. Whilst at this high pitch attitude, the aircraft rolled quickly to 11.8º causing the right wing tip, aileron, slat and flap fairing to contact the runway. The roll to the right was consistent with the recorded control inputs and a reduction of wind strength.

The high nose-up attitude, during a prolonged flare, increased the likelihood of a wingtip strike. This was explained in the manufacturer's e-learning module, the ORM and the FCOM of other Global variants. This information was not included in the FCOM for the Global 6000 or in the OM.

The practice of the flight crew of EC-LTF was to fly an approach at V_{REF}, except when gusts of wind were present, in accordance with the AFM and the FCOM. The operator's crews did not follow the instruction in their OM Part B, to use V_{REF} + 5 kt as the datum approach speed. The inclusion of this speed in the OM may have been made without the understanding that the manufacturer had certified this aircraft type using a V_{REF} which was more conservative than that used by other aircraft types.

CS-GLB

As in the case of EC-LTF, the crosswind experienced by CS-GLB was below the demonstrated maximum. Other similarities with the accident to EC-LTF, were that the de-crab manoeuvre began early and before the start of a prolonged flare which resulted in a high nose-up

© Crown copyright 2014

attitude. However, unlike EC-LTF, CS-GLB experienced a significant lateral acceleration at touchdown, due to not being aligned with the runway direction. As it touched down the aircraft rolled left and the downwind wingtip struck the runway. The airspeed decay recorded on CS-GLB was not as great as it was for EC-LTF but the decay was still more than the manufacturer's prediction for a normal flare.

The operator of CS-GLB had included a note in its OM to the effect that the bank angle in the flare should be less than 3º and that touchdown should occur as soon as the aircraft was aligned with the runway. The crew understood this instruction. However, the OM, the AFM and the FCOM for CS-GLB also lacked the crosswind landing guidance which the manufacturer presented in the FCOM for other Global variants or supplementary information from the e-learning module.

HUD

The commander of EC-LTF stated on the CVR that he was distracted by the HUD. The symbology on the screen needed to be bright to be discernible against external lights near the runway. The bright symbols may have caused distraction and prevented him from seeing the runway clearly and making it difficult to assess the usual visual cues during the landing.

The reference material provided by the operator to the pilots of EC-LTF did not include any guidance on the use of the HUD.

The pilot of CS-GLB made use of the HUD during his landing but did not believe that this affected the outcome.

The e-learning module produced by the manufacturer recommended that pilots should follow the flare cue below 50 ft aal when using the HUD for landing. This would give a 1º descent path and would lead to a firm landing with minimal pitch-up.

Representatives from the manufacturer acknowledged that pilots need to adjust the HUD brightness correctly, to allow them to "look through" the screen and see external features without being fixated by the symbology. To retain this ability, pilots should use the HUD all the time, when available, although they may decide to stow it prior to a demanding crosswind landing.

FDM

During the 12 months prior to the accident the crew of EC-LTF had triggered a number of high bank angle events, with retrospective analysis by the operator indicating that earlier than specified alignment of the aircraft nose with the runway centreline was evident. However, this had gone unnoticed as the relatively low number of bank angle events, which in part may have been a function of the low number of aircraft movements relative to crosswind landings, meant that they had not appeared in the operators list of top 20 events which had been prioritised as part of its review process. This accident has highlighted the need not only to review high rate events, but also to conduct routine reviews of FDM data for lower level trends.

© Crown copyright 2014

The operator of EC-LTF advised that following the accident it has made a number of changes to its FDM programme. This includes reducing the bank angle event trigger thresholds[10] to assist in identifying the earlier onset of an adverse trend, increased focus on bank angle and pitch attitude events during the landing and the FDM and Safety departments providing additional assistance to FSO's during the FDM monthly report review and follow-up with crew[11].

Safety actions

During the course of this investigation, the manufacturer amended the FCOM for the Global 6000 by adding the guidance on crosswind landings which is presented in the Global 6000 ORM and in the FCOM for other Global types. The manufacturer also carried out an internal review of its training material for wingtip strike avoidance to ensure that the issues highlighted by these accidents are understood across the community of pilots who fly Global aircraft. After this review the manufacturer:

- Amended and updated the e-learning module relating to crosswind operations in Global variants.
- Put in place a communication campaign designed to make all pilots of the Global series aircraft aware of the issues associated with crosswind operations. Emphasis is to be placed on using the rudder to de-crab while using the control wheel to keep wings level and then landing expeditiously. The flare should not be prolonged.
- Initiated discussions with training providers to ensure that all trainers teach the proper crosswind landing techniques and promote awareness of the associated issues.
- Added a note, in the new e-learning module, about the HUD, which stated that pilots should be familiar and current with HUD use and that if it was not used regularly the symbols and information could become distracting. Pilots who were unfamiliar or not current with HUD use were told they should not use it for crosswind situations. Another additional note stated that in strong crosswinds the flightpath vector on the HUD could become "non-conformal" and that pilots may therefore find it helpful to "cage the flightpath vector".
- Stated that in the short-term the language in the ORM regarding speed additives in crosswind situations would be brought into line with the AFM and the FCOM. There is a medium to long-term plan to make additional improvements to the FCOM and phase out the ORM.

Footnote

[10] The operator's FDM system provided three thresholds for each event termed as minor, major and critical. The minor, major and critical thresholds for the events monitoring bank angle from 20 ft agl to touchdown and at touchdown including the rollout were reduced from 4°, 5° and 6° to 3.5°, 3.75° and 4° respectively.

[11] If an event required the crew to be contacted, the UK AOC raised a Safety Occurrence Report (SOR) to provide traceability and to record, among other details, any safety actions. Following the accident, a similar process is to be introduced by the Spanish AOC holder.

© Crown copyright 2014

Several safety actions by the operators of EC-LTF and CS-GLB were taken as a result of the investigation:

- The operator of EC-LTF updated its OM and included some of the information provided by the manufacturer relating to crosswind landings and use of the HUD.
- The operators of EC-LTF and CS-GLB undertook to ensure that all their pilots of Global series aircraft completed the manufacturer's revised e-learning module on crosswind landings.
- The operators of EC-LTF and CS-GLB provided extra training in crosswind operations for their pilots when they next visited a simulator for recurrent training.
- The operators of EC-LTF and CS-GLB made changes to their FDM programmes.

© Crown copyright 2014

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-300, VP-CKY
No & Type of Engines:	2 CFM56-3B2 turbofan engines
Year of Manufacture:	1992 (Serial no: 26282)
Date & Time (UTC):	15 January 2014 at 2249 hrs (local Grand Cayman time)
Location:	Owen Roberts International Airport, Grand Cayman
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 64
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	18,450 hours (of which 13,800 were on type) Last 90 days - 65 hours Last 28 days - 42 hours
Information Source:	AAIB Field Investigation

Synopsis

Following an unstable approach to a wet runway, the aircraft was flared for landing but floated along the runway. The commander extended the speed brakes to cause the aircraft to touch down and applied maximum reverse thrust and braking. Reverse thrust was cancelled at a groundspeed of 22 kt with 139 m of runway remaining.

One Safety Recommendation is made relating to the reporting of serious incidents and one relating to the reporting of surface winds at Owen Roberts International Airport.

History of the flight

VP-CKY was operating a scheduled passenger flight between Miami, Florida and Grand Cayman, Cayman Islands, with six crew and 64 passengers on board. The commander was the pilot flying (PF) and the co-pilot was the pilot monitoring (PM). The crew recorded the ATIS (valued at 2200 hrs local time)[1] for Owen Roberts International Airport at Grand Cayman, which reported a calm surface wind, a visibility of 10 km, few clouds at 1,800 ft and broken cloud at 3,500 ft above the airfield. The temperature was 24°C and the sea level pressure was 1011 hPa. The crew planned to make a visual approach to Runway 08

Footnote

[1] Local time in the Cayman Islands is UTC - 5 hours and local time is used throughout this report. The event took place on 15 January 2014 at 2249 hrs local time (16 January 2014 at 0349 UTC).

© Crown copyright 2014

at the airport by routing from the north west of the island towards the Final Approach Fix (FAF) before turning onto the final approach. The approach was to be made using Flap 40 with a V_{REF} of 133 kt and an Autobrake setting of 3[2]. Figure 1 shows the actual track flown by the aircraft.

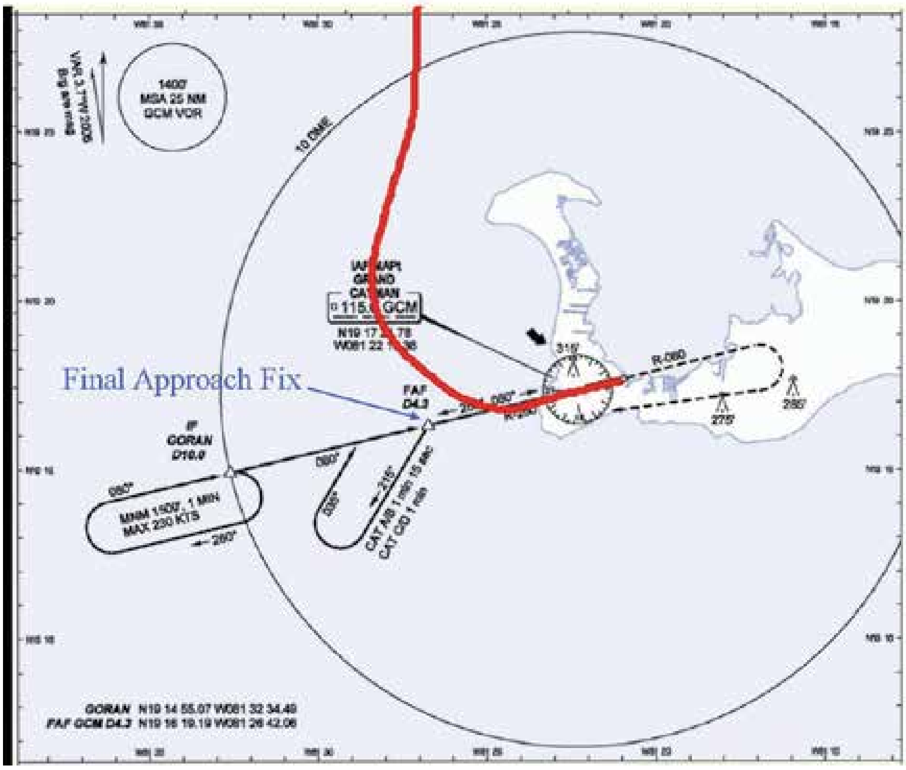


Figure 1

Extract from the Cayman Islands AIP showing the track flown by VP-CKY on its approach to Runway 08 at Owen Roberts International Airport

When the crew of VP-CKY first contacted Cayman Approach control, the Air Traffic Control Officer (ATCO) reported that there were light to moderate rain showers at the airport with a visibility of 2 nm. He also reported that there were rain showers approaching the airport from the east-southeast, moving north-northwest. VP-CKY was cleared to route via ATUVI[3] to the FAF and to descend to 1,500 ft amsl. At 2238 hrs, when the crew reported their position at ATUVI descending through Flight Level (FL) 130, the ATCO (who was in the visual control room in the ATC tower at the airport) reported that the visibility on final approach was now less than 0.5 nm. The commander reported to ATC that he could see on the aircraft's weather radar a "WALL OF BUILD-UP" running "ALL THE WAY OVER GRAND CAYMAN AND OVER THE VOR". The Cayman Islands National Weather Service later provided an image, timed at 2230 hrs, which shows the band of showers to which the commander referred. The colours yellow, amber and red in Figure 2 indicate increasingly heavy precipitation.

Footnote

[2] Available Autobrake settings are OFF, 1, 2, 3 and MAX.
[3] ATUVI is 43 nm north of the airport.

© Crown copyright 2014

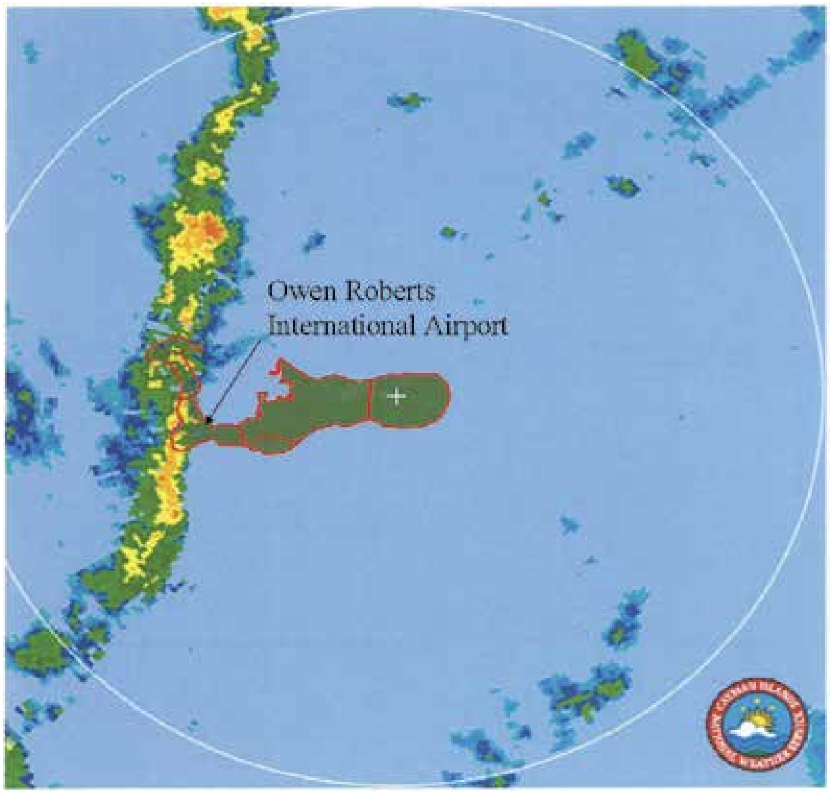


Figure 2

Weather image at 2230 hrs provided by the Cayman Islands National Weather Service showing the line of showers referred to by the commander of VP-CKY

The commander transmitted that he intended to route to the right (west) of a line towards the VOR and position on base leg for the runway. As a backup plan, the commander said that he would pass over the VOR and position to the east of the airport where the weather looked better on the aircraft's weather radar.

At approximately 2248 hrs, the crew reported that the aircraft was at an altitude of 1,500 ft and on a 5.5 nm base leg for Runway 08. The ATCO cleared the crew for a visual approach and to report when on final approach. Approximately 30 seconds later, the crew reported that the field was in sight and the controller cleared them to land, adding that the surface wind was from 350° at less than 5 kt. The aircraft touched down at 2249:25 hrs.

At 2250 hrs, the ATCO transmitted "107 TOWER" and, after the commander replied "GO AHEAD", he said "JUST MAKING SURE YOU'RE STILL ON [the runway]; BACKTRACK VACATE CHARLIE". The commander asked for the current wind velocity and was told that the anemometer was indicating calm wind while the digital system was indicating wind from 260° at 5 kt gusting to 15 kt[4].

Footnote

4 See the section, *Information from the Air Traffic Control Officer,* for an explanation of the two systems.

© Crown copyright 2014

Recorded data

Flight data recorded on the aircraft's Quick Access Recorder (QAR) was available from the flight and salient parameters relating to the approach and landing are shown in Figures 3 and 4.

The approach

Figure 3 starts with the aircraft at 1,300 ft amsl on the approach to Runway 08. At 1,000 ft amsl (992 ft aal), the landing gear was down, the flap was passing the Flap 15 position in transit to a final flap setting of Flap 30, and the calibrated airspeed (CAS[5]) was 188 kt. The engines were set at idle thrust during the descent from 1,100 ft to 550 ft amsl, during which the average rate of descent was 1,200 ft/min.

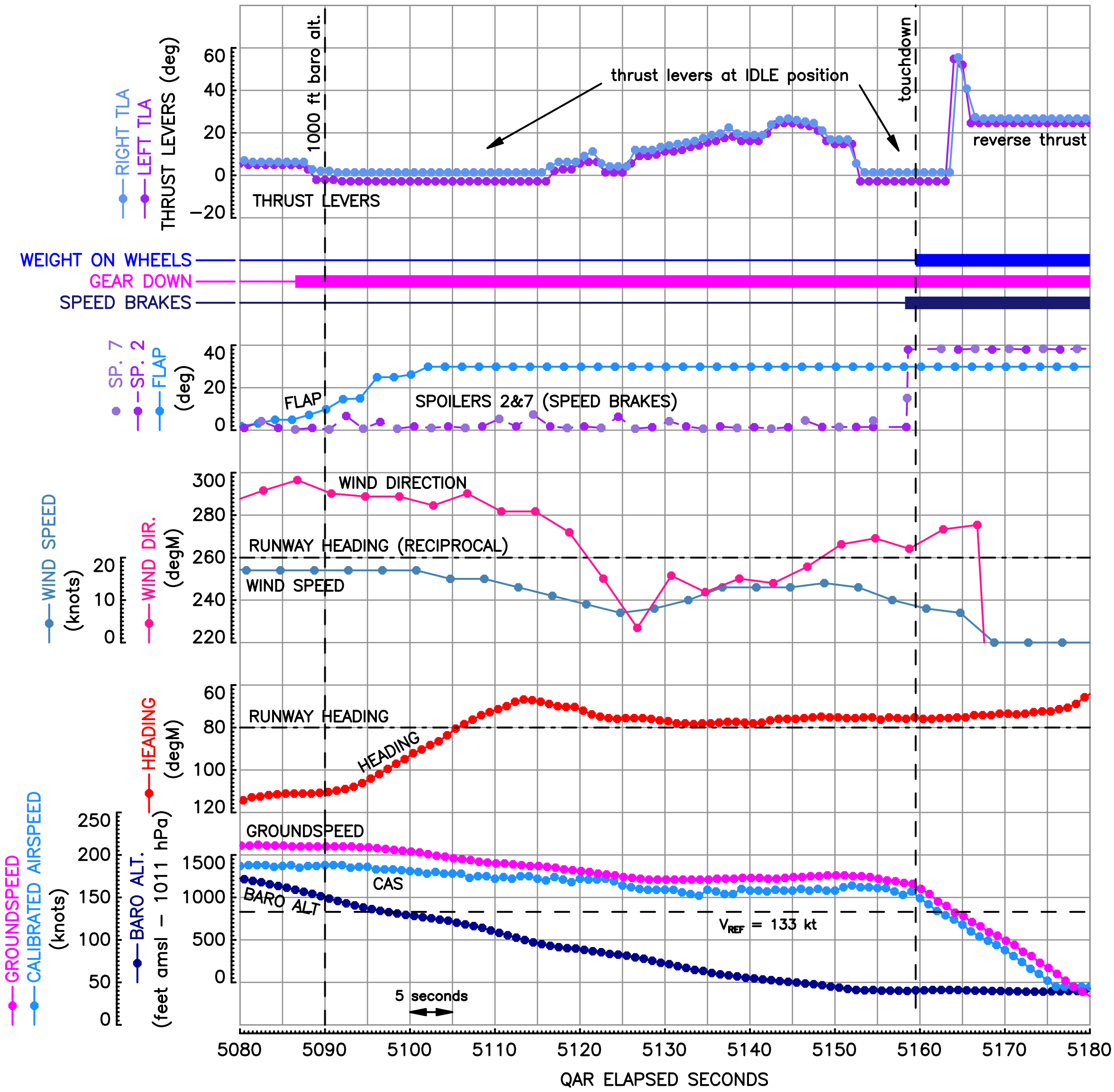


Figure 3

Recorded flight data during the approach

Footnote

5 CAS is the indicated airspeed (IAS) corrected for airspeed indicator system errors.

© Crown copyright 2014

As the aircraft descended through 1,000 ft amsl, the aircraft was in a left turn to intercept the runway centreline, which it briefly flew through at 800 ft amsl. The aircraft was established on the final approach track at approximately 400 ft amsl.

The landing

Figure 4 starts with the aircraft at 60 ft agl, a little under 12 seconds before touchdown. At 50 ft agl, the aircraft was flying at 160 kt CAS but had a groundspeed of 175 kt. At about 3 ft agl, approximately six seconds after the thrust levers were set to the IDLE position, the speed brakes were deployed and the aircraft touched down approximately one second later at 157 kt CAS (166 kt groundspeed). Maximum braking was then applied, followed four seconds later by the selection of reverse thrust, both of which were maintained until the aircraft slowed to approximately 22 kt groundspeed, by which time the aircraft was being positioned to the left side of the runway. The distance from touchdown to the point that reverse thrust was cancelled was 1,027 m (derived from recorded groundspeed).

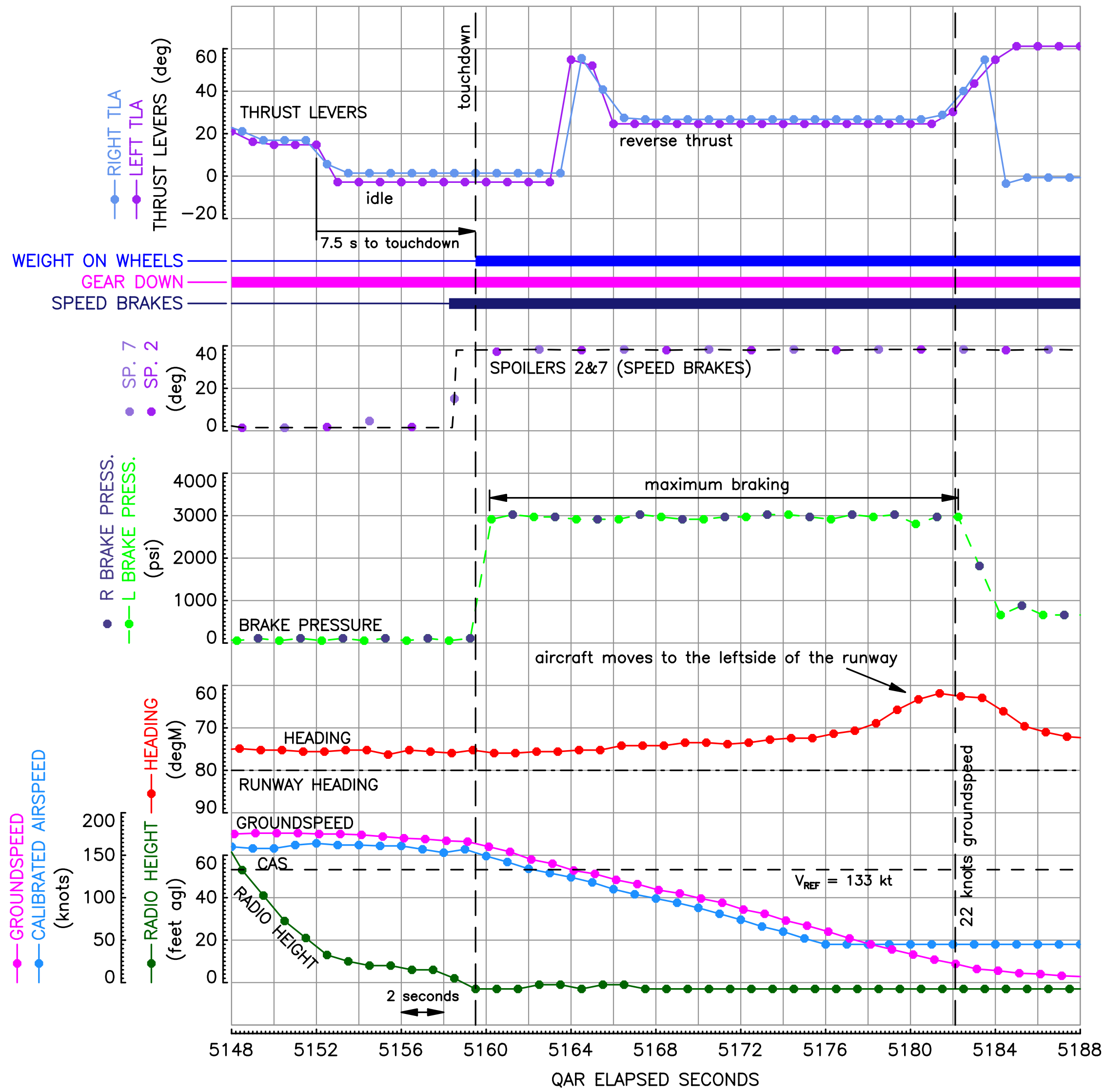


Figure 4

Recorded flight data during the landing

Figure 5 shows information on the landing derived from recorded flight data and depicted on a plan of the airport (all distances are approximate). The aircraft touched down 634 m beyond the touchdown zone markers. When reverse thrust was cancelled at 22 kt, there was 139 m remaining of the landing distance available (LDA). The aircraft began to turn around when the groundspeed was 6 kt, 95 m from the end of the LDA.

Calculation of ground stopping distance

The recorded flight data was used to calculate a ground distance from touchdown to the point on the runway where the aircraft was at 22 kt, the groundspeed at which the maximum braking action ceased. This gave a distance of 1,027 metres. This was compared with calculations based on the tabulated information in the Boeing 737-300 Quick Reference Handbook (QRH) for two cases:

1) a 'Dry' runway
2) a 'Wet' runway with 'good' braking action.

The conditions used in each case were a landing weight of 113,300 lb, an airspeed of V_{REF}+25 kt, a tailwind of 10 kt and maximum manual braking. Allowing an 'air distance' of 305 metres in each case, the calculated ground distances (to a standstill) were 785 metres for the Dry runway, 1,205 metres for the Wet runway.

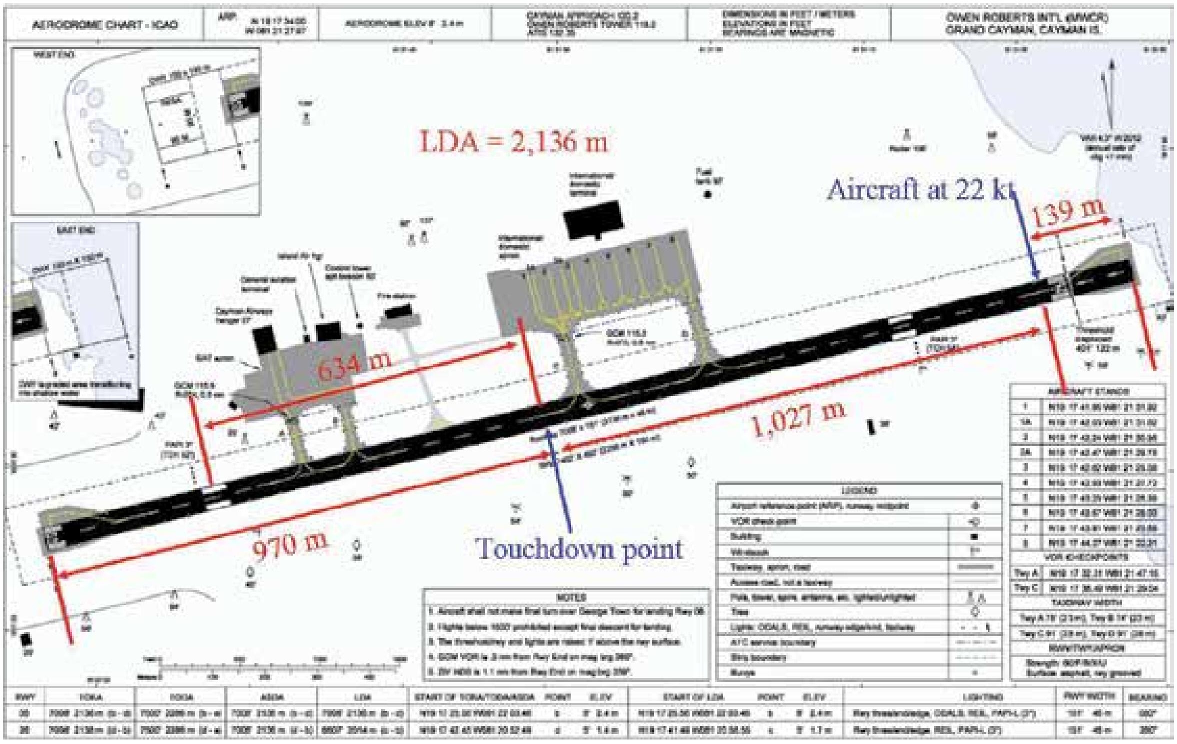


Figure 5

Information on the landing derived from recorded flight data

Engineering action

Following evaluation of the recorded data from the incident, and the identification of a significant peak value (2.249g) of vertical acceleration at touchdown, a Hard Landing inspection was ordered on VP-CKY. This inspection was in accordance with the aircraft manufacturer's Aircraft Maintenance Manual (AMM), which details two Phases. The Phase 1 inspection, conducted on 5 February 2014, did not show any damage so, in accordance with the AMM, the further Phase 2 inspection was not performed.

Information from the commander

The commander reported that, as the aircraft passed the north-western tip of the island, he could see the whole of the west coast of the island, including the airport and runway, beneath the cloud. The cloud had a "*flat ceiling*" at what he estimated to be 1,200 ft to 1,400 ft amsl. The aircraft joined the base leg approximately 5 nm west of the runway at 1,500 ft amsl and 220 kt. The commander reported that it was raining at the FAF (Figure 1) and so he turned left, inside the FAF, to avoid the weather and intercept the final approach at approximately 4 nm. He also briefed the co-pilot that the landing would be made using Flap 30 instead of Flap 40.

As the aircraft flew along the final approach path, the crew could see the runway through light rain. However, the commander reported that, just after the aircraft descended through 50 ft radio altitude and he began to flare, "a wall of heavy rain hit the windscreen". He considered that the situation was "too critical to go around", so he maintained runway alignment using the runway edge lights as his reference and deployed the speed brakes at what he estimated to be 6 ft radio altitude. After touchdown, the commander selected maximum reverse thrust and maximum manual braking and brought the aircraft to a halt just before the turnaround bay at the end of the runway. He commented that he had difficulty selecting reverse thrust, such that it seemed to take longer than normal to engage, and that the brakes felt ineffective.

The commander stated that, although he had been aware that the aircraft was faster than normal on the approach, the speed had been fluctuating in the gusty conditions and he had expected it to decrease when the aircraft was below 200 ft aal.

Information from the Air Traffic Control Officer

The ATCO was in the visual control room in the ATC tower and he based his report of visibility upon knowledge of the distance from the tower of lights in the local area.

The ATCO saw the lights of the aircraft while it was on base leg and commented that it appeared closer than would normally be expected. During the landing, he noticed that the aircraft floated before touching down just before Taxiway C. He had expected the aircraft to go around, basing his judgment on the distance it floated along the runway and the fact that the runway was wet. He lost sight of the aircraft after it touched down because of the intensity of the rain and the spray from the thrust reversers. He could see the red centreline lights at the end of the runway[6] and he saw them disappear as they were occluded by the passing aircraft. This prompted him to ask the commander whether the aircraft was still on the runway.

Footnote

6 The runway centreline lights are red along the final 300 m of runway.

© Crown copyright 2014

The ATCO explained that the primary system for reporting wind velocity is the digital Automated Weather Observing System (AWOS) which uses equipment located on the south side of the airfield. However, during inclement weather, there is doubt about the accuracy of the information this equipment provides because the wind can be disrupted by local obstacles. An alternative display of wind velocity is available in the ATC tower which takes its information from an anemometer on the north side of the airfield. During inclement weather, the controller considered this equipment to be more accurate.

Reporting of the event

The commander considered that the event did not lead to an accident or an incident that would be classified as reportable. Nevertheless, after discussion with managers at the airline, he submitted an *Air Hazard Report Form* as part of the operator's Safety Management System (SMS). Approximately two weeks later, the operator instigated an investigation after receiving further information about the event. Subsequently, the Civil Aviation Authority of the Cayman Islands (CAACI) asked the operator to produce a report on the event which the operator submitted through the CAACI's Mandatory Occurrence Reporting (MOR) scheme.

The ATCO did not feel that guidance on reporting within the Manual of Air Traffic Services (MATS) was clear in respect of this type of incident. He did not consider the incident to be reportable because the aircraft had remained on the runway.

Stabilised approach criteria

The landing mass recorded on the landing data card was 113,300 lb, at which mass V_{REF} would have been 133 kt for a Flap 40 landing and 136 kt using Flap 30.

At the time of the event, the operator required all approaches to be stabilised by 1,000 ft aal. The operator's stabilised approach criteria included:

1. Aircraft on the correct flight path.
2. Speed not more than V_{REF} + 20 kt and not less than V_{REF} with a thrust setting appropriate for the airplane configuration ('*engines spooled to the required engine thrust setting for the approach').*
3. Aircraft in the correct landing configuration ('*gear down and landing flaps*').
4. Sink rate no more than 1,000 ft/min.
5. All briefings and checklists completed.

Boeing 737 Flight Crew Training Manual (FCTM)

The Boeing 737 FCTM states that, if a go-around is initiated before touchdown but touchdown occurs, the crew can continue with the go-around. A go-around can be initiated after touchdown until the point at which reverse thrust is selected.

The FCTM states that, after touchdown and with the thrust levers at idle, the reverse thrust levers should be raised rapidly aft to the interlock position and then to the reverse idle detent.

© Crown copyright 2014

Safety Action

Following this incident, the operator issued an Operational Notice to reinforce its policy with regard to stable approaches. The Notice noted that two risk factors typical in runway excursion events during landing were that go-arounds were not conducted and that touchdown occurred beyond the expected point. The Notice stated that, in 75% of occasions, the prime cause was an unstable approach. It amended the operator's policy and guidance on stable approaches to require a go-around to be flown in circumstances where an approach was unstable at 1,000 ft aal. The Notice stressed the importance of the role of the PM who, if the approach was not stable at 1,000 ft aal, was to call "UNSTABLE GO AROUND".

The operator issued a further Operational Notice, instructing pilots to carry out a baulked/rejected landing in circumstances where the aircraft did not touch down within the touchdown zone of the runway. The touchdown zone is the first 3,000 ft (ICAO = 900 m) of the runway or one third of the LDA, whichever is less (equivalent to 712 m at Owen Roberts International Airport).

Reporting and investigating accidents and serious incidents

Definition of incidents and serious incidents

Annex 13, *Aircraft Accident and Incident Investigation,* to the Convention on International Civil Aviation (the Chicago Convention) contains definitions of incidents and serious incidents. An incident is defined as:

> *'an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.'*

A serious incident is defined as:

> *'an incident involving circumstances indicating that there was a high probability of an accident.'*

The Annex states that the difference between an accident and serious incident lies only in the result and suggests that takeoff or landing incidents are likely to be considered serious.

Reporting and investigating accidents and serious incidents in UK Overseas Territories

Section 75 of the *Civil Aviation Act 1982* contains provisions for the investigation of air accidents occurring in the UK, or to aircraft registered in the UK, in accordance with Annex 13 to the Chicago Convention. The Act adopts the definition of an accident contained within the Annex but states that the term includes:

> *'any fortuitous or unexpected event by which the safety of an aircraft or any person is threatened.'*

© Crown copyright 2014

The *Civil Aviation Act 1982 (Overseas Territories) Order 2001* extends the provisions of section 75 to specified Overseas Territories (including the Cayman Islands) and allows the Governor to make provisions for the investigation of air accidents. The Governor of the Cayman Islands makes such provisions in the *Cayman Islands Civil Aviation (Investigation of Air Accidents and Incidents) Regulations.* The Regulations require aerodrome authorities, aircraft commanders and aircraft operators to give notice to the Governor should an accident or serious incident occur on or adjacent to an aerodrome. The Regulations define an incident as:

> *'an occurrence, other than an accident, associated with the operation of an aircraft which affects or is relevant to the safety of its operation.'*

A serious incident is defined as:

> *'an incident involving circumstances indicating that an accident nearly occurred.'*

The Regulations require any undertaking[7] or authority to which a Safety Recommendation is made to consider the recommendation and act upon it where appropriate. The undertaking is to pass to the Governor details of measures to be implemented in response to the recommendation, if any, or an explanation of why no measures will be implemented.

Memorandum of Understanding (MoU) between the Government of the Cayman Islands and the AAIB

The MoU between the Government of the Cayman Islands and the AAIB provides for the AAIB to assist the Governor of the Cayman Islands in the event of an investigation into an aircraft accident or serious incident. Under the MoU, the Chief Inspector of Air Accidents at the AAIB is appointed as Chief Inspector of Air Accidents of the Overseas Territory of the Cayman Islands. The Governor determines whether AAIB assistance is required and the level of assistance is determined through discussion with the Chief Inspector of Air Accidents.

Mandatory Occurrence Reporting (MOR)

Part 21 of *The Air Navigation (Overseas Territories) Order (AN(OT)O) 2013* considers Mandatory Occurrence Reporting in Article 174 and states that reportable occurrences (as defined in the Order) must be reported to the Governor. The CAACI publishes the Manual of Mandatory Occurrence Reporting to satisfy this requirement. Article 174, paragraph (6) states:

> *'Any accident or serious incident notified to the Governor under regulations made under section 75 of the Act does not constitute a reportable occurrence for [the] purposes of this article.'*

Footnote

[7] Undertaking is defined in the Regulations as '*any natural person or any legal person, whether profit-making or not, or any official body whether having its own legal personality or not*'.

© Crown copyright 2014

The purpose of the MOR scheme is for the CAACI to investigate reportable occurrences and make the findings available to other organisations. Appendix C to the MOR manual describes the reporting procedure. It explains that the CAACI will categorise an occurrence and, for an accident or serious incident, the DGCA will consult with the AAIB when deciding whether AAIB support is required. For other incidents, the CAACI will carry out the investigation and publish the findings.

Overseas Territories Aviation Requirements (OTARs)

OTARs are published by Air Safety Support International, a subsidiary company of the UK CAA, as part of its objective to support Overseas Territories in the safety regulation of civil aviation. OTARs Part 13, *Occurrence Reporting,* reproduces or amplifies certain provisions of the AN(OT)O. Subpart A, paragraph 13.9, *Applicability,* states:

> *'In the event of an aircraft accident or serious incident occurring in a Territory any Civil Aviation (Investigation of Air Accidents and Incidents) Order or Regulations in force in the Territory will be applicable. The Order or Regulations lay down the requirements relating to the notification of accidents and incidents and the obligations to provide information to the Governor or to an Inspector of Air Accidents appointed by him to carry out an investigation.'*

OTAR Part 13 is amplified by Overseas Territories Aviation Circular (OTAC) 13-1 which describes the Overseas Territories MOR scheme and provides further guidance to those who are involved in its operation.

Information from the operator

Operator's Safety Management System (SMS)

The operator's SMS includes an internal hazard reporting procedure where a safety hazard is defined as:

> *'any event or situation with the potential to result in significant degradation of safety and [which] can cause damage and/or injury.'*

The MOR section of the SMS includes a process for reporting accidents to the CAACI under the CAACI's MOR scheme. The SMS also gives examples of events to be notified under the MOR scheme, some of which feature in the Annex 13 list of examples of serious incidents.

Operator's Safety Policy Manual

Section 2.14 of the operator's Safety Policy Manual details company policy with respect to the CAACI MOR scheme. Section 2.14.5 categorises *'Reportable Accidents and Incidents'* between Category 'A' and Category 'H'. A Category 'A' accident which, under the policy, is to be reported under the MOR scheme, is one that results in the apparent destruction of the aircraft and/or involves heavy loss of life.

© Crown copyright 2014

Cayman Islands Airports Authority (CIAA)

CIAA Safety Management System

The CIAA SMS requires ATCOs to report internally:

> *'any incident involving an unsafe, or potentially unsafe, occurrence or condition, irrespective of whether it involves injury or property damage.'*

In addition, the SMS lists examples of occurrences which are subject to mandatory reporting to the CAACI under its MOR scheme. It states that mandatory reporting is required for:

> *'any accident or event that results in a fatality, injury or illness to person or damage to property or the environment'; or*
>
> *'an event which if not corrected would likely endanger people, property or the environment, or an incident involving circumstances indicating that an accident nearly occurred.'*

Owen Roberts International Airport Manual of Air Traffic Services

The airport operator's MATS instructs controllers to:

> *'submit a report using the forms in the CAACI Manual of Mandatory Occurrence Reporting (CAM131) within 96 hours of any occurrence involving aircraft.'*

There is no other guidance in relation to the reporting of occurrences.

Analysis

Incident and accident reporting

The decision whether or not to report an event, and how to classify how serious it was, is aided by descriptive examples in the various documents referred to in this report. In this occurrence, to VP-CKY on 15 January 2014, procedures developed to prevent overrun accidents, in particular the options to go around from an unstable approach or reject a 'long' landing. The use of speed brakes in the air, in this event, was an improvised, non-standard technique which allowed the aircraft to touch down and decelerate and which possibly prevented a runway overrun. However, at the time the speed brakes were deployed, the length of runway required, or available, to stop were unknown and the aircraft's landing performance was compromised. Therefore, this event met the criteria to be classified as a serious incident.

This event was originally considered to represent a hazard to be recorded in the operator's SMS (and not to be reported otherwise) but it became the subject of an internal investigation once further information became available. Following a request from the CAACI, the event was reported by the operator under the MOR scheme to the CAACI and, thereby, to the Director General of Civil Aviation (DGCA) of the Cayman Islands. The DGCA, believing the incident to be serious, brought it to the attention of the AAIB through the provisions of the MoU between the Government of the Cayman Islands and the AAIB.

© Crown copyright 2014

Accidents and serious incidents are to be reported to the Governor of the Cayman Islands under the provisions of the *Civil Aviation Act 1982 (Overseas Territories) Order 2001*, and the *Cayman Islands Civil Aviation (Investigation of Air Accidents and Incidents) Regulations*. Accidents and serious incidents reported under the Order and Regulations are not reportable under the MOR scheme. In practice, however, it is the policy of the operator and airport authority to report all occurrences, including accidents and serious incidents, through the MOR scheme and for the CAACI to determine the appropriate response after categorising the occurrence. This process results in the correct type of investigation taking place but does not appear to be strictly in accordance with the Order and Regulations. Therefore:

Safety Recommendation 2014-036

It is recommended that the Civil Aviation Authority of the Cayman Islands review whether accidents and serious incidents are being reported in accordance with the requirements of the *Civil Aviation Act 1982 (Overseas Territories) Order 2001* and the *Cayman Islands Civil Aviation (Investigation of Air Accidents and Incidents) Regulations*.

The landing

The operator's stabilised approach criteria (SAC) were required to be satisfied as the aircraft passed 1,000 ft aal (1,008 amsl). As VP-CKY descended through 1,000 ft amsl (992 ft aal), the SAC required it to be at a maximum airspeed of V_{REF} + 20 kt whereas its actual airspeed of 188 kt was equivalent to V_{REF} + 52 kt for a landing with Flap 30. The SAC required the aircraft to be in the landing configuration with landing gear down and landing flap extended. In fact, the landing gear was down, but the flaps were travelling past Flap 15 towards Flap 30 which they reached at approximately 880 ft amsl. The SAC required the engines to be producing appropriate thrust for an approach in the landing configuration whereas they were actually producing idle thrust. The SAC required a rate of descent of no more than 1,000 ft/min whereas the average rate of descent was 1,200 ft/min from 1,100 ft to 550 ft amsl. It was clear from the data that the aircraft did not meet the operator's stabilised approach criteria at 1,000 ft aal.

As the aircraft descended through 50 ft agl, it was flying at 160 kt CAS (equivalent to V_{REF} + 24 kt) but the groundspeed was 175 kt because the aircraft experienced a tailwind during the approach and landing. This was consistent with the wind velocity reported by the ATCO shortly after the aircraft landed but would have been unexpected by the crew because, when the ATCO had cleared the aircraft to land, he had transmitted that the wind was from 350° at less than 5 kt. The ATCO commented that he was unsure about the accuracy of the AWOS during adverse weather conditions but it appeared that the AWOS might have been more accurate during this event than the anemometer. Tailwinds have a significant effect on aircraft landing performance, and it is important that crews are aware when a tailwind is present and that ATCOs have confidence in the validity of meteorological information they are passing to crews. Therefore:

© Crown copyright 2014

Safety Recommendation 2014-037

It is recommended that the Cayman Islands Airport Authority satisfy itself that it can be confident in the reliability and accuracy of the Automated Weather Observing System installed at Owen Roberts International Airport.

The high airspeed of the aircraft as it approached the runway, combined with the tailwind, caused the aircraft to float along the runway for a considerable distance. The pilot took the unusual decision to deploy the speed brakes, which helped the aircraft descend onto the runway at a point along its length equivalent to approximately 45% of the LDA.

Reverse thrust was selected approximately four seconds after the aircraft touched down rather than 'rapidly' as the FCTM advised. Once on the runway, the use of maximum manual braking and maximum reverse thrust was sufficient to stop the aircraft within the landing distance available. The aircraft slowed to 22 kt groundspeed in 1,027 metres after touchdown. Tabulated data from the QRH for a wet runway showed that the distance from touchdown to a halt would have been 1,205 meters. This suggests that the braking performance in this event was consistent with maximum manual braking on a Wet runway with 'good' braking action. Both distances were considerably greater than the braking distance on a Dry runway, which may explain the commander's impression that the brakes were less effective than normal.

Risk mitigation against runway overrun accidents

The point at which an aircraft comes to a halt on the runway is governed mainly by the touchdown point and speed, and the deceleration after touchdown. All three factors were compromised in this case: the aircraft touched down 634 m beyond the touchdown zone marker; the aircraft touched down at V_{REF} + 21 kt (157 kt CAS) with a groundspeed of 166 kt due to an unexpected tailwind; and there was a delay before full reverse thrust was achieved.

At a groundspeed of 166 kt, the aircraft would have covered 139 m (the length of runway remaining beyond the point where thrust reverse was cancelled) in less than 2 seconds. It is probable that the aircraft was capable of remaining airborne for at least that period given that it was flying at V_{REF} + 21 kt when the speed brakes were deployed. Therefore, it is likely that the act of deploying the speed brakes (in the absence of a go-around or rejected landing) prevented the aircraft from running off the end of the runway, or very close to it.

The operator issued two Operational Notices to mitigate the risk of a similar incident recurring. The first Notice was designed to ensure that crews go around from unstable approaches, thereby increasing the likelihood that their aircraft touch down at the correct place and with the correct speed. The second Operational Notice was designed to reduce the likelihood of a runway overrun by ensuring that crews reject the landing in circumstances where an aircraft appears to be landing too far into the runway.

© Crown copyright 2014

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 757-236, G-TCBC
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1999 (Serial no: 29946)
Date & Time (UTC):	17 August 2013 at 1610 hrs
Location:	During go-around at Newcastle International Airport, and diversion to Manchester Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 7 Passengers - 235
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nil
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	13,374 hours (of which 1,380 were on type) Last 90 days - 212 hours Last 28 days - 48 hours
Information Source:	AAIB Field Investigation

Synopsis

During an ILS approach to Newcastle International Airport (NCL), ATC instructed the crew to conduct a go-around. This manoeuvre was mishandled and it led to a slat and flap overspeed with an associated caution message. The Quick Reference Handbook (QRH) actions in response to this message were not followed correctly. Consequently the crew assumed that they would have to make a flapless landing and they decided to divert to an airport with a longer runway. They realised they would have to use some of the final reserve fuel but, when a low fuel caution light came on, the appropriate QRH checklist was not actioned. The crew continued to try to resolve the flap problem and, despite straying from the QRH instructions, they did ultimately regain normal flap control. When the aircraft arrived on stand at Manchester Airport (MAN), the total fuel was 700 kg below the final reserve figure and there was an imbalance of 500 kg between the tanks.

History of the flight

The crew of G-TCBC reported for duty at 0500 hrs, for a return flight from NCL to Fuerteventura (FUE). The commander was the pilot flying (PF) for the return sector to NCL. The flight was uneventful until, on a radar vector and with a relatively high groundspeed, the aircraft overshot the centreline whilst capturing the ILS for Runway 23. The localiser (LOC) and the glideslope (GS) were captured subsequently from a revised intercept heading but the commander was unsettled because he thought the aircraft had not performed normally.

© Crown copyright 2014

He mentioned the matter to the co-pilot several times as the aircraft was configured with landing gear down and FLAP 20. The intention was to land with FLAP 25, in accordance with the operator's Standard Operating Procedures (SOPs). The weather, as copied from the ATIS, indicated a wind from 210º at 13 kt varying between 170º and 250º, visibility of 10 km or more, scattered cloud at 2,300 ft aal, temperature 19ºC, dew point 14ºC and pressure 999 hPa. The ATIS included a windshear report from an aircraft that landed at 1525 hrs, with an apparent loss of airspeed of 15 kt at 500 ft aal. The runway was wet.

After the preceding aircraft had landed, its crew informed ATC of a possible birdstrike on the runway. In response to this, at 1600 hrs, ATC instructed G-TCBC to 'GO AROUND'. The aircraft was at 1,500 ft amsl, 3.8 nm from the threshold and at a speed of approximately 140 kt. The commander's response was to say "GO-AROUND" three times, to select maximum thrust and then to disconnect the autothrottle (A/T). The autopilot (A/P) however, remained engaged in the 'LOC' and 'GS' modes causing the aircraft to accelerate as it continued its descent. A few seconds later the commander disengaged the A/P, without informing the co-pilot, and started to pitch the aircraft nose-up. The speed was now 187 kt and increasing.

Shortly after instructing G-TCBC to go around, ATC amended the missed approach clearance and instructed a climb straight ahead to 3,500 ft amsl[1]. The co-pilot was selecting this altitude in the Mode Control Panel (MCP), when the master warning alert sounded. He was distracted while he cancelled the warning and assessed that it had been caused by disengagement of the A/P.

Initially the commander pitched the aircraft to 10° nose-up[2] but the airspeed continued to increase. The co-pilot announced "POSITIVE CLIMB" and the commander called for "GEAR UP" and for "V_{REF} +80, CLIMB THRUST" and then for "FLAPS 5" and subsequently "FLAPS UP". The co-pilot tried to input the V_{REF} +80 speed (205 kt)[3] into the MCP, but was unable to set it. The FLAP 20 limiting speed of 195 kt was exceeded by 18 kt before the flaps started to retract.

The commander had to ignore the Flight Director (F/D) as he tried to level the aircraft at 3,500 ft amsl as it had remained in the LOC and GS modes. At 1602 hrs he asked for the F/D to be turned OFF. The speed reached 287 kt before the thrust levers were moved from the maximum thrust to the idle position. Although the limiting speed for FLAP 1 was 240 kt, the trailing edge (TE) flaps retracted successfully. However, the leading edge (LE) slats remained partly extended. The caution message LE SLAT DISAGREE was displayed on the EICAS but there was a delay before it was acknowledged. The co-pilot experienced difficulty trying to engage the A/P and A/T. On three occasions the A/P disengaged after a short period and it was six minutes after the go-around (G/A) manoeuvre before both systems were successfully reinstated. The aircraft had by then been vectored downwind under radar control and the altitude had deviated almost 500 ft below the cleared altitude.

Footnote

1 The promulgated missed approach procedure was to climb to 2,500 ft amsl.
2 With the A/P disengaged the SOP was to select an initial attitude of approximately 15º nose-up.
3 V_{REF}+80 means V_{REF} for FLAP 30, plus 80 kt and is the safe manoeuvre speed with FLAP UP. Setting this speed with speed mode engaged commands an acceleration to permit flap retraction.

© Crown copyright 2014

The co-pilot suggested that they enter a holding pattern but the commander elected to extend the downwind leg and ATC were informed of a slight technical problem. The commander asked the co-pilot how much fuel was remaining and was told that they had 3,600 kg.[4]

Once the A/P and A/T were engaged, the co-pilot started to action the QRH checklist for the LE SLAT DISAGREE message. He also continued to operate the radio. Steps 1 to 4 in the QRH checklist (see QRH procedures), were followed correctly but, when step 5 called for the '*ALTN* [alternate] *FLAPS selector*' to be set to agree with the '*FLAP lever*', the co-pilot incorrectly set it to FLAP 1 instead of UP. Step 6 then called for the '*LE* [leading edge] *ALTN FLAPS switch*' to be set to '*ALTN*'. When this was done the LE flaps (ie the slats), ran to the commanded FLAP 1 position and the LE SLAT DISAGREE message cleared; shortly after that the TE FLAP DISAGREE message illuminated[5]. This was noticed by the crew and the commander said they should change to the '*Trailing Edge Flap Disagree*' checklist. This was started by the co-pilot and he got as far as step three in this checklist, which called for the alternate flaps selector to be set to agree with the flap lever, when he was interrupted by a radio call from ATC. ATC told them that they had left controlled airspace and were now in receipt of a Deconfliction Service.

After acknowledging this, the co-pilot tried to resume the checklist, but the commander interrupted by saying "SO CAN WE GET SOME MORE FLAP?...LET'S GO FOR FLAP 5". In a departure from the prescribed drill, the co-pilot selected both the flap lever and the alternate flaps selector to the FLAP 5 position. Shortly afterwards the co-pilot again tried to follow the QRH, but he was again interrupted when the commander stated "THAT'S ALL THE FLAP WE HAVE GOT; WE NEED A LONGER RUNWAY, DON'T WE?" The co-pilot responded "YEAH WE NEED MANCHESTER, DON'T WE?" After checking that 2,000 kg of fuel was required to fly to MAN, the commander stated that they should divert immediately.

The co-pilot agreed and told ATC that they could not get the flaps down and that they needed to divert to MAN for a longer runway. ATC instructed them to turn onto 230º and climb to FL100 and asked what level they would like. The co-pilot conferred with the commander, saying "WE DON'T WANT TO GO TOO HIGH, DO WE?", and they agreed to stop their climb at FL100. Before starting the climb, the commander asked for FLAP UP. In response, the co-pilot selected the flap lever to UP, without referring to the unfinished QRH checklist. The alternate flaps selector remained at FLAP 5 with the LE slats partially extended under alternate control and in agreement with the alternate flaps selector.

G-TCBC was approximately 25 nm east of NCL when the climb was commenced. The time was now 1612 hrs and the crew observed that 3,200 kg of fuel remained[6]. A few seconds later, a forward fuel pump low pressure light on the fuel panel illuminated, along with an associated EICAS advisory message. The co-pilot mentioned this, but no action was taken. The commander then gave the cabin manager a face-to-face briefing about the flap problem and the diversion to MAN.

Footnote

[4] The required fuel on the flight plan for a diversion to the primary alternate, Edinburgh, was 3,280 kg.
[5] The trailing edge flaps were UP but now in disagreement with the alternate flaps selector. See *Flap system.*
[6] The Pilot's Flight Log (PLOG), indicated that 1,999 kg of fuel would be burnt on a diversion from NCL to MAN in the clean configuration, thus a minimum of 3,626 kg was needed, including a final reserve of 1,627 kg.

© Crown copyright 2014

Although the aircraft had been cleared to FL100 the QNH of 999 hPa was still set when the aircraft levelled at 1614 hrs, 420 ft above the cleared level. A direct clearance to Pole Hill VOR was accepted, but the co-pilot could not manage to input this into the Flight Management Computer (FMC) and subsequently the commander used HDG SEL (heading select) as the lateral F/D mode in conjunction with raw navigational data. At this point the commander suggested that they declare a MAYDAY and the co-pilot told ATC "WE WANT TO DECLARE A MAYDAY". ATC acknowledged by saying "ROGER" but shortly afterwards they asked "HAVE YOU GOT ANY MORE DETAILS FOR THE PARAMEDIC?" The co-pilot said that they didn't need a paramedic but that they would be making a flapless landing at MAN.

One minute later a LOW FUEL caution illuminated on the EICAS and the FUEL CONFIG light showed on the fuel panel.[7] Without any crew discussion about this development, the co-pilot told ATC that they were requesting a priority landing due to a low fuel warning. Newcastle ATC said this message would be passed on and asked if an emergency was being declared. When this was replied to in the affirmative, the crew were asked to squawk 7700.

The TE FLAP DISAGREE caution remained illuminated throughout the climb and level off. At 1617 hrs the co-pilot suggested that they resume the '*Trailing Edge Flap Disagree*' checklist but the commander said that they should make preparations for the approach to MAN. A few moments later, without reference to the QRH, the co-pilot selected the TE alternate flaps switch to ALTN. This caused the TE FLAP DISAGREE caution to clear and the TE flaps to run slowly towards FLAP 5, under control of the alternate flaps selector. The crew noticed that the caution had cleared and the commander suggested they put the systems back to normal.

Both alternate flaps switches were turned OFF but, when the crew observed no immediate movement, they were re-selected ON. Various selections were then made, without use of the QRH checklists, over the course of a three-minute period. This resulted in both the LE and the TE flaps reaching FLAP 1 under normal control and without a caution message. The crew concluded that they could control the flaps normally and they retracted the flaps to conserve fuel. The commander now advised the passengers that they were diverting to MAN as a result of a flap problem.

After several attempts the co-pilot managed to programme the FMC by use of the alternate routing option, Route 2. While doing this he attempted to contact the next ATC radio frequency (Scottish Control) but no MAYDAY prefix was used and the crew did not notice when ATC failed to respond. Shortly afterwards the crew realised that the After Take-Off Checks had been overlooked. As a result, the altimeters were re-set to 1013 hPa and the aircraft was descended to FL100.

At 1627 hrs, after further discussion about the flaps, the crew agreed that they should be able to make a normal FLAP 30 landing but they would slow up early in case they needed to use the alternate system. The pilots also talked about earlier events. They were unsure if

Footnote

[7] A LOW FUEL caution along with a FUEL CONFIG light on the fuel panel indicates that the fuel level in either main tank has fallen below 1,000 kg (see *Fuel system).*

© Crown copyright 2014

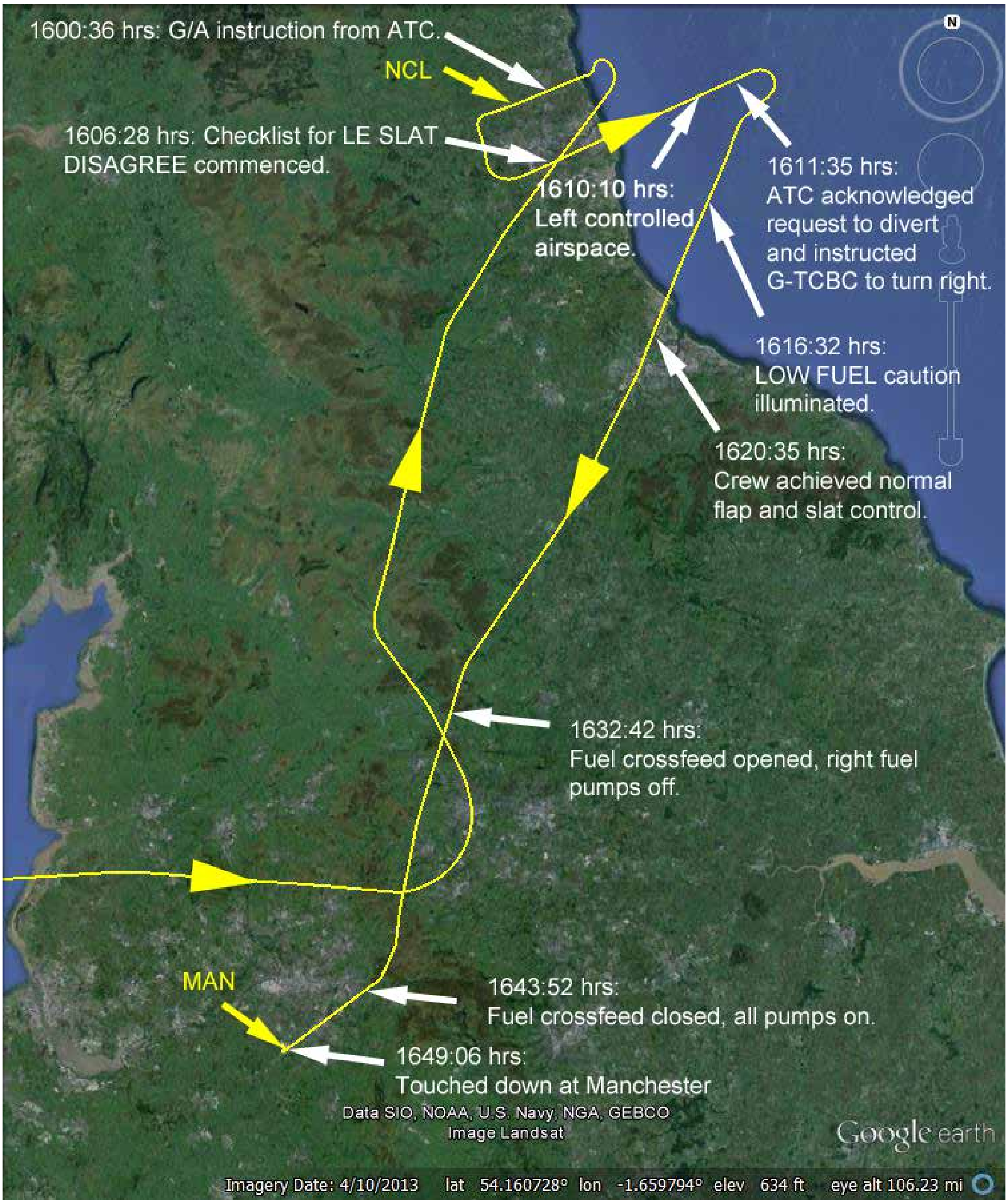


Figure 1

Plot of the track for G-TCBC showing inbound and outbound tracks from NCL and the diversion to MAN

there had been a flap overspeed or not and they were perplexed as to why the automatic systems had not worked as expected.

Five minutes after changing frequency, two-way communications were regained with ATC and clearance was given direct to a 10 nm final for Runway 23R at MAN. Immediately after this the commander observed that they needed to do something about the fuel and that they should use the fuel in the left tank. Fifteen minutes had passed since the LOW FUEL caution had illuminated and this was the first reference to a fuel imbalance. However, the co-pilot did not respond because ATC started to pass the MAN weather, followed by a descent clearance.

At 1632 hrs the commander asked for the fuel to be balanced. The co-pilot opened the fuel crossfeed and turned off the right fuel pumps without referring to the QRH. One minute later, idle thrust was selected and the descent was commenced. At 1643 hrs, at a range of 10 nm from touchdown, the fuel crossfeed was closed and the fuel pumps were turned back on. The commander commented "WE'RE COMMITTED TO LAND NOW, WE HAVE TO LAND", and later "WE DON'T WANT TO GO-AROUND…WE CAN'T". The co-pilot acknowledged these remarks.

The aircraft made a FLAP 30 landing at 1649 hrs and taxied to stand with the RFFS in attendance. The fuel recorded on shutdown was 700 kg in the left tank and 200 kg in the right tank. The commander noted in the technical log that they could not select a speed in the speed window following the G/A and that EICAS messages for LE SLAT ASYMMETRY[8] and TE FLAPS DISAGREE had been displayed.

During his journey home it occurred to the commander that he had not told the engineers about a possible flap overspeed, so he telephoned them and a further technical log entry was made relating to a suspected flap overspeed of 18 kt at FLAP 20. Overnight analysis of the flight data verified this figure and as a result of further maintenance checks it was apparent that the FLAP 1 speed limit had been exceeded by 46 kt. An internal investigation was commenced and the AAIB informed.

Crew information

Commander's background

The commander had been flying the Boeing 757 (B757) for about two and a half years before this incident. Prior to that he had operated Airbus types for over 13 years, but he was now at a stage where he "felt comfortable" with the B757. When he reported for this duty at 0500 hrs, he believed he was as well rested as could be expected for that time in the morning. Although he had not flown in the preceding week, he felt that in the previous few months he had experienced more technical problems than was usual. He stated that he had had in excess of 48 hours rest prior to reporting. Examination of his roster indicated that on the day before the incident he had been on home standby from 0900 hrs to 1500 hrs but had not been called to work.

He sensed that the airline was in turmoil due to a major internal re-organisation programme. The direct effect for him was that he had been told that he would be one of several captains who would be demoted to first officer in March 2014 and that his salary would reduce significantly. He was unhappy about this impending change and the matter weighed heavily on his mind at work, despite his best efforts to ignore it.

Footnote

8 This was an erroneous entry due to incorrect recollections by the crew immediately after the flight.

© Crown copyright 2014

Co-pilot's background

Like the commander, the co-pilot had not flown for several days before the incident and he stated that he felt well rested when he reported for duty. Although he had been rated on the B757 for over five years, he felt he had little experience of two engine G/As. He recalled one instance, about three years previously, when he had flown a G/A on the line but he could not remember having much practice of such a manoeuvre during simulator training. He had been the Pilot Monitoring (PM) on a flight into NCL around six weeks before when another commander executed a G/A, in accordance with SOPs, from an altitude of between 1,500 ft and 2,000 ft.

Pilots' comments

In the commander's opinion, he and the co-pilot had operated the flight from NCL to FUE in a professional manner. He said that a full approach brief was given by the co-pilot and recalled that this included the techniques that would be employed in the event of a G/A. On the way back to NCL, the commander gave a shortened approach brief, in accordance with SOPs. He did not discuss the manner in which a normal G/A would be flown but he did use the QRH to brief the procedures in the event of a windshear encounter and G/A.

On the flight to FUE, the co-pilot recalled briefing the missed approach procedure from the instrument plate but he said that it was not his habit to brief the handling actions in the event of a G/A. He said that it was unusual for someone to brief this and it had not been advocated to him as being a good practice. He had no recollection of receiving any training on the handling of G/As from well above the decision altitude.

Both pilots said that the return flight proceeded smoothly until the start of the ILS approach when the aircraft had not seemed to capture the LOC as well as normal. This compounded the commander's concerns regarding technical reliability. The instruction to commence the G/A was given when he was visual with the runway and was expecting to land. He remarked that he was in the habit of mentally reviewing his actions in the event of a G/A at or about 500 ft aal, but this G/A came at an earlier stage. He remembered that he called "GO-AROUND", but did not state "FLAPS 20" and that he advanced the thrust levers. He knew that he needed to do something with his thumb, but instead of pressing the G/A switch, he said he must have disconnected the A/T. In retrospect he believed that he had reverted instinctively to his Airbus training[9] and that he had then failed to employ the mnemonic "GAGL"[10]. At his last simulator check he recalled that he had practised a two engine G/A from decision altitude, but he noted that in the simulator you "know they are coming". After realising that something was wrong with the G/A, the commander disengaged the A/P but did not tell the co-pilot. He thought that he had pitched up to around 12º and was conscious of a speed increase.

Footnote

[9] On the Airbus aircraft flown previously by the commander a G/A was initiated by advancing the thrust levers to the takeoff position.
[10] See report section headed Operator's Operations Manual, *Go-arounds.*

© Crown copyright 2014

When the G/A was initiated, the co-pilot heard the commander call "GO-AROUND" but no flap setting was mentioned. He was not aware of the A/T being switched off but when he cancelled the master warning he realised that the A/P had been disconnected. He was surprised to see that the G/A was being flown manually and he looked across to make sure that the commander was all right. At this stage he was not aware that the G/A switch had not been pressed and he did not check to see 'GA' (go-around mode) indications on the Flight Mode Annunciations (FMA) panel of the Attitude Director Indicator (ADI). In retrospect he realised that his thought processes were confused by the breakdown in SOPs.

Because the commander called for a target speed of V_{REF} +80 and climb thrust, the co-pilot tried to select the relevant speed on the MCP. However, he was unable to open the speed window to do so. He recalled that before the departure from NCL, an engineer had said the previous commander had mentioned having difficulty in viewing one of the digits in the speed window, so the co-pilot wondered if there was a technical malfunction. Meanwhile, although he was aware that the speed was increasing rapidly, he was trying to retract the flaps and failed to monitor the speed adequately.

While the co-pilot tried to re-engage the automatics, the commander did his best to climb and maintain 3,500 ft amsl. The commander felt that his scan had broken down as a consequence of the unusual situation but he also felt that the co-pilot appeared "stunned" and did not offer the support that he was capable of. The co-pilot acknowledged that he ought to have realised that the speed was excessive and brought it to the attention of the commander but his situational awareness and his scan had broken down.

When the aircraft levelled at around 3,500 ft amsl, the commander was still flying manually and the A/T and the A/P did not remain engaged when selected by the co-pilot. Eventually the speed window did function normally and the A/T and the A/P remained engaged. At some point the co-pilot was aware that the commander had asked for the F/D to be switched OFF and back ON again.

The co-pilot recalled that when he started the '*Leading Edge Slat Disagree'* checklist he felt frustrated and agitated because of his previous difficulties. As he progressed through the checks, he knew the flap lever was UP but he saw that the indicator was between FLAP 0 and FLAP 1. In retrospect he thought that this caused him to select the alternate flaps selector to FLAP 1 in error. After he had pressed the LE alternate flaps switch, the TE FLAP DISAGREE caution illuminated. He saw both it and the LE SLAT DISAGREE message illuminated together at one stage but the commander suggested that he transfer his attention to the '*Trailing Edge Flap Disagree'* checklist. His recollection of the sequence of events after this was unclear but he thought that he did turn the alternate flaps selector to FLAP 5 and he did move the flap lever by mistake at one point. Neither of the checklists were completed and he was convinced that the flaps would not extend and that they would be committed to a flapless landing.

The commander did not recall hearing the co-pilot say that the QRH checklist was completed. In retrospect he felt that he ought to have had the co-pilot pause and action the checklist more slowly. The commander felt his own thought processes were distracted by worries about the paperwork and the other potential repercussions of the mishandled G/A.

© Crown copyright 2014

During the actioning of the checklist the commander was looking at the flap position indicator for movement. He knew it would take time in alternate mode but he also knew he was running out of options. He had a "ballpark" landing distance of 1,600 m in his head for a flapless landing but, the previous week, he had seen an aircraft make an abnormal landing at NCL with FLAP 20 and it had appeared to use much more than this. In addition, he was aware that there was no stopway on Runway 25 at NCL. Another concern was that the ATIS had included a windshear report from a previously landing aircraft and with a wet runway and the crosswind he "was reeling" at the idea of a flapless landing at NCL. He discounted Edinburgh (EDI) because the runway there was not much longer, so he considered only MAN where the runway was definitely longer, plus there were other airfields in that direction. These thoughts were not verbalised but he believed that the co-pilot felt the same way.

The co-pilot remembered the windshear report at NCL, so readily accepted the commander's suggestion to divert to a longer runway, which he assumed to mean MAN. A fuel emergency was not declared immediately because the co-pilot thought this was required only when the level in either main tank fell below 1,000 kg. He knew that the final reserve fuel for the flight was 1,627 kg and that they were likely to land with less than this.

This was the commander's first experience of being low on fuel but he decided that on balance it was better to go to MAN and land with less than final reserve fuel. He knew that a MAYDAY call should be made when it was evident that the final reserve fuel would be encroached, so he could not explain why there was a delay in making this declaration. Once the decision to divert was made, he felt things were normalising, albeit that he expected to land with a low fuel state. He said he was concerned about the fuel throughout, though he accepted that the imbalance was not dealt with as soon as he noticed it. He remarked that it would be SOP to rebalance fuel once a split of 400 to 500 kg developed but he was not sure if this had been done on the way from FUE towards NCL. His recollection was that the fuel crossfeed had been opened with about 1,700 kg in the left tank and about 600 kg in the right and that it had stayed open, with the right pumps off, until after they landed.

The co-pilot accepted that, as the flight progressed towards MAN, his awareness of the fuel situation decreased. His attention was focussed on trying to programme the FMC and in communicating with ATC. When the LOW FUEL message appeared, his belief was that it was mentioned but not addressed. He felt that he did not react to the message because he had been subconsciously prepared for it from the start of the diversion. He could not remember if there was an imbalanced fuel state at this point. (He thought some fuel balancing was conducted between FUE and NCL, after an imbalance of around 300 kg had developed.) Later in the flight towards MAN, he was aware of an imbalance but the co-pilot recalled that the commander dealt with it. This was also the first time that the co-pilot had been involved in a low fuel scenario.

Once they had climbed to 10,000 ft, the co-pilot suggested going back to the '*Trailing Edge Flap Disagree'* checklist but the commander asked him to get out the MAN instrument charts instead. Later he was asked to put the flap controls back to normal. After the co-pilot made various selections the flaps appeared to work normally but the pilots still prepared for the possibility of using the alternate system or a flapless landing.

© Crown copyright 2014

When it became evident that the flaps were working again, the commander realised that NCL was still the nearest airport. However, a decision to divert had been made and he did not believe that the co-pilot would contemplate a return to NCL. En-route to MAN, the commander felt there was little time available to conduct a joint review of the situation but that he did mentally review things himself. He also remarked that the situation had felt unreal and that it seemed to get out of control very easily. He recalled that on a couple of occasions he had tried to offer the co-pilot some reassurance.

The co-pilot could not recall any discussion concerning actions in the event of a G/A from the approach at MAN. The cloud was reported as being broken at 1,500 ft aal with rain and he believed that they could have flown a visual circuit if necessary.

After the flight, the commander wrote up the technical defects that he remembered. He thought that this was a serious incident but he was unaware of any responsibility to isolate the CVR or to ensure that FDR data was preserved. He saw no need to review or debrief the incident with other crew members before dispersing. The ASR was not filled in immediately because he was in the habit of leaving these reports for a couple of days. He did try to contact the Duty Flight Operations Manager as soon as he could but was unable to reach anyone until two days later.

Recalling the event, the co-pilot considered that the problems caused by the G/A made him agitated and this was one reason why he did not handle the QRH correctly. He felt that if he had been made to sit and compose himself prior to starting the non-normal checklists then he might have performed better. He also remarked that he and the commander ought to have communicated more, and that they had not reviewed their actions as advocated during company training and laid down in Part A of the operator's Operations Manual (OM)[11].

QRH procedures

The Boeing QRH includes the following instruction on the use of non-normal checklists:

> *'Try to do checklists before or after high work load times. The crew may need to stop a checklist for a short time to do other tasks. If the interruption is short, continue the checklist with the next step. If a pilot is not sure where the checklist was stopped, do the checklist from the start. If the checklist is stopped for a long time, also do the checklist from the start. After completion of each checklist, the pilot reading the checklist calls, "________ CHECKLIST COMPLETE."'*

The end of a checklist is indicated by four solid black squares positioned in a horizontal line. The QRH instructions also state that:

> *'troubleshooting i.e. taking steps beyond published non-normal checklist steps, may cause further loss of system function or system failure. Troubleshooting should only be considered when completion of the published non-normal checklist results in an unacceptable situation.'*

Footnote

11 See the '*TDODAR*' section of *'Operator's Operations Manual'*.

© Crown copyright 2014

A section of the OM concerning emergencies after V_1 stated that the PF should be responsible for radio communications when the PM was carrying out QRH drills. This division of tasks was not explicitly associated with any other procedure.

Non-normal checklists

The '*Leading Edge Slat Disagree*' checklist from the Boeing 757 QRH is shown at Figure 2.

The second non-normal checklist to be referred to was titled '*Trailing Edge Flap Disagree'.* This was presented on pages 9.18 to 9.20 of the QRH. It was similar to the previous checklist but it had only nine numbered steps.

Performance

Landing distance

Reference to the '*Non-Normal Configuration Landing Distance tables'* in the QRH would have indicated that a minimum landing distance of around 1,455 m was needed to land with the flaps retracted at NCL. Alternatively the electronic flight bag, (Boeing's EFRAS tool[12]), was available on the flight deck. This would have calculated that a landing distance of 1,465 m was required. These distances were unfactored in accordance with the operator's guidance regarding the calculation of Operational Landing Distance (OLD) in the event of a technical emergency. A technical emergency was defined as '*a situation where there has been, or likely to be, a significant impact on the safety of continued flight. Normally this is the result of system failure.*' The OM said:

> ***'Diversion due to Technical Emergency:*** *In the event of a technical emergency the crew must confirm that the planned landing runway distance available is equal to or greater than the Operational Landing Distance required for the aircraft in the configuration that it will be landing in. However, pilots are reminded that this distance has no margin for pilot technique. As a result, whenever possible, pilots should attempt to land on runways which offer a greater margin of landing distance. In determining the best options available the Commander must consider the severity of the situation and compare the risk of continued flight to a more appropriate runway versus the risks inherent in landing on a limiting runway.'*

Where no technical emergency existed, the operator's policy was to increase the safety margin by adding 15% to the OLD. This would increase an unfactored landing distance of 1,465 m to 1,685 m. Runway 25 at NCL had a declared LDA of 2,125 m. The LDA of Runway 24 at EDI, the first alternate, was 2,347 m and Runway 23R at MAN had an LDA of 2,714m.

Footnote

[12] Two hand held computers on the flight deck provided access to publications, the electronic technical log and a tool for performance calculations known as EFRAS (Electronic Flight Report and Runway Weight Chart System). This tool interrogates Boeing Standard Computerised Aeroplane Performance (SCAP) data to derive takeoff and landing performance values.

© Crown copyright 2014

9.10

BOEING
757 Flight Crew Operations Manual

LEADING EDGE

LEADING EDGE SLAT DISAGREE

Message: LE SLAT DISAGREE

Condition: The leading edge slats are not in the commanded position.

Caution! Limit airspeed to 240 knots maximum.

1 GND PROX FLAP OVRD switch . . . . OVRD

2 Choose one:

- ◆Indicated flap position **greater than** 20:
  - Use current flaps and VREF 20 for landing.
  - ►►**Go to step 10**
- ◆Indicated flap position **20 or less:**
  - ►►**Go to step 3**

3 Use flaps 20 and VREF 20 for landing.

4 Choose one:

- ◆FLAP lever position **greater than** 20:
  - ALTN FLAPS selector. 20
  - ►►**Go to step 6**
- ◆FLAP lever position **20 or less**:
  - ►►**Go to step 5**

5 ALTN FLAPS selector . . . . Position to agree with FLAP lever

6 LE ALTN FLAPS switch . . . . ALTN

▼ Continued on next page ▼

9.10 D632N001-62JMA Nov 2009

BOEING
757 Flight Crew Operations Manual 9.11

▼ LEADING EDGE SLAT DISAGREE continued ▼

7 TE ALTN FLAPS switch. . . . . ALTN

8 Choose one:

- ◆LEADING EDGE light is **illuminated:**
  - LE ALTN FLAPS switch . . . . Off
  - ►►**Go to the LEADING EDGE SLAT ASYMMETRY checklist on page 9.6**
  - ■ ■ ■ ■
- ◆LEADING EDGE light **extinguishes**:
  - ►►**Go to step 9**

9 ALTN FLAPS selector . . . Extend or retract leading edge slats and trailing edge flaps as needed

10 Check the Non-Normal Configuration Landing Distance tables in the Performance Inflight-QRH chapter.

11 Checklist Complete Except Deferred Items

▼ Continued on next page ▼

Nov 2009 D632N001-62JMA 9.11

9.12

BOEING
757 Flight Crew Operations Manual

▼ LEADING EDGE SLAT DISAGREE continued ▼

Deferred Items

Descent Checklist

Pressurization. . . . . LDG ALT

Recall . . . . Checked

Autobrake . . . . ___

Landing data . . . . **VREF 20, Minimums**___

Approach briefing . . . . Completed

Approach Checklist

Altimeters . . . .

Nav Aids . . . . IDENTIFIED, COURSE SET

Landing Checklist

Speedbrake . . . . ARMED

Landing gear . . . . Down

Flaps. . . . . **As directed**

Cabin . . . . **SECURE/WARNED**

■ ■ ■ ■

9.12 D632N001-62JMA May 2009

Figure 2

Leading Edge Slat Disagree checklist

© Crown copyright 2014

Fuel

At FUE the aircraft was fuelled to 20,000 kg. The Pilots' Flight Log (PLOG) showed that this was 295 kg in excess of the minimum required. The taxi fuel was predicted as 306 kg, with a trip fuel of 15,650 kg, a contingency allowance of 469 kg and a final reserve figure of 1,627 kg. The PLOG indicated that to divert to EDI, 3,280 kg of fuel would be needed to land with final reserve fuel. MAN was listed as the second alternate option with a minimum of 3,626 kg required, including a predicted burn of 1,999 kg. The PLOG gave a cruise level of FL170 from NCL to MAN and a track distance of 132 nm. The quoted burn presumed a clean configuration and a normal speed profile.

System information

Automatic systems

The Autopilot Flight Director System includes the Flight Control Computers and the MCP. The A/P, F/D, altitude alert, and A/T parameters are controlled using the MCP on the glareshield and by the thrust mode select panel.

F/D steering indications normally display on the ADIs any time the related F/D switch is ON. The manufacturer's Flight Crew Training Manual (FCTM) notes that when establishing on a localiser with a large intercept angle, some overshoot can be expected. After the LOC and GS modes are captured they can only be disengaged by pressing a G/A switch or by firstly disconnecting the A/P and then turning both F/D switches off.

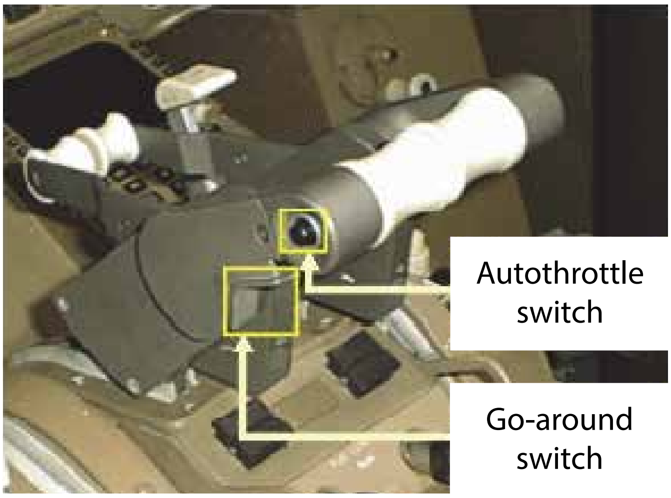


Figure 3

Thrust levers and associated switches

Each thrust lever has a G/A switch and an A/T disconnect switch (Figure 3). Pressing a G/A switch activates the GA modes using the A/P or, in manual flight, the F/D only. GA roll mode will command existing ground track at the time of mode engagement. GA pitch mode will command a pitch to achieve the existing speed or MCP speed if this is higher.

If a G/A switch is pressed with the A/T and A/P engaged, thrust is increased to a maximum of G/A thrust, to establish a climb rate of at least 2,000 ft/min. Once a climb rate of

2,000 ft/min is established, thrust is adjusted to maintain that climb rate. If the A/P and the F/D are both off, the A/T will provide a reference thrust that protects flap and VMO speed limits.

Normal A/P disengagement is by means of either of the control wheel A/P disengage switches. Alternatively there is an A/P disengage bar on the MCP. Movement of the manual trim switches on the control wheel can also cause disengagement while large control wheel movements or large or rapid control surface movement can prevent the A/P from engaging when commanded. Disconnection of the A/P illuminates the A/P DISC light and the EICAS warning message AUTOPILOT DISC. The A/T can be operated independently of the A/P or F/D.

Figure 4

Left portion of the MCP on the glareshield panel

With the A/T Arm switch set to ARM, the system will engage when any one of the adjacent EPR, SPD, VNAV or FL CH switches or the G/A switch (Figure 3) is pressed. With EPR pressed, thrust is controlled according to which selection is made on the Thrust Mode Select Panel. With SPD pressed, the white speed selector knob to the right of it can be used to set a target airspeed in the speed window (labelled IAS/MACH in Figure 4). The small select switch (labeled SEL) can be pressed to alternate between IAS and MACH. The speed set in the window during an approach will become the initial target speed if SPD mode is engaged after a G/A. To command acceleration, the speed selector can be rotated clockwise to a higher speed, typically V_{REF} +80.

When an A/T disconnect switch is pressed during an approach, the SPD mode annunciation on each ADI will clear but the speed window should still indicate the speed that was last targeted. To re-instate the A/T, the arm switch must stay in the ARM position and an A/T mode then engaged. For SPD mode, the speed switch must be pressed and the selector rotated to adjust the reference speed if required. If the selector was accidentally pressed instead of the switch, the speed window would close. A second press of the end of the selector would re-open the speed window. This was investigated in a simulator detail and it was found that if pressure was applied obliquely to the end of the selector then it might not open the window. The selector is normally pressed squarely towards the panel but when the pilot in the right seat leant across the flight deck, it was possible to apply pressure obliquely so that the window remained blank. No technical irregularity was found when the system was checked on G-TCBC immediately after the incident.

© Crown copyright 2014

Flap systems

The primary control for the flaps and slats is the flap lever on the control stand and their primary power source is hydraulic. The flaps can be selected to one of seven detent positions. The slats only have three positions. When FLAP UP is selected the slats are commanded to retract. When the flap lever is moved to FLAP 1, the slats should move to a mid-range position and when the flap lever is moved past FLAP 20, the slats should fully extend. The position of the control surfaces and the associated limit speed is indicated on the centre instrument panel. If the flap and slat positions selected by the crew are not reached within an appropriate time, a DISAGREE is recorded by the FDR and a caution is generated on the EICAS, along with an amber LEADING EDGE or TRAILING EDGE light on the centre instrument panel.

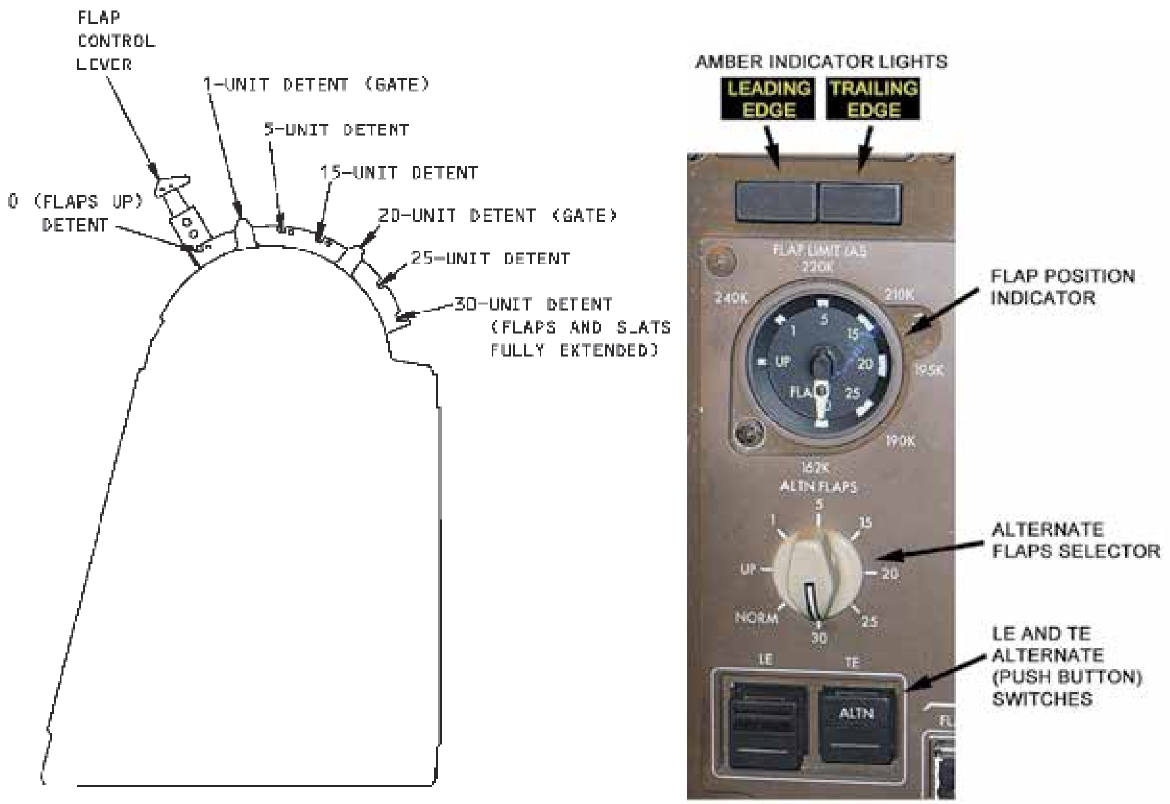


Figure 5

The main flap/slat control on the control stand (left diagram), the flap position indicator with associated alternate controls and indicators on the centre instrument panel (right diagram)

There is an alternate control and power system for the flaps and slats and two alternate flaps switches (labelled LE ALTN and TE ALTN). Note that although the LE devices are generally referred to as slats, their associated alternate switch is known as the LE or TE alternate flaps switch. Selecting either alternate switch will isolate hydraulic power from both the LE and TE systems. Selecting either alternate switch will also switch the DISAGREE warning logic of both LE and TE devices from the control stand flap lever to the alternate flaps selector on the centre instrument panel. However, the electrical power for driving the surfaces will only be connected if the appropriate alternate flaps switch for that system has

© Crown copyright 2014

been pressed. This means that arming only one of the alternate switches, results in the other system being unable to respond to selections made via either the flap lever or the alternate flaps selector. Under this condition, if the alternate flaps selector does not match the position of one surface, a DISAGREE condition will exist and this will cause the associated amber indicator, at the top of the flap panel, to illuminate and an EICAS LE SLAT DISAGREE or TE FLAP DISAGREE message will be presented. Note that a DISAGREE condition can also exist under normal control (with neither alternate flaps switch pressed), should one surface disagree with the position commanded by the flap lever.

The flap position indicator also shows the limit speeds for that configuration. Exceeding that limit can result in damage or an inability for the system to reach the selected position. If a system does not reach the position commanded by the flap lever within the appropriate time, the hydraulic power is shut off, freezing the system at its achieved position and causing a DISAGREE condition to exist. The Operator's SOP Manual states that any incident of a flap limit speed exceedence with flap extended must be recorded in the technical log.

Fuel system

The B757 has a centre fuel tank as well as left and right main tanks located in the wings. Each tank has a forward and aft fuel pump. The two centre tank fuel pumps have greater output pressure than the left and right main tank fuel pumps. When all six pumps are operating, the centre tank pumps override the left and right main tank pumps, so that the centre tank fuel is used before left or right main tank fuel. If any pump has low output pressure, the appropriate switch PRESS light illuminates on the fuel panel and an advisory message is displayed on the EICAS.

When total usable fuel in the left or right main tank drops below approximately 1,000 kg, a FUEL CONFIG light on the fuel control panel illuminates and the EICAS caution message LOW FUEL is displayed. If the fuel quantities in the main tanks differ by 800 kg or centre fuel pump switches are OFF with more than 600 kg in the centre tank, the FUEL CONFIG light illuminates and an EICAS advisory message FUEL CONFIG is displayed. This operator's SOP was for the QRH to be used in response to EICAS messages. The SOP Manual included a maximum imbalance limitation of 880 kg.

Figure 6 shows the layout of the fuel panel on the overhead console. Each fuel pump switch has an integral low pressure indication (PRESS). The crossfeed valve switch controls two valves operating in parallel. Below this switch is the FUEL CONFIG light.

The fuel manifolds are arranged so that any fuel tank pump can supply either engine. The crossfeed valves isolate the left fuel manifold from the right. These valves are normally closed to provide fuel feed from tank to engine. Fuel balancing is accomplished by opening the crossfeed and turning off the fuel pumps for the main tank that has the lowest quantity.

The OM permitted fuel balancing to be done at any stage in flight, whilst the FCTM included the following notes:

© Crown copyright 2014

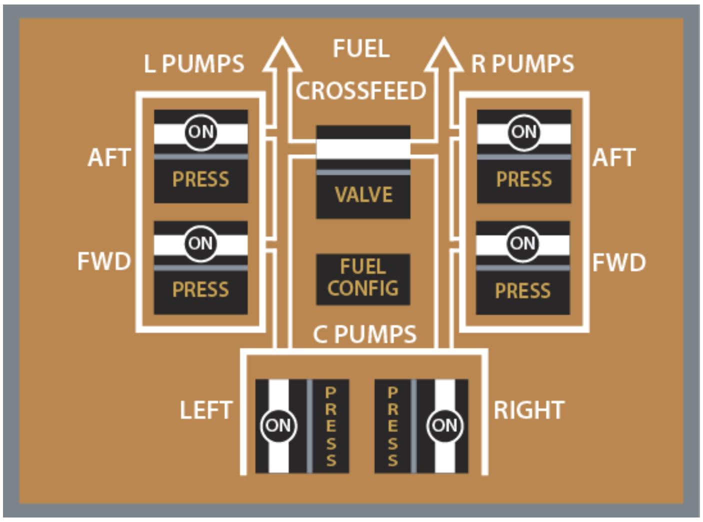


Figure 6

Diagrammatic representation of the fuel panel situated on the overhead instrument console

> ***'Fuel Balancing Considerations***
>
> *The crew should consider the following when performing fuel balancing procedures*
>
> - *use of the Fuel Balancing Supplementary Procedure in conjunction with good crew coordination reduces the possibility of crew errors*
> - *routine fuel balancing when not near the imbalance limit increases the possibility of crew errors and does not significantly improve fuel consumption*
> - *during critical phases of flight, fuel balancing should be delayed until workload permits. This reduces the possibility of crew errors and allows crew attention to be focused on flight path control*
> - *fuel imbalances that occur during approach need not be addressed if the reason for the imbalance is obvious (e.g. engine failure or thrust asymmetry, etc.).'*

The Fuel Balancing Supplementary Procedure mentioned above stated that when the fuel quantities in the main tanks differed 'by an appreciable amount', the crossfeed switches should be turned on and the fuel pump switches in the low quantity tank turned off until the fuel load balanced. The FCTM also offered guidance for flight with the LOW FUEL message displayed. For approach and landing it said:

> *'In a low fuel condition, the clean configuration should be maintained as long as possible during the descent and approach to conserve fuel. However, initiate configuration changes early enough to provide a smooth, slow deceleration to final approach speed to prevent fuel from running forward in the tanks. A*

© Crown copyright 2014

> *normal landing configuration and airspeed appropriate for the wind conditions are recommended. Runway conditions permitting, heavy braking and high levels of reverse thrust should be avoided to prevent uncovering all fuel pumps and possible engine flameout during landing roll.'……….. 'If a go-around is necessary, apply thrust slowly and smoothly and maintain the minimum nose-up body attitude required for a safe climb gradient. Avoid rapid acceleration of the airplane. If any wing tank fuel pump low pressure light illuminates, do not turn the fuel pump switches off.'*

The QRH actions for a LOW FUEL caution involve opening the crossfeed valves but leaving all pumps on. This ensures that both engines receive fuel, even if one tank is empty but the other still has fuel. The QRH actions for a FUEL CONFIG message are to open the crossfeed valves and turn off the fuel pumps to the low tank until fuel is balanced. There is also an instruction in this checklist to refer to the '*Low Fuel*' checklist if the fuel quantity in either main tank is low.

The amount of fuel imbalance at the start of this diversion is unclear but it is known that the crossfeed valves were open for 11 minutes and 12 seconds, during which time 369 kg of fuel was used from the left tank. As the left tank was recorded as having 500 kg more fuel than the right tank at shutdown, it is probable that there was an imbalance of close to 800 kg when the crossfeed valves were opened.

Flight Management Computers

There were two FMCs on G-TCBC. Pilots input flight plan information as a route via their onside Control Display Unit (CDU) and the related FMC combines it with information from aircraft sensors and from its memory. The left FMC is usually the master system and the right is the slave. Once a route is input into the FMC, it is activated by pressing a Line Select Key adjacent to the command 'ACTIVATE>' on the CDU. The route in use is normally RTE 1 but there is an option to pre-load and activate an alternative route, RTE 2. When the end of a route is overflown or passed (eg when diverting but without a diversion route prepared), a new waypoint can be added to the route in use. It must then be activated before the FMC will provide relevant navigational information. When using RTE 1, there is a Line Select Key that provides a shortcut to RTE 2, which can be built up and activated in-flight if needed.

Recorded data

The aircraft was fitted with an FDR and a CVR. Pertinent extracts from the CVR are provided in the *History of the flight* section of this report. The FDR recorded pertinent data for the majority of the investigative needs.

The problems encountered during the flight relate to different systems over different periods so the following plots and descriptions cover overlapping periods.

© Crown copyright 2014

Go-around

Figure 7 shows the pertinent parameters for the G/A sequence.

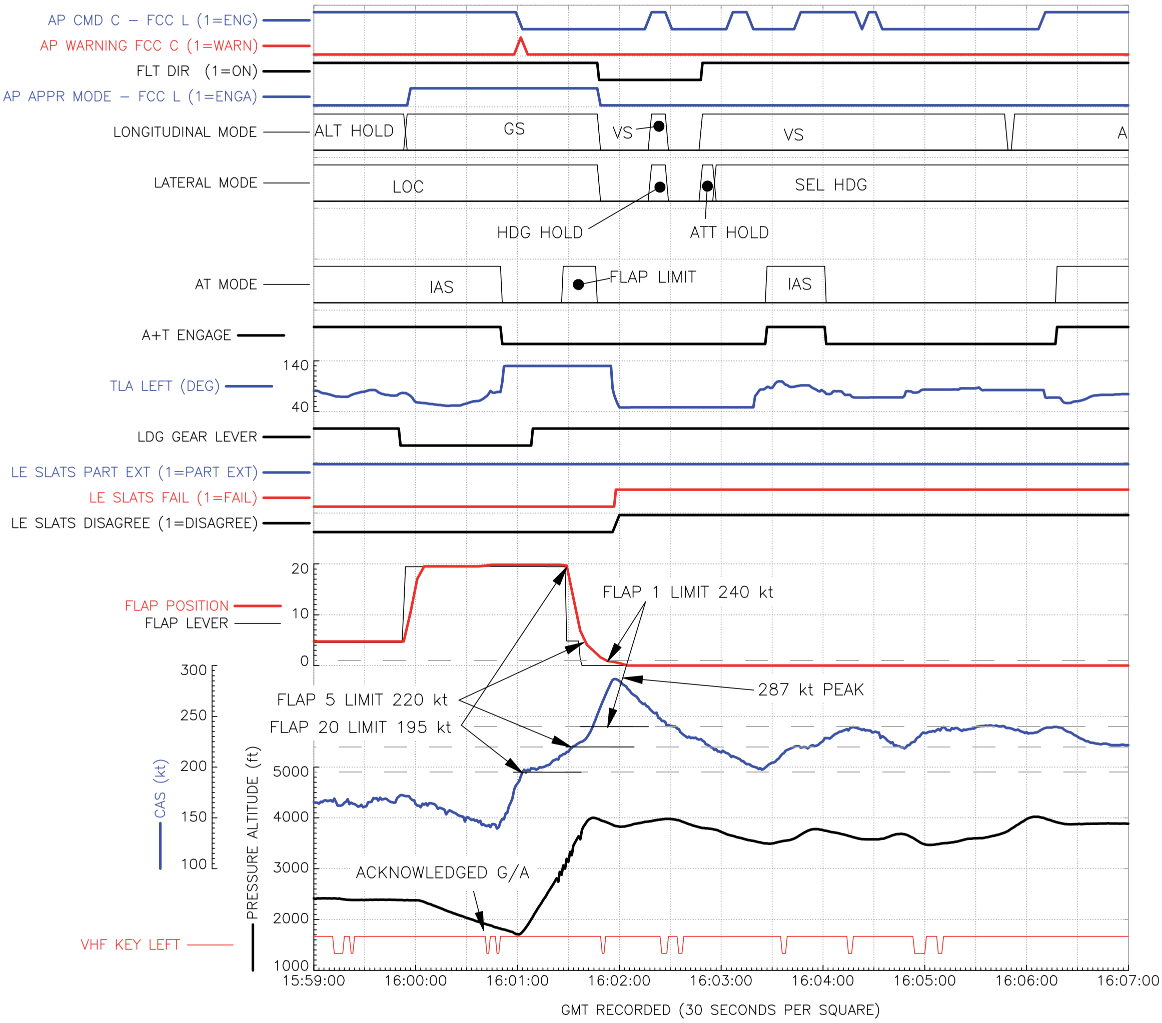


Figure 7

Go-around speeds, flap limits and automatics

The G/A call was acknowledged at approximately 1600:40 hrs. Soon after, the thrust levers were advanced and the A/T was disconnected. The A/P remained engaged and the aircraft followed the glideslope but accelerated due to additional thrust. It reached the FLAP 20 limit speed just after the A/P was disengaged and the aircraft was pitched up. This slowed the acceleration but FLAP 20 remained selected for a further 30 seconds. The subsequent flap retraction rates and aircraft accelerations were such that the aircraft speed remained above the relevant flap limit speeds until the flaps were fully retracted, soon after the speed peaked at 287 KCAS. At this point LE SLAT FAIL and LE SLAT DISAGREE conditions were recorded. 20 seconds prior to reaching the peak speed, the aircraft levelled at a pressure altitude of 4,000 ft (approx 3,580 ft barometric altitude), after which the F/Ds were switched off. The A/P and A/T went through a number of iterations of being engaged and then disengaged until the final engagement at approximately 1606 hrs.

© Crown copyright 2014

Flaps and slats

The position of the alternate flaps selector is not recorded. This can be inferred or partially inferred when no failure or disagreement is recorded and either the LE or TE alternate flaps switch is selected, as this indicates the alternate flaps selector position matches the recorded surface positions.

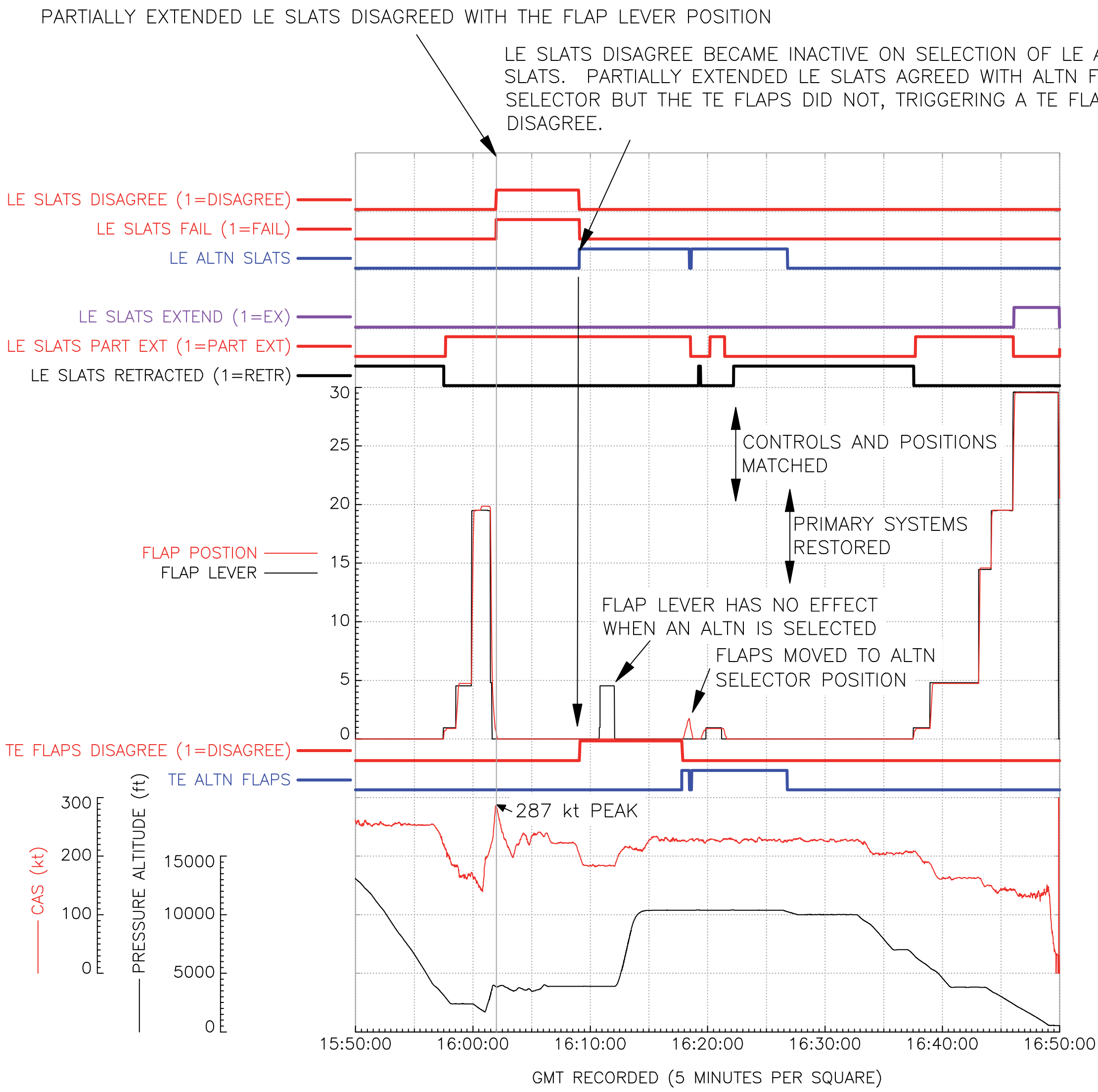


Figure 8

Flap and slat parameters for the G/A and remainder of the flight

The LE SLAT DISAGREE parameter, along with the partially extended state of the LE slats with the flap lever at 0, indicate that the slats could not reach the selected retracted state. This condition started when flaps retracted past FLAP 1, when the slats should have started retracting and the aircraft was above the FLAP 1 limit speed. The end of the LE SLAT DISAGREE condition coincided with the recorded selection of LE ALTN SLATS. This indicates that the LE alternate flaps switch had been pressed which:

- switched the DISAGREE logic from the flap lever to the alternate flaps selector
- removed hydraulic power from the flap and slat systems
- provided electrical power to the alternate slat system
- left the flap system without any motive power

This resolved the slat anomalies but triggered a TE FLAP DISAGREE. This indicates that the alternate flaps selector was now in agreement with the partially extended state of the LE slats but disagreed with the retracted position of the TE flaps. Approximately nine minutes later the TE alternate flaps system was armed, providing electrical motive power to the TE alternate flaps system. The flaps started moving and the TE FLAP DISAGREE parameter no longer indicated a problem. The flap movement initially continued past FLAP 1 then reversed and all surfaces were retracted before running back to FLAP 1 for a few minutes under alternate control. During this time the flap lever was also moved to FLAP 1. All surfaces were then retracted and approximately five minutes later both the alternate systems were disarmed and normal flap/slat control was established. The inference is that once the TE alternate flaps switch was pressed, the TE flaps ran under control of the alternate flaps selector (which must initially have been positioned beyond FLAP 1), until both alternate systems were disarmed.

No other flap/slat issues were recorded for the remainder of the flight and the landing was made using FLAP 30. Other than the conditions associated with excessive speed and partial slat extension, the flap and slat parameters reacted as expected for the given crew selections.

Fuel

Figure 9 shows the pertinent fuel related parameters. The derived fuel weight figures are based on recorded gross weight and zero fuel weight parameters, recorded once every 64 seconds. The CVR captured the crew agreeing the remaining fuel at two points during the flight. These were approximately 150 kg more than the derived figures indicate. However, the final derived fuel figure of 871 kg is close to the reported 900 kg final fuel figure. Part of the mismatch may be associated with timing and the quality and resolution of the source values. The fuel figures quoted in the earlier *History of the flight* section are the figures that were acknowledged by the crew.

After the G/A a forward fuel pump low pressure condition was recorded for a period during the climb from 4,000 ft. This was probably associated with the geometry of the fuel tank and aircraft attitude during the climb. The low fuel quantity parameter started indicating LOW FUEL soon after the top of climb and remained in that state for the rest of the flight. The parameters relating to crossfeeding became active at 1632 hr for approximately 11 minutes. The majority of this time was in the descent with relatively low fuel flow. The fuel flow figures indicate that approximately 813 lb (369 kg) of fuel was used during this period.

© Crown copyright 2014

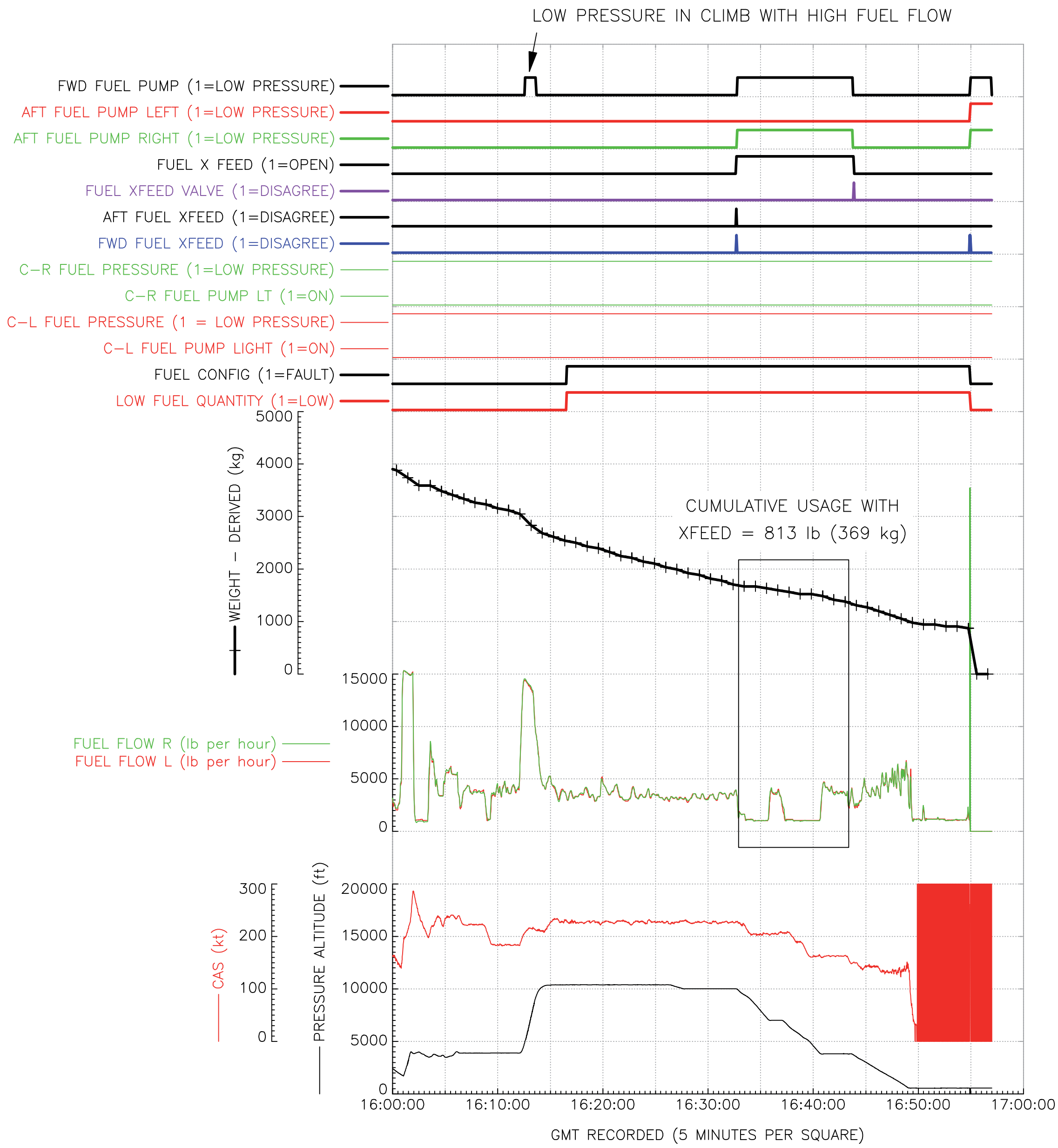


Figure 9

Fuel usage

Protection of CVR recordings

After reporting this occurrence the operator requested release of the FDR back to service, which was granted. It also accessed the CVR and used a transcription of the recording for its internal investigation, which is not permitted.

Regulation (EU) 996/2010, Article 14 states that cockpit voice recordings shall not be used for purposes other than safety investigation[13]. This protection exists whenever a safety investigation authority is conducting an investigation.

Footnote

[13] Regulation (EU) 996/2010 defines safety investigation as a process conducted by a safety investigation authority, such as the AAIB.

© Crown copyright 2014

Operating procedures

Go-arounds

Regarding briefing prior to approach, the OM stated:

> *'When an approach briefing is conducted for the home base of both pilots then the brief may be abbreviated if both pilots agree they are fully familiar with the procedure.'*

A full briefing is expected to cover the '*Missed Approach Procedure – to include an engine inoperative scenario*'. No written guidance is offered as to whether or not the handling technique for an all engines operating G/A should be included within the briefing of the Missed Approach Procedure.

The guidance given in the manual for an approach made using the A/P was that it should normally remain engaged for the G/A. For a manually flown G/A the SOP was that, with both engines available, the aeroplane should initially be rotated to approximately 15º nose-up and the F/D pitch bar followed thereafter. To further enhance workload management and ensure that an appropriate level of automation was used during a G/A after manual flight, with or without F/D selected, the SOP was to use the mnemonic "GAGL". This was a reminder to press the G/A switch, engage the A/P, so that vertical speed and heading hold modes both functioned, before again pressing the G/A switch to engage GA modes, which would be checked on the FMA. When the climb was stabilised, an appropriate Lateral mode was expected to be used to follow the missed approach procedure.

The PM's duties during a G/A were to acknowledge the initial call of "GEAR UP, FLAPS 20" by moving the flap lever if necessary, check the engine thrust rating and confirm that GA was displayed on the FMA. When a positive climb was seen, it was announced and the gear selected up when commanded. After that the PM would inform ATC of the G/A and check again that GA was annunciated on the FMA. The A/P would be selected if requested, along with any modes stipulated. Above the acceleration altitude 'V_{REF} +80, climb thrust' would be called for and the PM would dial up the V_{REF} +80 figure in the speed window. As the speed increased the PF would call for the flaps to be retracted to FLAP 5, FLAP 1 and then UP and the PM would acknowledge each call, check the speed and retract each stage of flap. A section in the manual dealing with monitoring duties stated:

> *'In the event of an airspeed discrepancy of more than -5 kt or +10 kt from the required airspeed, PM should call 'SPEED.'*

Fuel emergency

The following paragraph appeared in the Part A of the Operator's OM:

> ***'Fuel Emergency (EU-OPS 1.375 b)***
>
> *The Commander shall declare an emergency when the calculated usable fuel on landing, at the nearest adequate aerodrome where a safe landing can be performed, is less than final reserve fuel.'*

© Crown copyright 2014

TDODAR

The Part A of the OM gave detailed guidance about decision making processes. This included the way in which the pilots should deal with new or unfamiliar situations. It said:

> *'………..we recommend the use of the mnemonic* ***TDODAR****. It can also be useful as a mental checklist to ensure all eventualities have been covered. The most important element of the process is the last item, the review. Time for a review must always be found. A proper review will enable one to ensure the decision(s) you have made still fit the situation as it develops.'*

TDODAR is described as the following series of actions or considerations:

> ***'Time*** *How quickly must you get the aircraft on the ground? This will dictate how much time you can give to considering options and reaching a decision.*
>
> ***Diagnosis*** *What are the symptoms? ....Use all resources and senses available to you and your crew. What is the problem? ....Not what is the solution. Ask what, how, why, etc...............Time spent on diagnosis is rarely wasted.*
>
> ***Options*** *Is there more than one option? ....There often is. Consider the consequences of each. Has anyone else thought of an option? ....Consulting is not a sign of weakness and taps into others' situational awareness (crew SA).*
>
> ***Decision*** *There is not always a "perfect" decision but a thorough diagnosis (with all options and consequences considered) will probably be the best decision that can be made with the information and time available.*
>
> ***Assign Tasks*** *Consider workload and experience. Beware of overloading yourself or others. Ensure others' roles are understood.*
>
> ***Review*** *Is the decision still valid? Are tasks completed? Has everyone been updated? Time for the review must always be found and if the situation no longer fits the decision made then the process has to be repeated, hence this technique is also called the "Decision Making Loop.'*

Serious incident procedures

ICAO Annex 13 defines accidents and serious incidents and notes that the only difference between the two lies in the result. It gives examples of serious incidents and these are repeated in Regulation (EU) 996/2010 regarding the investigation and prevention of accidents and incidents in civil aviation. In the UK the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996 requires the commander of a UK registered aircraft or of an aircraft flying in the UK, to inform the AAIB if they are involved in an accident or serious incident.

Section 11.2 of Part A of the operator's OM dealt with accident reporting. It stated that it was the pilot's responsibility to ensure that relevant reporting procedures were followed without delay but that in the UK the company would be responsible for notifying the AAIB.

© Crown copyright 2014

Serious incidents were not mentioned in this section although it was noted that if there was any doubt as to classification, then the captain should report an occurrence in the same way as an accident. There was no instruction in the OM to inform pilots that serious incidents should be reported to the AAIB.

Section 11.3 of Part A dealt separately with incidents and included the following notes about serious incidents:

> ***'11.3.2 Serious Incident***
>
> *A serious incident is defined as an incident which:*
>
> *(a) Has jeopardised the safety of passengers, crew or aircraft and narrowly avoids being an accident (by good handling, good luck, etc)*
>
> *(b) Has serious potential technical or operational implications, or*
>
> *(c) May result in formal disciplinary action against aircrew or engineers.*
>
> *The decision to classify an Incident as 'Serious' will normally be made by the Director of Flight Operations or the Flight Safety Manager. This decision must be made as soon as possible after the event and before the crew or aircraft fly again and the operations supervisor will contact the DFO or Flight Safety Manager as soon as notification of a potentially serious incident is received.'*

The Duty Flight Operations Manager was not mentioned in the above paragraph but his responsibilities were laid out in an earlier section of the Part A, where it stated:

> *'The Duty Flight Operations Manager (DFOM) roster gives 7-day, 24-hour cover to grade operational incidents and provides round the clock pilot management access for the Flight Crew. The DFOM is the first point of contact for Operations Control in the event of any accident, incident, security threat or issue that might attract unwanted publicity.'*

According to the operator's procedures, when the DFOM became aware of an accident or serious incident, he would contact the on-call safety manager who would then notify the AAIB. The OM Part A also stated:

> *'At all times where possible a manager should speak to the crew. Ideally this will be face to face but where necessary this may be with the DFOM over the telephone who as a pilot, will then exercise his discretion. The Captain should be encouraged to carry out a "crew post incident de-brief" to ensure that all aspects of the incident are captured for reporting purposes and to enhance CRM.'*

The requirement for a crew post-incident debrief was not included in the guidance given to commanders. However, there was an instruction that required a pilot who was involved in an incident to fill in an Air Safety Report within six hours of the occurrence or of landing.

© Crown copyright 2014

Preservation of recorded data

The regulations for the preservation of FDR and CVR data are laid down in EU-OPS 1.160 and in JAR-OPS 3.160. In 2011 the CAA issued Safety Notice 2011/011 to reinforce the need for operators to have robust procedures to ensure protection of this data after both accidents and serious incidents. This operator's OM required that every effort should be made to preserve all forms of aircraft data unless advised to the contrary by the flight safety department. One of the commander's responsibilities according to Part A of the OM was not to permit recorded data to be erased after a flight when an accident or incident subject to mandatory reporting had occurred. Elsewhere in Part A pilots were instructed to ensure that after an '*incident*' the CVR was to be isolated to avoid over-writing and that they should ensure the security of the FDR and Quick Access Recorder until the data or the units were removed. No details were given as to how to accomplish this on the B757.

CAA guidance

As a result of reported incidents that arose from all-engines operating G/As, the CAA published a notice in 2008 (FODCOM 11/2008) which highlighted these occurrences. This guidance was later incorporated in CAP 789 (Requirements and Guidance Material for Operators). An extract from Chapter 24 relating to Flight Crew Training is shown below:

'4.1 ***Go-around Training***

4.1.1 Most go-arounds are flown from positions not normally practised during simulator training and checking. These include go-arounds from below decision height and from well above decision height close to the acceleration altitude. They may also take place when not in the final landing configuration and when not asymmetric as required by Licence Proficiency Checks (LPC) or OPC. There have been a number of incidents during which a go-around was carried out in a serviceable aircraft that resulted in the loss, or near-loss, of that aircraft. Two events that were frequently linked with go-arounds were:

a) altitude busts; and
b) flap and/or landing gear limit speed exceedance.

4.1.2 Go-arounds with all engines operating are part of the initial type rating training course for Multi-Pilot Aeroplanes (MPAs) but not a mandatory part of annual or six-monthly recurrent training. The practice of go-arounds with all engines operating from other than at DA should be carried out regularly. As a minimum, this should be included in the operator's three-year training programme but should not be too prescriptive in detail. Unplanned go-arounds should be included to verify pilot understanding of SOPs. This would enable operators to vary the training in order that it encompass a variety of circumstances including:

© Crown copyright 2014

> a) *above DA and above the platform altitude in the Missed Approach Procedure;*
> b) *between DA and touchdown; and*
> c) *after touchdown.*
>
> *Briefing material should be produced to provide crews with guidance on appropriate autoflight modes relevant to the differing circumstances. Operators should ensure that sufficient training is provided to enable crews to execute go-arounds satisfactorily from various altitudes.'*

Since this incident took place, the CAA published Information Notice (IN-2013/198) which reiterated the guidance quoted above.

Operator's training

The operator of G-TCBC included all-engines operating G/As in its recurrent simulator training for pilots in early 2011, incorporating use of the mnemonic GAGL. This training package was undertaken by the co-pilot in July 2011. The commander undertook his type conversion during this period and did not experience the same scenario but his conversion training included all-engines operating G/As from other than decision altitude (DA).

The operator's recurrent training in early 2013 included briefing on the use of the mnemonic GAGL in association with a visually flown manual approach that resulted in a G/A. In this training scenario the all-engines operating G/A was initiated from above DA following a technical malfunction. The commander undertook this training in April 2013. The associated training record stated that this was *'very well handled and good decision made leading to a well flown G/A'*. It did not record from how far above DA the manoeuvre was commenced. During the co-pilot's recurrent training in July 2013, he acted as PM during a similar all-engines operating G/A from above DA.

Prior to the serious incident to G-TCBC, the operator had planned all-engines operating G/A training from above DA into its recurrent training scenario for the second half of 2013. This simulator training for all the operator's pilots was in accordance with the CAA's recommendations.

During 2014 the operator adjusted its guidance on G/As advising pilots to take time, discuss the intended actions and if necessary to re-engage the autopilot first.

Operator's response

The operator commenced an internal investigation when details of the occurrence became clear. Initially the operator accessed the CVR and FDR data. This was subsequently passed to the AAIB when the AAIB upgraded the level of its own enquiry. The operator also engaged an independent Human Factors (HF) specialist to interview the crew and to produce a report. The following remarks were made in this report with regard to the disengagement of the A/T by the commander:

© Crown copyright 2014

> *'The Captain was visual with the runway on a coupled ILS final approach, with every expectation of continuing to land. After many times of experiencing this situation the captain's brain (unconsciously), brings to readiness a motor response to squeeze the right thumb in order to disconnect the A/T, because that is what normally happens at this point – in order to commence visual landing off the approach. This might also have been consciously anticipated (he was soon intending to do so). In the second after the go-around instruction, the captain is preparing the action and is only consciously aware that he "needs to do something with his thumb". Unfortunately his thumb is almost certainly covering or touching the right A/T button as well as being unconsciously primed to disengage the A/T. The primed response (disengaging the A/T), is extremely similar to the required response (pushing the GA buttons). Given the physical thumb position and the highly sensitized action of disengaging the A/T with the thumb (due to [contextual] priming), this error was relatively likely to occur….'*

The report also discussed the decision to divert and the crew's failure to refer to the QRH drill for LOW FUEL. Some pertinent extracts from this section of the report are quoted:

> *'The decision appeared to solve the problem caused by the flaps and suddenly gave the crew a welcome perception of regaining control over the situation……… It re-focused the crew with a clear joint plan……..It gave the impression that they were taking back control of the situation and hence they started to emerge from their discomfort. Furthermore it helped the cockpit dynamics (the crew relationship) because they had jointly agreed on a plan/goal (this is known to increase group cohesion, which improves relationships).*
>
> *An important point here is that both crew felt so much better about the situation after the decision was made, it made them reluctant to question it further (if unconsciously). The choice to go to Manchester 'felt' very good and this affect probably duped the crew into a false sense that the choice was better than it was in reality, and stopped them reviewing or scrutinising it.*
>
> *It is probable that the criticality of the fuel situation was never properly realised for a number of reasons; partly due to being consumed with a reflection on earlier mistakes, partly due to a reticence to discuss further problems during the flight (and therefore a tacit reassurance from each other), and partly due to unfamiliarity around diverting and what to expect. However the main reason is probably that the crew viewed the fuel state as being planned as part of the decision to divert.......Because below-minimum fuel was part of that 'very good' decision, and the fuel state progressed 'as planned' in line with that 'very good' decision, the actual criticality of the fuel situation did not make the impact upon the crew that it might have done. This even applied to the EICAS message and failure to run the low fuel QRH.'*

© Crown copyright 2014

Safety actions

The operator's report proposed the following actions:

- A review of G/A training to include an external study of best practice.
- The role of the PM was to be addressed during recurrent ground and simulator training sessions.
- An internal newsletter for pilots was to focus on high workload issues, as an interim measure, pending the introduction of a revised HF training package.
- A review of the way that pilots use the QRH. Prior to this being completed, B757 pilots were to receive specific training to enhance their familiarity with checklists relating to slat and flap problems.
- A notice was circulated reminding pilots of the operator's fuel policies and of the need to declare an emergency with a low fuel state. The same notice explained how pilots should contact Operations Control or the DFOM in the event of an emergency and how CVR and FDR data should be secured.
- As part of a harmonisation programme, among several airlines in the same group, the Part A of the OM was to be amended to incorporate changes needed after this incident.

Analysis

Go-around training and briefing

The CAA recognises the need for pilots to regularly practise all-engines operating G/As and has issued guidance with a recommendation that, as a minimum standard, such training should take place every three years. The commander and co-pilot involved in this incident had experienced an all-engines operating G/A without use of the autopilot during training in April and July 2013 respectively. The commander's recollection was that this G/A took place at DA but the operator's records indicated that it was from above DA. The circumstances of this occurrence differed from that of training in that it was not a premeditated G/A and both the autopilot and the autothrottle were engaged when the G/A was initiated.

This incident highlights the need for pilots to be prepared for a G/A at any stage of an approach. The G/A technique was not discussed in the abbreviated approach briefing. The commander believed that the co-pilot had briefed this technique on the previous approach but this did not accord with the co-pilot's recollection. Moreover the co-pilot said that it was unusual for these G/A actions to be briefed. This incident indicates that such a briefing would be beneficial.

© Crown copyright 2014

The go-around

On final approach, the commander was distracted by his perception that the aircraft had not captured the localiser "as well as normal". There was no evidence of a system fault but with a slightly late turn onto the intercept heading and a high groundspeed, the aircraft did overshoot the centreline in the process of capturing. When ATC noticed the overshoot a new intercept heading was given and this gave the crew the impression that the aircraft was not performing correctly.

With the runway in sight the commander was mentally attuned to a landing and was in the habit of reviewing the G/A routine "at about 500 ft" on an approach. In this instance the instruction to G/A came at an earlier stage and he reverted to the G/A procedure relevant to a previous type. Consequently he advanced the thrust levers before realising that he needed to press something with his thumb. This should have been the G/A switch but instead he disengaged the A/T. The G/A switch was never pressed and the commander did not make the standard call '*Go Around, Flaps 20'.* One consequence of disengaging the A/T was that automatic protection against flap speed exceedence was lost.

The report commissioned by the operator noted that if the G/A had not been commanded, the next action that the commander was expecting to carry out with his right thumb was to disengage the A/T for landing. Even if he realised that he needed to press the G/A switch he was already primed for a very similar action and consequently the A/T disconnect switch was pressed as a reflexive action.

The commander observed the aircraft accelerating but still following the glideslope and this contradicted the actions that he thought he had taken. In order to rectify this situation he repeated "GO-AROUND" and eventually disconnected the A/P. He now had to adjust to an un-anticipated G/A whilst flying manually and disregarding the F/D commands. He was mentally stretched as he tried to work out what had happened and he only achieved 10º of pitch-up instead of the recommended 15º. In the short time that it took the fully powered aircraft to reach 3,500 ft amsl it accelerated quickly and several flap speed limits were exceeded.

The operator's SOPs required the co-pilot, as PM, to verbalise any speed discrepancies. However, on this occasion the co-pilot's monitoring ability was degraded and he did not provide this assistance. He, too, had to adjust his mental model from landing to G/A. This was hindered because the initiating call from the commander was incomplete (no flap setting was mentioned), and because he responded to the ATC call to climb straight ahead to 3,500 ft. This diverted his attention when he should have been looking for GA annunciations on the FMA. After that his eyes were drawn to the EICAS screen when the A/P was disengaged. Instead of following the mental GAGL routine, he struggled to put the new situation into context and this degraded his performance. When asked to select V_{REF} +80 and climb thrust, he experienced difficulties. He found the speed window was closed and he started to become frustrated when it would not open. The window may have been closed by accidentally pressing the end of the speed selector instead of the adjacent SPD switch and then would not work because oblique pressure was applied.

© Crown copyright 2014

On reaching 3,500 ft amsl, the commander requested the A/P to be engaged but that proved problematic as well. It either failed to engage or did not remain engaged. It is possible that movements of the control wheel and control surfaces may have prevented A/P engagement, or the commander may have inadvertently disengaged it through use of the pitch trim before he appreciated that the A/P was working. It is also relevant that, because the G/A switch had not been pressed, the LOC and GS modes were still active. The only other way to remove these was by turning the F/D OFF and then back ON with the A/P disengaged. As the F/Ds were not turned OFF and ON before the first attempt to engage the A/P, the LOC and GS modes would have been active and the commander would have had to override the A/P.

Slat and flap problems

Eventually the automatics were successfully engaged but the slats remained partially extended due to an exceedence of the limiting speed by a significant margin. The co-pilot began the relevant QRH checklist but he was frustrated by his poor performance prior to that. Interruption caused him to lose his place in the checklist and instead of starting again, in accordance with SOPs, he struggled to find where he had got to. The similarity in presentation of steps 2 and 4 made this quite difficult. Step 5 required the alternate flaps selector to be positioned to agree with the flap lever. The flap lever was in the UP position but the co-pilot set the alternate flaps selector to FLAP 1, possibly as a result of his heightened anxiety.

Step 6 was to set the LE alternate flaps switch to ALTN. When this was done, the LE flaps, ie the slats, were powered by the alternate electric system and they ran towards the FLAP 1 position, as instructed by the alternate flaps selector. This caused the reference for both the LE and the TE flaps to shift from the flap lever to the alternate flaps selector, but the power source for the TE flaps had not been changed to the alternate system. This action was called for at step 7, at the top of the next page on the checklist, but the checklist was stopped before this was reached, when the TE FLAP DISAGREE caution illuminated. This appeared because the TE flaps were UP, as commanded by the flap lever, but their reference source had been switched to the alternate flaps selector, which was incorrectly set to FLAP 1. System knowledge and familiarity with this drill from training should have ensured that both systems were switched in quick succession.

When the TE FLAPS DISAGREE caption illuminated, the decision was made to prioritise this, even though there was no guidance to that effect. Instead of completing the first checklist, the pilots switched to the '*Trailing Edge Flap Disagree'* checklist. The crew only progressed this checklist to step 3. Had steps 4 and 5 been completed, then both the slats and the flaps would have been controlled and referenced to the alternate flaps selector. If either checklist had been finished, the crew would have been instructed to check the '*Non-Normal Configuration Landing Distance tables'* for the appropriate performance data.

The checklist was interrupted, first by ATC and then when the commander asked if they could get more flaps. The commander's attention had slipped from the checklist because he was becoming convinced that this was another technical failure (following problems on other aircraft and the issue at the start of the approach), and he wanted confirmation that

© Crown copyright 2014

they had a flap fault. The consequence was that the co-pilot diverged from the QRH and mistakenly tried to move the flaps with the flap lever. The commander did not notice this error but he did see that the flaps were not moving, which convinced him that there was a problem and that they would have to land without flap.

The commander stated that he had concerns about conducting a flapless landing at NCL. Calculation of the Operational Landing Distance indicates that Runway 23 at NCL offered sufficient length. The nearest planned alternate destination was EDI, but the commander did not consider this as he believed the runway there was not much longer than NCL. The pilots did not calculate the Operational Landing Distance or review the decision to divert to MAN.

The operator's report indicated that the pilots felt more in control of the situation having decided on a course of action. They knew that this entailed landing with less fuel than normal, but accepted this as part of the solution.

The QRH warned against troubleshooting by deviating from non-normal procedures, prior to completion of appropriate checklists. This crew ignored this instruction and made random flap system selections without completing either checklist. As it transpired, they did manage to regain normal control of the flaps, but if they had followed the QRH correctly they might not have had to consider a flapless landing or a diversion.

Fuel

When the diversion commenced the pilots observed that the remaining indicated fuel quantity was 3,200 kg. The PLOG showed a fuel burn to MAN of 1,999 kg but only 1,653 kg to go to EDI. The EDI option was not discussed and neither were the implications of landing at MAN with less than final reserve fuel of 1,627 kg. No attention was given to the extra track miles to be covered, from 25 nm east of NCL, or to the increased fuel burn that would result because of the non-normal flap configuration (although when they later re-gained flap control the pilots did raise the flaps to reduce fuel burn). The pilots decided to cruise at FL100 but the predicted burn was based on climbing to FL170. An emergency should have been declared as soon as it became evident that the aircraft would land with less than final reserve fuel but there was a delay before this was done.

The pilots did not refer to the QRH in response to EICAS indications of forward fuel pump low pressure or the LOW FUEL caption. They had accepted when they started the diversion that this would entail a landing in a low fuel situation, so may have considered these indications a consequence of the solution. Also, their ability to respond methodically may have been affected by the difficulties they had encountered earlier.

It was unclear if any balancing of fuel had been done on the flight from FUE to NCL, although the co-pilot thought that this had occurred. Both pilots said that they would routinely balance fuel when a difference of between 300 kg and 500 kg was seen. It is unclear what the exact imbalance was at the point that the fuel level in the right tank reduced to 1,000 kg and the LOW FUEL caution came on. The left tank had substantially more but the EICAS FUEL CONFIG had not illuminated, so the imbalance should have been less than 800 kg.

© Crown copyright 2014

The imbalance was not discussed until 15 minutes later when fuel balancing was attempted without reference to the QRH. In this circumstance the '*Low Fuel'* checklist should have been used. Even if the '*Fuel Configuration*' checklist had been begun instead, it would have referred the crew back to the '*Low Fuel'* checklist because the fuel quantity in one tank was low. This would have meant the crossfeed was left open with all pumps on until landing. Instead, the crossfeed was only open for 11 minutes and as the thrust was at minimum for much of this period, there was not enough time to balance the tank levels.

The FCTM includes some important notes concerning an approach and landing with the LOW FUEL caption illuminated These ought to have been discussed prior to landing, along with the potential difficulties that could be encountered in the event of a further G/A. From comments made just before landing, the commander was aware just how critical the situation was but all he said was "WE DON'T WANT TO GO-AROUND…WE CAN'T".

ATC was not told how critical the fuel situation was. With around 200 kg in the right tank and the crossfeed valves closed, the right engine could have flamed-out during, or immediately after, a G/A.

ATC input

The instruction by ATC at the start of the G/A to climb straight ahead to 3,500 ft may have been made in order to simplify matters for the crew but the instruction came at a point of high workload when the crew were trying to initiate the G/A. The co-pilot had to reply to the instruction to climb to 3,500 ft and then had to input this on the MCP. This distracted his attention when he should first have been checking to see GA annunciations on the FMA. It would have been better if ATC had given the change of G/A procedure either in the same transmission as the G/A instruction or after observing the aircraft start to climb.

When G-TCBC was downwind, ATC knew the crew were dealing with a technical problem and provided assistance by giving extended downwind vectors. However, it could have been helpful for the crew if they had been warned before they reached the boundary of controlled airspace, rather than being told when they had left it. This would have given them the opportunity to opt to remain within controlled airspace so as to retain the best traffic separation service.

RTF discipline

A MAYDAY should have been declared, using standard phraseology, as soon as it became evident that the aircraft was going to land with less than final reserve fuel. Instead, a non-standard declaration of an emergency was made which only led to some confusion. The co-pilot used the phrase "AND WE WANT TO DECLARE A MAYDAY", but it became apparent later that ATC had interpreted this as a request for a paramedic. The confusion was only sorted out a little later when the crew reported that they wanted a priority landing because they were low on fuel. This prompted ATC to ask if they were declaring an emergency.

A MAYDAY prefix could then have been used for subsequent radio exchanges. This could have helped ATC to provide maximum assistance and it could have alerted other aircraft

© Crown copyright 2014

to their predicament. When the co-pilot first checked in with Scottish Control he did not notice that he received no reply. It is possible that if the MAYDAY prefix had been used, then ATC would not have missed that call. In the event, Scottish Control did not realise that the aircraft was on frequency until six minutes later when the co-pilot asked for a direct routing.

Altitude deviation and FMC difficulties

The After Take-Off Checks were overlooked because of the other problems created by the G/A. This led the crew to climb to, and cruise at, 10,000 ft on the QNH rather than at FL100. Consequently the aircraft was 420 ft higher than it should have been, but this was not brought to the crew's attention by ATC.

Following the G/A, the aircraft had passed the end of the route entered in RTE 1. The co-pilot was unable to re-programme RTE 1, so raw data was used to navigate towards Pole Hill VOR. The co-pilot repeatedly tried to re-programme the FMC, whilst also trying to sort out the flap/slat situation and deal with radio calls. However, his performance with these tasks was affected by the difficulties he had encountered during the G/A and with the QRH checklists. He had lost confidence in his own ability and he had probably reached an over-aroused mental state, where his capacity to think straight had started to deteriorate. Like the commander, he was now experiencing a low fuel scenario for the first time. At this point it is likely they were both task-saturated. This helps explain why the After Take-Off Checks were missed. It is most likely that a new waypoint could not be programmed because it was not activated. Eventually, when the option was taken to use RTE 2, this was activated and the FMC provided navigational assistance again.

Crew

There was no indication that the crew's performance was degraded by fatigue or medical reasons. However, the commander was affected by the major re-organisation that was taking place in the company. He tried to put worries about his pending demotion to one side when he was at work but inevitably these still intruded into his mind. Following the mishandled G/A he worried about the potential repercussions. Without this distraction he may have been able to pace the crew actions more effectively. Specifically he could have offloaded the co-pilot, by taking responsibility for radio transmissions while the QRH checklists were done.

Pilot type rating training as well as recurrent training is designed to ensure that pilots understand aircraft systems and are familiar with QRH checklists. This crew had difficulty applying their knowledge in an unexpected situation and did not use the QRH correctly. The checklists should have been run to completion, despite the interruptions.

The exchange of information and regular reviews of what has happened and what is planned are fundamental to the successful outcome of any occurrence. The operator's OM explains how tasks should be shared and states that time for a review must always be found. The mnemonic TDODAR is advocated as a tool to aid problem solving and decision making. These guidelines were not followed during this serious incident.

© Crown copyright 2014

Post-flight actions

The operator's policy was that the DFOM should be told about all incidents and should give them a classification. In this case the DFOM did not categorise this as a serious incident and did not contact the commander to discuss it. The commander tried unsuccessfully to phone the DFOM. If the two had spoken, it is likely that the matter would have been treated as a serious incident and the commander would have been counselled to conduct a crew debrief. Had it been treated as a serious incident straightaway the DFOM would have set in train the process to alert the AAIB. The OM Part A was the pilot's prime point of reference and this ought to have emphasised that serious incidents and accidents are to be reported in a similar way.

Although the operator's OM indicated that the commander had a responsibility after an incident to preserve CVR and FDR data, no guidance was provided on how to accomplish this.

Details of the flap overspeed were not given to the engineers until sometime after the incident and this delayed the initiation of detailed technical checks. It was two days after the incident before the operator realised the severity of the fuel issue and the AAIB was contacted. When the AAIB began its investigation, the CVR data became protected under applicable regulations and should not have been used for any purpose other than the AAIB safety investigation.

Conclusion

This serious incident had its origin in an incorrectly executed G/A from well above decision altitude. The approach briefing had not mentioned the techniques that might be employed in such a circumstance. Initially the autothrottle disconnect switch was operated rather than the G/A switch and the thrust levers were advanced manually. In order to climb, the autopilot was disconnected but the flight director remained in approach mode and did not provide the pilots with appropriate guidance.

SOPs were not adhered to and consequently the pilots' situational awareness became degraded and their workload was increased. As a result there was a slat/flap overspeed which necessitated the use of the QRH to address a non-normal situation. The pilots became stressed and task-saturated and were unable to follow the checklists correctly in order to regain full use of the slats and flaps and then land at their destination.

When a decision was made to divert, it was accepted that the fuel in tanks would drop below the final reserve level before landing. However, fuel caution messages were overlooked because a low fuel state was seen as an integral part of the solution to the earlier difficulties. The low and imbalanced fuel state which developed could have had serious implications in the event of a further G/A.

The outcome could have been improved by greater adherence to SOPs along with better monitoring and workload management skills. One tool that was overlooked and which could have helped with decision making in these unfamiliar circumstances was the mnemonic TDODAR.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Pilatus Britten-Norman BN2B-21 Islander, G-CIAS
No & Type of Engines:	2 Lycoming IO-540-K1B5 piston engines
Year of Manufacture:	1982 (Serial no: 2162)
Date & Time (UTC):	3 November 2013 at 1908 hrs
Location:	Near Devil's Hole, approximately 2.5 nm north of Jersey Airport, Channel Islands
Type of Flight:	Private (charitable search and rescue)
Persons on Board:	Crew - 1 Passengers - 4[1]
Injuries:	Crew - None Passengers - None
Nature of Damage:	Significant damage to wing, left main landing gear and forward fuselage; aircraft damaged beyond economic repair
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	25,200 hours (of which 60 were on type) Last 90 days - 101 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

During a search and rescue flight at night in very poor weather conditions, one engine ceased producing power. During the subsequent diversion towards Jersey Airport the other engine also stopped. Despite the dark night and turbulent weather conditions, the pilot was able to reach the Jersey coast and make a forced landing, in which the aircraft suffered significant airframe damage.

The aircraft had operated a previous flight with the fuel system configured so that tip tank fuel was being supplied to the engines. The aircraft departed on the accident flight in the same configuration, and the engines stopped when the tip tank fuel became exhausted.

Background – the operator

G-CIAS was operated in a search-and-rescue operations (SAROPs) role by a voluntary organisation based in the Channel Islands and run by a Board of Trustees and an executive, with funding from private donations and the Channel Islands' governments. As such, the aircraft's flights were categorised as private.

Footnote

[1] Although the occupants of the aircraft, other than the pilot, were passengers under the relevant regulations, they were on board to assist in search and rescue operations; elsewhere in this report they are referred to as 'crew' or 'crew-members'.

© Crown copyright 2014

The aircraft was routinely flown with a crew consisting of a pilot, in the front left-hand seat, an observer in the front right-hand seat, a search director seated at a workstation behind the pilot/front observer, and two further observers seated behind the search director's workstation.

History of the flight

At approximately 1830 hrs on 3 November 2013 the operator's duty pilot received a request that the aircraft should be despatched to carry out a search. The volunteer crew-members were alerted and made their way to the airport.

Weather conditions in the Channel Islands were poor, with a southerly wind gusting up to 41 kt, turbulence, rain, cloud below 1,000 ft aal, and visibility of 3 to 6 km[2].

On arrival at the aircraft's hangar, the crew was established, consisting of a pilot, search director, and three observers. They donned immersion suits and life jackets and prepared for flight. The search director obtained details of the search request, which was to search for two fishermen near Les Écréhous (a group of rocks in the English Channel approximately 5 nm north-east of the north-eastern corner of Jersey). Some evidence suggested the men were in a small dinghy; other information was that they were in the water. The men were reported to be alive and communicating by mobile telephone.

One crew-member carried out pre-flight preparations, although he did not check the fuel quantities or carry out a water drain check. When interviewed, he recalled having reported to the pilot that he had not checked the fuel.

The aircraft was then pulled out of its hangar and the search director explained the details of the search request to the pilot and other crew-members. Bearing in mind the weather, the fact that it was dark, and the fishermens' predicament, the pilot recognised the need for "a lot of urgency" about the task. In the context of the operation, he regarded the task as being routine, but the weather not so.

The pilot "walked round" the aircraft, though he did not carry out a formal pre-flight inspection; it was the organisation's custom to ensure that the aircraft was ready for flight at all times. The technical log showed that the aircraft was serviceable, with no deferred defects, and that the wing tanks contained 55 USG each side and the tip tanks, 18 USG each side. The search director recalled asking the pilot whether he was content to fly in the prevailing conditions, and that the pilot stated that he was willing to fly. The crew boarded the aircraft. The observer in the front right-hand seat had recently obtained a Private Pilot's Licence and this influenced the decision for him to be placed next to the pilot.

The pilot reported that he carried out a "fairly rapid" start, although the normal pre-departure sequence was interrupted while a problem with switch selections, affecting the functioning of the search equipment in the aircraft's cabin, was resolved. The pilot obtained clearance

Footnote

[2] Guernsey: 1900Z 18031G41KT 6000 RA FEW009 SCT014 BKN025 11/11 Q0993=;
Jersey: 1850Z 17028KT 5000 RA SCT008 BKN010 10/09 Q0996 TEMPO 3000 +RA BKN005=

© Crown copyright 2014

from ATC to taxi, enter the runway, and take off when ready. He described that he carried out engine power checks during a brief back-track, checking the magnetos and propeller controls at 2,100 rpm, before carrying out pre-takeoff checks. He did not refer to the written checklists[3] provided in the aircraft but executed a generic set of checks from memory.

Following an unremarkable takeoff, in the strong crosswind[4], the pilot corrected for drift and established a climb towards a cruising altitude of 900 ft. When interviewed, he described the conditions as being "awful" and "ghastly", with turbulence from the cliffs contributing to occasional activation of the stall warner, even though the speed was "probably 100 plus knots"[5]. At 900 ft, the aircraft was "in the bottom" of the cloud, which was unhelpful for the observers, so the pilot descended the aircraft to cruise at 500 or 600 ft, flying by reference to the artificial horizon, and making constant control inputs to maintain straight and level flight. He stated that, although he would normally have begun checking fuel flow, mixture settings, etc, shortly after establishing in the cruise, he found that the conditions required him to devote his full attention to flying the aircraft.

As the aircraft passed north abeam the western end of Jersey, the rain and low cloud continued and the turbulence worsened, The pilot gained sight of red obstacle lights on a television mast on the north side of the island but had few other visual references.

The pilot noticed a change in an engine note. He immediately "reached down to put the hot air on" which made little difference; the observer recalled that the pilot checked that the mixtures were fully rich at this time. The right-hand engine rpm then began surging. The pilot made a quick check of the engine instruments, before applying full throttle on both engines, setting both propellers to maximum rpm and beginning a climb. The observer noticed that the fuel pressure gauge for the right-hand engine was "going up and down" but did not mention this to the pilot; the pilot did not see the gauge indication fluctuating.

Around this time the pilot switched the electric fuel pumps on.

The pilot turned the aircraft towards Jersey and made a MAYDAY call to ATC; the search director made a similar call on the appropriate maritime frequency. These calls were acknowledged, and a life boat, on its way to Les Écréhous, altered course towards the aircraft's position. Although the pilot was "amazed" at how few lights he could see on the ground, he perceived what he thought was the runway at Jersey Airport, and flew towards it. The aircraft reached approximately 1,100 ft amsl.

The right-hand engine then stopped. The pilot carried out the shut-down checks, feathering the propeller as he did so. The aircraft carried on tracking towards Jersey Airport, descending towards the north side of the island.

Footnote

3 See section 'Checklists and pre-take-off checks'.

4 The wind reported by ATC for the takeoff was 180/28 kt; the maximum demonstrated crosswind for the Islander is 30 kt.

5 The stall speed published in the flight manual for the aircraft at the operating weight and with flaps UP is 50 KIAS.

© Crown copyright 2014

Some moments later, the left-hand engine's rpm began to fluctuate briefly before it also stopped. The pilot later recalled being "fairly certain" that he "was trying to change tanks" but acknowledged that he could not recall events with certainty. He trimmed the aircraft for a glide, still heading towards the airport at Jersey, but with very limited visual references outside the cockpit. The crew-members prepared the cabin for a ditching or off-airport landing; the observers in the rear-most seats considered how they might deploy the aircraft's life raft (stored behind their seats) should a ditching occur.

The pilot's next recollection was that the automated decision height voice call-out activated (he had selected it to announce at 200 ft radio height). He switched the landing lights on and maintained a "reasonable speed" in anticipation of landing or ditching. One crew-member recalled the pilot calling "brace, brace, brace", while another recalled being instructed to tighten seat belts and brace. No brace position had been set out in the operations manual, or rehearsed in training, and the responses of the crew-members to this instruction varied.

The pilot glimpsed something green in front of the aircraft, and flared for landing. The aircraft touched down and decelerated, sliding downhill and passing through a hedge. With the aircraft now sliding somewhat sideways, it came to a halt when its nose lodged against a tree, with significant airframe damage.

The pilot made various cockpit selections safe and all the occupants vacated the aircraft, with some difficulty. The search director became entangled in his headset lead as he egressed but freed himself. The front seat occupants experienced difficulty because their door could not be opened. They climbed over the search director's desk and vacated the aircraft via the door adjacent to the search director's position (the rear-row observers simultaneously opened the pilot's door from the outside). The pilot and crew made their way to nearby habitation where they were subsequently assessed by an ambulance crew; none were injured.

The search director returned to the aircraft with fire-fighters, to ensure that pyrotechnics and the self-inflating life raft on board the aircraft did not pose a hazard.

In his very frank account of the flight, the pilot acknowledged that a decision to turn back soon after departure would have been justified by the weather conditions. He added that before the engine power changed, his workload was already very high, on account of the task and conditions.

Recorded information

The aircraft position and Mode C altitude (± 50 ft) were recovered from radar recordings provided by Ports of Jersey Air Traffic Control (Figure 1). The first radar recording was at 18:51:42 hrs as G-CIAS departed Guernsey Airport. At 19:03:19 hrs G-CIAS was located just over 6.3 nm from Jersey Airport at approximately 500 ft amsl when it began a right-hand turn towards Jersey, climbing to approximately 1,100 ft amsl over the next 1 min 40 sec. At 19:05:36 hrs, when 1.2 nm from the coast, the altitude began to reduce until 19:07:52 hrs when the final radar return recorded the aircraft at a position approximately 200 ft from the first ground mark at the accident site.

© Crown copyright 2014

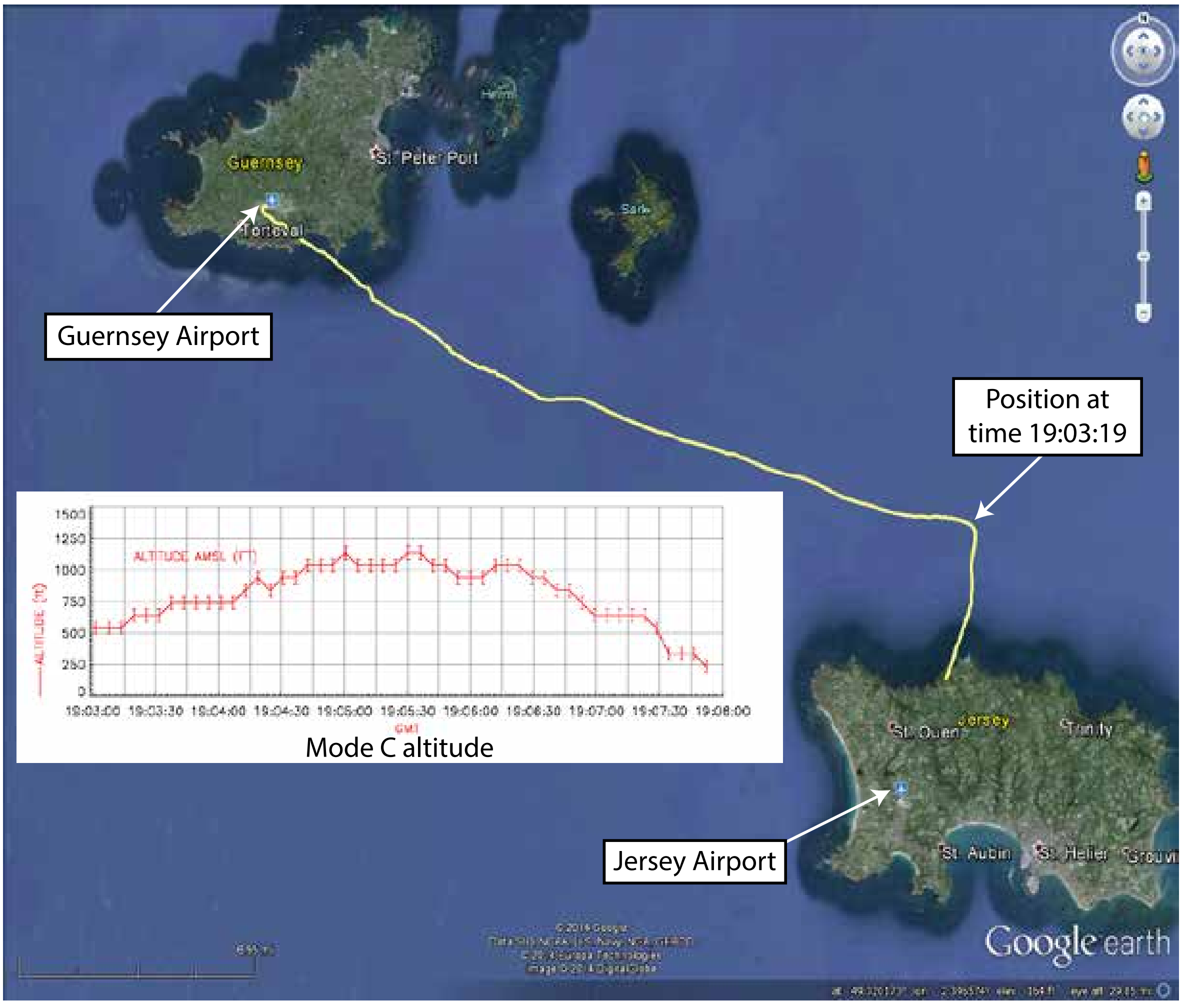


Figure 1

G-CIAS radar position and Mode C altitude

Flights and refuelling prior to the accident flight

Flight on 26 October

The aircraft flew on a training exercise on 26 October 2013 lasting 1 hr 20 min with a different pilot. The technical log showed that the flight departed with 55 USG in each main tank and 18 USG in each tip tank. After flight, 163 litres of fuel were uplifted to restore the pre-departure quantity. The pilot on this flight recalled that the entire flight was conducted with main tank fuel feeding the engines. The fuel tank quantities were not checked visually before or after flight and a written note of fuel quantities was not kept in flight (it was not usual for the pilots of G-CIAS to make notes when flying).

Flight on 2 November

The accident pilot flew a training exercise in G-CIAS on 2 November 2013, to maintain recency and to provide an opportunity for the other crew-members to rehearse their procedures. Following a normal departure, the aircraft flew to the Roches Douvre, a reef situated between Île-de-Bréhat and Guernsey, dropped some smoke floats, and carried out

© Crown copyright 2014

some observer training, before returning for a normal landing at Guernsey. The duration of the flight was 55 minutes.

After arrival, the pilot called the refuelling company, and recalled that he instructed them to refill only the main tanks. The pilot carried out paperwork in the hangar while the refuelling took place, but did see the fuel tanker drive away; a large digital display on the tanker showed 20 litres of fuel delivered. Considering the duration of the training flight, this struck the pilot as being a smaller figure than he had anticipated, and he telephoned the refueller to query it. The refueller confirmed that he had delivered only 20 litres.

The pilot concluded that, rather than the main fuel tanks being somewhat less than full prior to the training flight as usual, they had perhaps been full, and in replenishing them only to the customary slightly-less-than-full state, the delivery of 20 litres made sense. The pilot acknowledged during interview that he "never physically checked" the fuel level in the tip tanks.

The pilot believed that the tip tanks were routinely kept "nearly full" with a quantity of 18 USG in each, and that the aircraft would be left in its hangar with the main tanks selected. His habit, which he believed to be in line with other pilots' procedures, was to take off with the main tanks selected, until approximately three hours into a flight, and then to feed fuel from the tip tanks. He commented that it was rare for flights of this duration to take place and therefore the tip tanks were seldom used.

The pilot stated that the usual fuel burn for the aircraft was between 12 USG per engine per hour in normal flying and 14 USG per engine per hour at higher speed. Given the comparatively low altitude (typically at or below 2,000 ft) of most SAROPs flying, he preferred not to lean the mixture aggressively. Fuel flow meters were used to judge mixture leaning, although the aircraft was fitted with EGT gauges.

Examination of the aircraft and wreckage site

The nose of the aircraft had struck the base of a tree that marked the boundary of a sloping field. The damage was consistent with the nose striking the tree at a relatively low speed, probably around 10 kt. Figure 2 shows a general view of the wreckage site.

The left main gear leg had been distorted aft at its mounting in the wing. The propeller blades on the left engine showed signs of having been rotating whilst striking the ground but, due to the rearward deflection of the propeller blade tips, showed little signs of power. There was some rotational scoring on the spinner hub from a damaged piece of engine cowling. The propeller on the right engine had been feathered.

There were ground marks covering 140 m from the brow of the hill down to where the aircraft had come to rest that were made by the landing gear, and approximately 20 m from the aircraft there was a wider ground mark followed by a series of regularly-spaced slash marks. The left main gear had been distorted rearward and made the large ground mark, and the left propeller blades, which were rotating, caused the slash marks. It was estimated from the slash marks that the rotational speed of the left engine was well below 1,000 rpm.

© Crown copyright 2014

Figure 2
General view of the wreckage site

There was significant distortion of the main wing box and some fuel was dripping slowly from both main wing tanks. Fuel samples were taken from both main tanks and from both gascolators. With the aircraft on level ground the fuel quantity in the tanks was measured using dip sticks. Making allowances for the some loss of fuel due to the leaks and for the fuel samples taken, both main fuel tanks were almost full when the aircraft landed. Both tip tanks were empty. The fuel pipes closest to the engines were removed and only very small samples of fuel were recovered, consistent with both engines being starved of fuel.

The fuel tank selector switches in the cockpit were both found in the 'tip tank' position. The fuel tank indication switches were both found in the position that would dim the tank selection indicator lights. Figure 3 shows the tank selector switches and gauges.

Mounted beneath the main engine controls for throttle, rpm and mixture, were two levers marked CARB HEAT. The lever for the left engine was found in the CARB HEAT fully ON position and for the right engine it was in the CARB HEAT OFF position.

Aircraft information

The aircraft was built in 1987 and was modified in 1993 for its role with the operator. It carried aviation and maritime communication equipment, search radar, and infra-red and video cameras, as well as smoke flares, lights and loudhailers, and an air-droppable dinghy.

The aircraft was powered by two fuel-injected Lycoming IO-540 piston engines. Being fuel-injected, this type of engine does not have carburettor heat but does have a selectable alternative air supply. As noted above, the levers controlling the selectable alternative air supply had retained their CARB HEAT marking.

© Crown copyright 2014

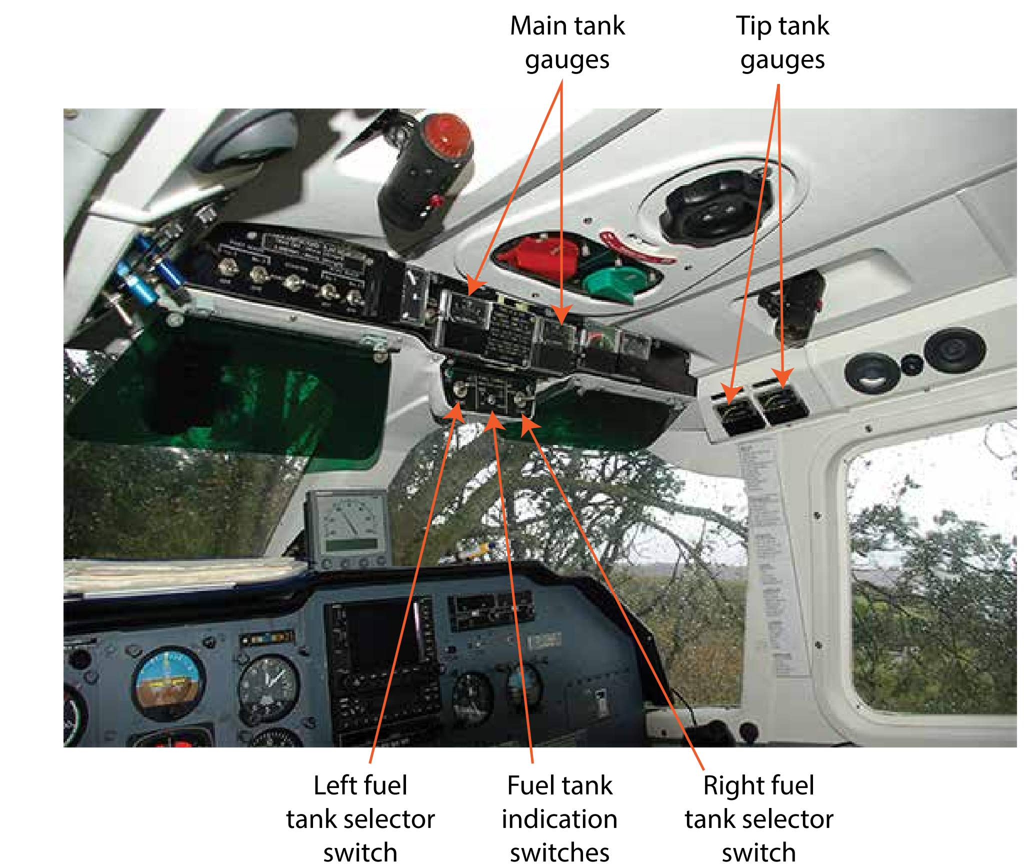


Figure 3

Image of the cockpit showing gauges and fuel tank switches

The aircraft had two main fuel tanks and two tip tanks, with switches in the cockpit to select the fuel supply to the engines from either the main or tip tanks. There were two further switches associated with the fuel system; these served two purposes, depending on which tanks were selected to feed the engines. With the main tanks selected, it disabled the lights which indicated tank selection. With the tip tanks selected, it dimmed the lights which showed that the tip tanks were in use.

It was noted that the fuel selectors for the engines and main fuel tanks were prominent, and the main fuel tank quantity gauges were conveniently sited above the top of the centre windscreen pillar (Figure 3). However, the tip/main tank switches were much smaller and located away from the main fuel selectors, remote from the tip tank quantity gauges which were themselves on the right-hand passenger service unit, above the right-hand cockpit window.

Restraint harnesses

The front row occupants and the search director were provided with three-point harnesses incorporating lap straps and a shoulder strap, the rear row occupants were only provided with a lap-strap.

© Crown copyright 2014

Fuelling procedures

The aircraft was routinely hangared ready to fly, with each main tank filled slightly below full, and each tip tank containing fuel, but not full. Records showed that the main tank quantity was routinely recorded as 55 USG, and the tip tank, 18 USG. It was normal for refuelling to be carried out immediately after each flight, except during the night when refuelling would require the call-out of personnel. In that case, the aircraft would be parked outside its hangar, and would be refuelled prior to departure, should a further flight be necessary.

Flight manual supplements

A supplement to the aircraft's flight manual detailed the procedures, limitations and information for operation of Islanders with tip tanks.

The *'Normal Operating Procedures'* section stated:

> *'before take-off, check the functioning of the electrically actuated fuel cocks by selecting from main tanks to tip tanks and returning to main tanks, checking that the appropriate indicator lights illuminate. Select the appropriate tank for take-off and again check that the position lights are correctly illuminated.'*

This was not reflected in the operator's checklists.

Technical log

A technical log was kept for the aircraft. It included a section on each sector record page, intended to be completed after the flight recorded on the previous page, detailing the fuel on board the aircraft when parked. This would enable a pilot to see that sufficient fuel was on board for a SAROPS flight, without having to check the fuel tanks with a dip-stick. Although fuel uplifted was noted in the technical log, the distribution of the uplift (left-hand or right-hand and main or tip tanks) was not recorded.

Checklists and pre-takeoff checks

The pilot stated that he did not use a written checklist during pre-start checks, but did look "to see where everything is set". He used a generic pre-takeoff checklist based upon British military flying procedures, which he executed from memory. It included a check of 'fuel', during which the pilot recalled checking the main fuel tank contents on the fuel gauges but not the gauges for the tip tanks, and checking that the electric fuel boost pumps were ON. He did not recall checking the positions of the tip tank selector switches.

There were three checklists in the aircraft: one attached to the right-hand cockpit window pillar; one on an A4 card, and one on A5 sheets in a display booklet. The checks detailed in these lists differed and some included items which others did not.

Carburettor icing

The pilot stated that, during the accident flight, he selected the "carburettor heat" as an instinctive reaction to a sign of engine trouble. He commented that he had never experienced carburettor icing in G-CIAS.

© Crown copyright 2014

Previous similar events

Three previous events with BN2 Islander aircraft, with notable similarities to the G-CIAS accident, were identified:

G-BDNP at St Andrew, Guernsey, Channel Islands, on 18 September 1981

The AAIB reported (Bulletin 15/1981) that the cause of the accident was:

> *'…the Commander's mismanagement of the aircraft's fuel system in that both engines failed through fuel starvation because the usable contents of the tip tanks, which were feeding the engines, became exhausted when there was ample fuel remaining in the aircraft's main tanks. Contributory factors were the operator's procedures, inadequacies in the check lists, and the position of the fuel selector panel and switch levers in relation to the pilot's eyes.'*

The report included Safety Recommendations on the fuel selection and indicating system.

G-BBRP at Netheravon Aerodrome, Wiltshire, on 20 February 1982

The AAIB report (Bulletin 4/1982) explained that prior to the accident flight, another pilot had flown the aircraft and left the tip tanks selected to feed fuel to the engines. This went unnoticed by the G-BBRP accident pilot. One engine ceased producing power shortly after takeoff, and the second engine may also have suffered loss of power. This report also included Safety Recommendations on the fuel selection system. As these recommendations were made in the early 1980s, it is not apparent what actions were taken in response to them.

A report prepared by a UK CAA airworthiness surveyor based in Antigua on an accident in 2002 to a BN2 Islander, N616GL, concluded that the aircraft suffered fuel exhaustion following a departure with the tip tanks selected to supply fuel to the engines. Safety Recommendations were made concerning maintenance arrangements and operational documentation.

Management organisation

Evolution of the operation

Until 1983, if it appeared that benefit would be gained from aerial searching around the Channel Islands, available members of the local flying club were asked to use their various light aircraft to search and to report any casualties via air traffic control. In 1983 a group of aviators identified that a more organised approach might be of benefit, and the owner of a six-seat twin-engine piston aircraft, a Piper Aztec, made it available for the search role, when it was not otherwise in use. A charity was established, run by a board of trustees and an executive, with volunteers trained to operate the aircraft; its funding came from the Channel Islands' governments and public donations. The aircraft was gradually equipped for the search role, and in due course, it became available exclusively to the organisation. In 1993, the organisation acquired the Islander aircraft, which was equipped for searching and had an air-droppable dinghy. As noted earlier, the aircraft was flown as a Private operation, there being no requirement for the operator to hold an Air Operator's Certificate.

Investigation

During the investigation of the accident to G-CIAS, the AAIB conducted a series of interviews with senior pilots and managers within the Channel Islands Air Search organisation. Although it was clear that the management team included individuals with relevant experience in search-and-rescue operations, and commercial air transport, a number of areas of weakness were identified within the organisation's operational procedures and practices:

- a visual inspection of fuel tanks was routine before each flight, but although dip-sticks were provided, it was not routine to use them to measure quantities
- no operational flight plan or log was kept and it was not usual for pilots to make written notes in the course of a flight, for example to maintain a log of fuel used and remaining
- pilots were not required to use a written checklist and checks carried out from memory were acceptable
- the checklists provided did not reflect operational procedures detailed in the flight manual
- no brace position had been established for pilots or observers on board the aircraft, although training had been carried out with regard to normal and emergency exits
- there was awareness of the flight manual supplement concerning tip tank use but the detailed information in the supplement, including the description of symptoms of fuel starvation, and the operational procedures to be carried out before each flight, were not well known
- there was limited awareness of the previous accident involving tip tank selection in an Islander aircraft in the Channel Islands in 1981

Analysis

Technical investigation

The inspection of the aircraft at the accident site, combined with the crew accounts gathered early in the AAIB accident investigation, indicated that no mechanical or electrical defect had been a factor in the accident. The evidence indicated that the fuel supply to the right-hand engine, and then the left-hand engine, had become exhausted in flight and the engines ceased producing power approximately 15 minutes after the aircraft became airborne.

The accident flight

The pilot's and crew-members' accounts of the flight concurred in presenting a picture of a very dark and turbulent night. Against this backdrop, the search request, which they sought to fulfil, appeared to have great importance and urgency. They were all aware that the lives of the fishermen, for whom they were to search, could depend upon their success in locating them and directing lifeboats to their rescue[6].

Footnote

6 The fishermen were located and taken to safety later that night by a Coastguard helicopter from Lee-on-Solent.

© Crown copyright 2014

The pressing nature of the task no doubt influenced the rapid sequence of events before take off, though this reflected the operator's normal practice, which sought to have the aircraft always ready to fly with the minimum pre-flight activity.

Fuel use and recording

Analysis of the technical log and fuel on board the aircraft after the accident indicates that the training flight on November 2013 took place with the tip tanks supplying fuel to the engines. It was not possible to determine when, or by whom, the tip tanks were selected.

Following this training flight, the accident pilot noticed that the fuel uplift was less than he expected, and he queried it with the refueller. However, being mindful of the custom of leaving the main tanks somewhat less than full, his conclusion that the main tanks had been completely full before the flight, but had been replenished only to the less-than-full state, made sense of the uplift figure.

An evaluation, during the training flight, of the fuel quantity on board could have identified that tip tank fuel was being supplied to the engines. A written check, comparing expected fuel quantities with gauge indications, might also have identified the unusual configuration of the fuel system.

An inspection of fuel quantities (on the gauges or using the dipstick) - or detailed analysis in the technical log of quantities in each fuel tank and quantities delivered into each tank, rather than simply the total delivered - could have identified before the accident flight that the tip tanks were selected to supply the engines but contained little fuel.

It is possible that the problem with the switch selections for the search equipment may have disrupted the pilot's checks. Conversely, the discovery of one cockpit switch in an unusual position might have been a good prompt for a thorough review of all switch selections, and this could have identified that the tip tanks were selected.

Compliance with the flight manual supplement requirement to check the functioning of the tip tank fuel system would have provided an opportunity to verify the correct configuration before takeoff. However, this procedure had not been incorporated into the checklists provided in G-CIAS, and pilots were not expected to use the written checklists.

Actions during the flight

The weather conditions after takeoff were very demanding, with turbulence and limited visibility increasing the pilot's workload. Although the pilot later acknowledged that a return to land would have been justified, such a decision would have been made bearing in mind the possible consequences for the safety of the fishermen.

The pilot's reaction to the change in engine note, selecting alternate air, could have corrected a problem with the engine's air supply, although the controls were incorrectly labelled as CARB HEAT. His check that the mixture was fully rich, and in selecting the electric fuel pumps on, sought to assure the supply of fuel but was not followed by a check of the configuration of the fuel system or an attempt to select an alternative fuel source for the engine. Such

© Crown copyright 2014

a check would have enabled a supply to be restored, not only to the failed engine, but the other engine too.

With one engine failing, the pilot's decision to gain height and turn towards Jersey began the sequence of events which concluded with a successful forced landing in extraordinary conditions. Although the pilot was "fairly certain" that he tried to change fuel tanks, around the time that the second engine stopped, the time available to re-establish power was very limited.

The pilot's response to the automatic voice call-out, switching the landing lights on and anticipating a landing or ditching, may have been crucial to his reaction when he glimpsed the ground and flared. The aircraft's trajectory, towards one of the very few areas on the north side of Jersey where a survivable landing might be attempted, and close to cliffs and other terrain where impact might well not have been survivable, was largely a result of good fortune. However, the forced landing itself was achieved and the aircraft, although significantly damaged, remained intact and those on board were uninjured.

Cockpit layout

The locations of the fuel controls and tank quantity gauges were examined. Although the main fuel selectors and main tank gauges were located centrally in the cockpit, the tip tank selector switches were smaller and not co-located with the respective quantity gauges. The dimming function of the tip tanks indicators further complicated the presentation of fuel supply information to the pilot. In the operation of G-CIAS, the typical search duration and main tank capacities, meant that the tip tanks were seldom used. These factors may have led to some complacency with regard to the configuration of the fuel system.

Management factors

As described earlier in this report, the evolution of the operating organisation had been from an operation by individual pilots using their private aircraft on a voluntary basis, to a well-supported public charity operating an aircraft with sophisticated search systems, essentially as a public service.

Much public service aviation, such as police and helicopter emergency medical services, is operated by commercial organisations, which in the United Kingdom hold Air Operator's Certificates. These organisations must demonstrate their continuous fitness to hold their certificates to the regulator[7].

An appropriately robust set of procedures, supported by effective training and oversight from the operational management, may have ensured the correct configuration of the fuel system before departure, and prevented the loss of power. A similar approach to crew safety (for example with regard to brace positions and cabin equipment) may also have improved the probability of a benign outcome in similar emergency situations.

Footnote

[7] The UK CAA

© Crown copyright 2014

Safety action

The aviation regulator in the Channel Islands has held discussions with the operator of G-CIAS and set out a number of requirements concerning operational procedures, oversight of flying operations and safety management, with which the operator must comply before resuming flying.

In September 2014 the aviation regulator confirmed to the operator that, having reviewed the documentation submitted, he was satisfied that it was appropriate to issue permission to operate. This permission would be granted for a period from October 2014 to April 2015, with a review of the new processes during that time.

© Crown copyright 2014

AAIB correspondence reports

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

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

The accuracy of the information provided cannot be assured.

© Crown copyright 2014

SERIOUS INCIDENT

Aircraft Type and Registration:	Bombardier CL600-2B16, N664D
No & Type of Engines:	2 General Electric CF34-3B turbofan engines
Year of Manufacture:	2008 (Serial no: 5505)
Date & Time (UTC):	26 March 2014 at 1354 hrs
Location:	Biggin Hill Airport, Kent
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 3 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Main wheel tyres blown, damage to main wheels and brake units
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	7,695 hours (of which 410 were on type) Last 90 days - 100 hours Last 28 days - 28 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, investigation report submitted by the maintenance organisation, occurrence report submitted by ATC and recorded flight data.

Synopsis

A post-maintenance check flight, requiring an airborne check of the air-driven generator (ADG), involved placing the aircraft in an emergency electrical configuration. The check was completed successfully, but the pilots did not return the aircraft to the normal electrical configuration. Consequently, several aircraft systems remained inoperative, including flaps, ground spoilers, anti-skid and nosewheel steering. The aircraft landed in this configuration and the pilots experienced difficulty stopping it on the runway. All four main tyres deflated, causing damage to the main wheels and brake units.

Background to the flight

An airborne test of the aircraft's ADG was required[1] as part of its scheduled maintenance programme. This was to be carried out when the aircraft flew to Biggin Hill for maintenance but this had not been done prior to landing, necessitating the check flight.

A further single visual circuit at Biggin Hill was planned, during which the ADG would be tested. The incident occurred during the landing phase of this flight. An engineer from the

Footnote

[1] In case of a failure of the aircraft's primary and auxiliary AC systems in flight, the ADG deploys automatically into the airflow and powers the AC essential busbar. Provision is also made for manual deployment.

© Crown copyright 2014

maintenance organisation, who occupied the flight deck jump seat, accompanied the two pilots.

History of the flight

The aircraft took off from Runway 03 in good weather conditions and with the commander as the handling pilot. After takeoff the pilots maintained the takeoff flap setting of 20° required for the ADG test. During the downwind leg, the flight crew took the main aircraft generators off-line, thus simulating the failure conditions which would cause the ADG to deploy. Correct deployment and functioning of the ADG was confirmed. The aircraft was not then reconfigured to its normal operating condition.

On base leg to land on Runway 03 the pilots selected wing flaps for landing but they remained at the takeoff setting of 20°. The commander continued the approach with the reduced flap setting and at a speed of 160 kt, which was appropriate for the configuration. The aircraft landed at an estimated 150 kt and the commander selected reverse thrust. Only the left thrust reverser deployed. The aircraft did not decelerate as expected and the commander applied maximum wheel braking, bringing the aircraft to a stop approximately 120 m from the runway end (Landing Distance Available was 1,550 m).

Biggin Hill ATC reported that, after what seemed like a fast landing, smoke was seen to come from the aircraft tyres and continued to do so for most of the landing roll. When the aircraft stopped the controller alerted the Airport Fire and Rescue Service, who attended the scene.

The pilots attempted to taxi the aircraft from the runway but were unable to do so. Subsequently it was established that all four main wheel tyres had ruptured, and the main wheels and the brake units on the left wheel had been damaged. The aircraft remained in position until the main wheels could be replaced, allowing it to be towed.

Technical information

The aircraft operating manual details a recommended procedure for an in-flight check of the ADG. A note at the beginning of the procedure states *'Normal electrical power must be restored before final landing approach is commenced.'* The procedure calls for deployment of the ADG using the manual deployment handle, after a number of preliminary steps and checks have been completed. Once deployed, the main generator switches are turned off, which should generate a red EMER PWR ONY (emergency power only) warning and an amber caution message for each generator. Further checks are then made to confirm the functionality of the ADG. Finally, normal electrical power is restored by switching the generators back on, checking that the caution and warning lights extinguish, and pressing a power transfer override switch. This last action de-energises the AC emergency contactors and returns the electrical system to normal operation.

The operating manual lists aircraft systems that are not available when operating on emergency power. The list includes flaps, ground spoilers, nosewheel steering and the brake anti-skid system. A note also states that, if the ADG is the only source of electrical

© Crown copyright 2014

power for landing, the manual deployment handle should be pulled. This ensures that the DC essential busbar remains powered by the aircraft batteries as airspeed (and thus ADG output) reduces on landing, otherwise damage to the aircraft's thrust reversers can result.

Aircraft commander's report

The commander reported that when the aircraft was downwind it was agreed the aircraft's main generators would be taken off-line (producing conditions for ADG deployment). This was done, and correct deployment and functioning of the ADG was confirmed.

The commander observed that the roles of the pilots and the engineer had not been clearly established before takeoff, and the pilots assumed that the engineer would 'talk through' what he needed to see once airborne. The commander also observed that the crew should have referred to the Quick Reference Handbook (QRH) for the situation rather than rely on the engineer to guide them. The commander later discovered that the engineer was not expecting to make decisions or inputs during the flight, so a misunderstanding had existed.

Engineer's report

The engineer described his role as primarily that of an observer, although with the intention of noting any defects or abnormalities that might arise during the flight test. He did not see the flight crew read or refer to the ADG test operational procedure. Once airborne, the crew initiated the ADG test by switching the generators off. They then checked to confirm that the ADG had deployed and was powering the AC essential bus.

The engineer was aware that the flaps had not moved when selected, and thought the co-pilot announced the abnormality twice without response from the commander. He was not aware of any attempt to bring the main generators back on-line. The approach continued and the engineer was expecting the pilots to discontinue the approach, but they did not. On the runway, it was evident that the aircraft was not decelerating as normal and that the pilots were having difficulty controlling it.

Maintenance organisation's report

The maintenance organisation conducted an investigation into the occurrence and provided the AAIB with a copy of its report and findings. Among the internal recommendations made by the report was the requirement for a full briefing to be given to flight crews undertaking a maintenance check flight, irrespective of whether or not the crew declared themselves to be familiar with the procedure.

Recorded data

The aircraft's Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) were available for inspection. The CVR was not isolated immediately[2] after the incident and the recording was overwritten.

Footnote

[2] The maintenance organisation stated that it was isolated "approximately 20 minutes after the incident".

© Crown copyright 2014

FDR data showed that the flight lasted 271 seconds from liftoff to touchdown. Airspeed on short final was 172 kt, reducing to about 159 kt at touchdown. The left thrust reverser first indicated unlocked at 153 kt; the right thrust reverser remained stowed during the landing roll.

Discussion

Detailed advice on check flights may be found in the CAA's CAP 1038 '*Check Flight Handbook*'.

In this case, the flight crew embarked on a very short flight with no firm plan how to conduct the check, and a misunderstanding of the roles of the three people on board. A visual circuit at a busy airfield requires crew vigilance even in normal circumstances, so was not a suitable operating environment for the check.

A detailed procedure for the check was available but was not followed by the crew. Because of this, and the time pressure the crew imposed on themselves by attempting to do the check during one visual circuit, the aircraft was not returned to its normal electrical configuration prior to landing. There were several indications to the crew that the aircraft was not correctly configured, including warning and caution messages in the cockpit, and the inoperative flaps. Addressing these might have alerted the crew to the need to restore normal electrical power.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Avions Pierre Robin, G-BLWF
No & Type of Engines:	1 Continental IO-360-D piston engine
Year of Manufacture:	1973 (Serial no: 183)
Date & Time (UTC):	26 July 2014 at 1257 hrs
Location:	Bourn Airfield, Cambridgeshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to left wing, propeller and engine firewall. Damage to parked private vehicle
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	848 hours (of which 17 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was preparing the aircraft for a local flight. The weather was fine and the ground surfaces were dry. He moved the aircraft out of its hangar onto an adjacent taxiway and attempted to start the engine. The start was not successful so, before attempting a second, he advanced the throttle. The subsequent start was successful but the engine immediately produced high power, and the aircraft began to move forward and to the right. The pilot was unable to stop the aircraft before it had travelled approximately 30 ft and collided with a parked, unoccupied private vehicle. Both the aircraft and the vehicle sustained damage but the pilot was uninjured. He attributed the high power setting on start to the throttle position, which was more advanced than he had intended.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Cessna A185E, SE-FMX
No & Type of Engines:	1 Continental IO-520D piston engine
Year of Manufacture:	1978 (Serial no: 18501740)
Date & Time (UTC):	5 April 2014 at 1300 hrs
Location:	Bentwaters Airfield, Suffolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Engine shock-loaded, propeller, wings and fin damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	200 hours (of which 15 were on type) Last 90 days - 1 hour Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on the tarmac Runway 25 at Bentwaters Airfield, with wind from 180° at 15 kt. Having observed the windsock, the pilot made a wing-down crosswind approach with the tail wheel locked in the trailing position to assist directional control on the ground. On touchdown there was a slight bounce before the aircraft settled on all its wheels. It then slewed violently to the left and the right tyre "dug in", causing the right wing to contact the runway and tipping the aircraft on its nose while still travelling at approximately 50 mph. The aircraft came to rest inverted and the uninjured occupants vacated it using the normal exits.

The pilot stated that he underestimated the severity of the gusting crosswind and had been unable to prevent the aircraft yawing into wind. He commented that the aircraft had a "notoriously big fin", making it particularly susceptible to crosswinds, and that in future he would avoid landing in a crosswind of this magnitude.

Even in crosswinds less than the demonstrated maximum for a type, rudder alone may not be sufficient to maintain directional control. Applying into-wind aileron throughout the landing ground roll can assist in maintaining directional control. There was no indication of any pre-existing mechanical defect that might have affected the outcome.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	DH82A Tiger Moth, G-ANHK
No & Type of Engines:	1 De Havilland Gipsy Major I piston engine
Year of Manufacture:	1939 (Serial no: 82442)
Date & Time (UTC):	7 June 2014 at 1310 hrs
Location:	Near Hampstead Norreys, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to wing and struts, propeller, landing gear and engine cowling
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	1,285 hours (of which 327 were on type) Last 90 days - 4 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Whilst taking off, the aircraft's lower right wing struck standing crops adjacent to the grass airstrip. Travelling at about 35 kt, the aircraft yawed to the right through about 120°, causing the lower left wing to strike the ground. The aircraft then tipped forward onto its nose and the propeller also struck the ground, causing the engine to stop. The pilot, who was wearing a full harness and protective helmet, was uninjured. He reported that weather conditions had been fine, with a light wind blowing directly along the airstrip.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Enstrom 280C Shark, G-IDUP
No & Type of Engines:	1 Lycoming HIO-360-E1AD piston engine
Year of Manufacture:	1979 (Serial no: 1163)
Date & Time (UTC):	3 June 2014 at 1657 hrs
Location:	Northampton/Sywell Aerodrome, Northamptonshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the rotor blades and fuselage, and gearbox shock-loaded
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	1,572 hours (of which 1,210 were on type) Last 90 days - 18 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The helicopter was hover-taxied to the airfield refuelling point and positioned parallel to the fuel pumps. It was established in a hover and, as it descended to land, the main rotor blades struck the roof of a small, single-storey building adjacent to the pumps.

History of the flight

The pilot had planned to refuel the helicopter before returning to his private operating site. Having started the helicopter, he was cleared by ATC to hover taxi to the refuelling point, with which he was familiar, from his parking spot on the grass northeast of the apron. The weather was good, with a surface wind from 270° at 7 kt and visibility in excess of 10 km. The hover taxi was uneventful and flown at a skid height of about 4 ft.

The refuelling area, which is on the apron, consists of a small, single storey building and three fuel dispensing pumps, each with their associated hose and nozzle. The pilot approached from the north of the refuelling point, across the apron and slowed to a hover, maintaining the 4 ft skid height. He yawed the helicopter 90° to the right, to land parallel to the pumps, and moved a few feet to his left, remaining clear of the pumps, to ensure the refuelling hose would reach the fuel tank filler on the right side of the helicopter. The pilot then commenced a descent to land but the tips of the rotor blades struck the overhanging

© Crown copyright 2014

roof of the single-storey building. The pilot landed the helicopter immediately and shut it down, isolating the fuel and electrical systems before vacating through his side door.

The position of the point of impact on the building meant that it was outside the pilot's field of view when he was looking ahead, to land (see Figure 1).

Figure 1

Aerodrome information

The aerodrome operator informed the investigation that a white line surrounds the refuelling area. Also, there are two short parallel white lines, adjacent to a drainage channel (see Figure 2) and opposite the fuel pump nearest the single-storey building, which has a longer hose, that provide position guidance for helicopters being refuelled.

Figure 2

This information does not appear in the United Kingdom Aeronautical Information Publication (UKAIP) or commercially available flight guides.

The UKAIP includes the following information for Northampton/Sywell Aerodrome:

> *'Ground Movement*
>
> *a. No apron markings, caution when parking to ensure adequate wing tip clearance. Aircraft should not block access to the refuelling area and hangar access gate when parking on the concrete apron.*
>
> *b. All parking self-manoeuvring, assistance available on request.'*

The flight guide, which the pilot consulted, states:

> *'No apron markings, all parking at pilot's discretion.'*

Conclusion

The pilot considered that, as he approached the fuel pumps, his eye line was level with the roof overhang and he had not appreciated the potential hazard. On turning parallel with the pumps, the building was then located over his left shoulder, behind him and out of his field of view. When he descended to land, he could not see the obstacle and the main rotor blade tips struck the roof overhang.

The pilot had consulted a commercially available flight guide but was not aware of the unpublished information regarding the white markings at the refuelling area.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Europa, G-BXFG
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	1999 (Serial no: PFA 247-12500)
Date & Time (UTC):	14 June 2014 at 1640 hrs
Location:	Eaglescott Airfield, Burrington, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Minor damage to fuselage and left wing, propeller blades broken
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	974 hours (of which 422 were on type) Last 90 days - 13 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The landing gear operating lever was probably not locked in the DOWN position before landing, with the result that the landing gear retracted when the aircraft touched down.

History of the flight

The pilot reported that, following a short local flight, he carried out his pre-landing checks, during which he clearly remembered lowering the landing gear and checking, by feel, that the operating lever was in the DOWN position. He commented that, on the Europa, the landing gear and the flaps are controlled by the same lever and it should have been evident by the attitude of the aircraft if the landing gear was not in the DOWN position during the approach. He stated that, while the landing attitude appeared to be normal, on touchdown the landing gear retracted and the aircraft slid along the grass strip for approximately 150 m, before coming to rest.

Discussion

The landing gear operating lever moves in a narrow slot and is locked into position by moving the lever sideways into a detent. A safety latch fitted to the lever engages in this detent and prevents the lever from being inadvertently moved out of the DOWN position. The position of this latch also provides visual confirmation that the landing gear is locked DOWN.

© Crown copyright 2014

The pilot believed that he had moved the operating lever into the correct position but did not then visually confirm that he had done so. His key learning point from this accident was always to visually check that the landing gear lever is correctly locked in the detent.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Europa XS, G-FIZY
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2007 (Serial no: PFA 247-13291)
Date & Time (UTC):	30 June 2014 at 1445 hrs
Location:	Tangley, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left door detached, damaging the left tailplane
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	72 years
Commander's Flying Experience:	17,670 hours (of which 5 were on type) Last 90 days - 79 hours Last 28 days - 34 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and LAA information

Synopsis

The aircraft was on a local flight from Thruxton Aerodrome for the purpose of conducting an air test as part of the revalidation of its Permit to Fly. The aircraft was flying at approximately 110 kt and 950 ft amsl when the left door detached without warning. After checking the control response was normal, the pilot returned to Thruxton where the aircraft landed without further incident.

The pilot and the observer stated that they had checked the doors were closed before departure and the observer, who was sitting next to the door, added that there was no flapping or draught to suggest the door had not been properly closed.

The missing door was not recovered, but the failure face on the remaining part of the hinges was reported as appearing "fresh" and no damage was reported in the area of the shoot bolt guides, suggesting that a hinge failure was unlikely. A post-flight inspection identified that the door had struck the left tailplane, causing significant damage. The LAA later reported that there was evidence of the extended rear shoot bolt rubbing on the outside of the door frame.

Additional information

The doors are of a gull wing arrangement. Each door is hinged in two places along its top edge, (Figure 1). A gas strut is fitted to the rear of the door to support it in the open position.

© Crown copyright 2014

The door is held closed by two tapered shoot bolts which extend out longitudinally, from the lower corners of the front and rear sides of the door, into guides in the door frame. If the door is not fully closed at the rear, it is possible to move the door locking lever to the closed position with only the front shoot bolt engaged in its guide. This gives the false impression that the door is closed and fully locked. There have been a number of previous incidents on the Europa fleet where a door has detached due to the rear shoot bolt not engaging in its guide when the door was closed.

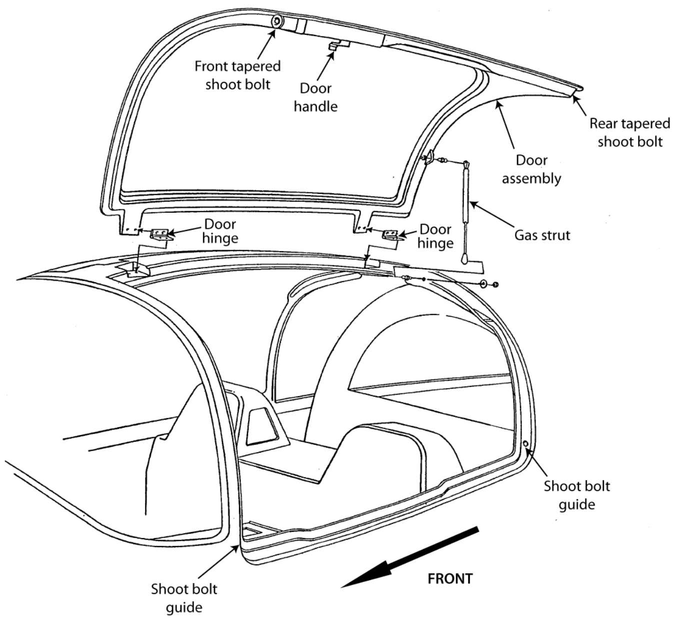


Figure 1

Door arrangement (courtesy of Europa Aircraft Ltd)

Safety action

The LAA are working with Europa Aircraft Ltd to design a safety modification intended to prevent a recurrence.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Luscombe 8E Silvaire Deluxe, G-AGMI
No & Type of Engines:	1 Continental Motors Corp C85-12F piston engine
Year of Manufacture:	1941 (Serial no: 1569)
Date & Time (UTC):	23 July 2014 at 0925 hrs
Location:	Private airstrip near Albourne, West Sussex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left wing and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	826 hours (of which 119 were on type) Last 90 days - 13 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During takeoff a hinged cover on the aircraft's pitot probe, designed to deflect under air loads, did not operate correctly, giving erroneous airspeed indications. The pilot abandoned the takeoff but the aircraft overran the grass strip and collided at very low speed with a hangar.

Description of the event

The weather was fine with good visibility; the surface wind was generally from 030° at 8 kt, but the direction was variable between 010° and 130°. The grass, of the 440 m long airstrip, had been recently cut. Take off was planned in a direction of 020°. The pilot carried out a normal pre-flight inspection, during which the pitot cover was checked for correct operation. The cover was a hinged flap arrangement, designed to move under air loads to expose the pitot tube orifice.

The takeoff roll appeared normal initially, but about two-thirds of the distance along the strip, the indicated airspeed was approximately 40 mph so the pilot decided to abandon the takeoff. As he did so, his passenger announced that the pitot cover had not opened. The pilot applied wheel brakes and braking action seemed effective at first but then became less so. With about 80 m of strip remaining, the aircraft was not slowing as expected despite firm brake application, and started to drift to the left.

© Crown copyright 2014

The aircraft's outer left wing made contact with a hangar at an estimated 10 mph, causing the aircraft to yaw left, which brought its propeller into contact with the wire mesh hangar gates. The contacts occurred at very slow speed and neither the pilot nor his passenger was injured.

The aircraft's brakes were later tested and found to operate normally. The pilot believed that braking effectiveness may have been reduced as the aircraft passed over uneven ground and weight was taken off the wheels, and that possibly the brakes had faded or locked the wheels on the recently cut grass. No reason was found for failure of the pitot cover to open during the takeoff roll. The pilot intended to investigate the feasibility of removing the existing pitot probe and installing one without a hinged cover.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Piper PA-18-150 Super Cub, G-ARAN
No & Type of Engines:	1 Lycoming O-320-A2B piston engine
Year of Manufacture:	1960 (Serial no: 18-7307)
Date & Time (UTC):	26 July 2014 at 1030 hrs
Location:	Cromer (Northrepps) Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Landing gear, propeller, wing spar, tailplane and engine cowl
Commander's Licence:	Private Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	295 hours (of which 35 were on type) Last 90 days - 4 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

While on a flight from Leicester Airport to Northrepps (Cromer) Airfield, the pilot was unable to make radio contact with either Norwich Airport or Northrepps. The weather had deteriorated from CAVOK to solid cloud, so the pilot decided to fly further off the coast in an attempt to get under the cloud layer but this was not possible. While climbing, with the intention of returning to Leicester, he finally made contact with Northrepps, and was advised to head inland where the weather had improved. He made visual contact with the airfield and commenced an approach to Runway 33. During the final stages of the approach the pilot realised that the airspeed was decaying rapidly and applied power, but he was unable to prevent the aircraft landing at the edge of a cornfield, just short of the Runway 33 threshold. The aircraft then hit a gully filled with tyres, causing it to overturn. The pilot and passenger were uninjured and vacated the inverted aircraft without assistance. The tyre-filled gully is intended to stop aircraft rolling off opposite direction Runway 15 and crossing the public footpath, which runs between the end of the runway and the cornfield.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Piper PA-18-150 Super Cub, G-OOMF
No & Type of Engines:	1 Lycoming O-320-A2B piston engine
Year of Manufacture:	1968 (Serial no: 18-8560)
Date & Time (UTC):	2 June 2014 at 1324 hrs
Location:	Near Wellesbourne Mountford Airfield, Warwickshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller, wing struts, wings, tail plane and canopy.
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	55 years
Commander's Flying Experience:	1,842 hours (of which 701 were on type) Last 90 days - 54 hours Last 28 days - 19 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

While flying the base leg in the circuit, the student inadvertently set the mixture control to lean which resulted in a loss of engine power. As a result of this action the aircraft was forced to land in a field of standing crop during which it tipped onto its back.

History of the flight

The student was on his second flight of a tailwheel differences training course when the accident occurred. He had already flown three successful circuits during the flight and it was while positioning the aircraft, and reducing engine power, on the base leg of the fourth circuit that the engine rpm rapidly reduced. The instructor took control and, as the symptoms were consistent with fuel starvation, told the student to "turn on the fuel". The student confirmed that the fuel was selected ON. The instructor established that some power could be obtained from the engine by moving the throttle between the idle and fully forward position.

Unable to reach the airfield, the instructor made a MAYDAY call and positioned the aircraft for a landing in the only suitable field but which contained a standing crop. As the aircraft touched down, the crop became entangled in the main landing gear causing the aircraft to turn upside down. The instructor and student, who were both uninjured, vacated the aircraft before the arrival of the airfield emergency vehicle.

© Crown copyright 2014

The instructor reported that, following the accident, the mixture control was found in the fully lean position. The student, who had over 350 flying hours, normally flew a Robin DR400 aircraft which has a carburettor heat control that operates in a similar manner to the mixture control on the Piper Super Cub. The instructor and student believe that the student inadvertently operated the mixture control instead of the carburettor heat when the power was reduced on the base leg.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-180 Cherokee, G-ASIL
No & Type of Engines:	1 Lycoming O-360-A4A piston engine
Year of Manufacture:	1963 (Serial no: 28-1350)
Date & Time (UTC):	2 July 2014 at 1057 hrs
Location:	Wolverhampton Halfpenny Green Airport, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Firewall bent, engine shock-loaded, damage to nose landing gear, propeller and underside of fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	193 hours (of which 87 were on type) Last 90 days - 26 hours Last 28 days - 9 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was on the approach to Runway 16 at Wolverhampton Halfpenny Green Airport. It had joined the circuit on the downwind leg at 1,100 ft agl, slowing to 90 mph on base leg whilst extending two stages of flap. After turning finals, the pilot reduced speed to 85 mph whilst selecting the third stage of flap and, crossing the airfield boundary, he again slowed to 80 mph. He states that he was happy with all aspects of the approach as he then closed the throttle to glide the remaining 50 – 100 ft to touchdown. As he neared the beginning of the paved surface, he started to flare the aircraft but, before the flare was complete, the wheels touched and the aircraft bounced, he believes three times, before the nose landing gear collapsed and the aircraft slid to a halt on its nose.

The pilot believes that the aircraft struck a bump at the beginning of the touchdown zone, whilst it was in a relatively flat attitude, and travelling quite fast across the ground due to the lack of headwind and the lack of opportunity to lose speed in the flare.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Piper PA-28R-201T, G-BEOH
No & Type of Engines:	1 Continental TSIO-360-FB3B piston engine
Year of Manufacture:	1977 (Serial no:28R-7703038)
Date & Time (UTC):	21 July 2014 at 0651 hrs
Location:	Gloucestershire Airport
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Light damage to leading edges of wing, heavy damage to leading edges of tail plane
Commander's Licence:	Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	3,267 hours (of which 444 were on type) Last 90 days - 9 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot, a report from the airport operator and a technical report from the aircraft's maintenance organisation

Synopsis

Shortly after takeoff, the pilot reduced to a climb power setting, but sensed a much greater reduction in actual power. The aircraft began to sink and the pilot selected full power. He also changed fuel tanks. The aircraft struck tree tops in two locations before the pilot was able to climb away. The aircraft joined the visual circuit and landed without further incident. A technical investigation identified a distorted fuel gascolator upper housing, which was believed to have had the effect of allowing air to be ingested into the fuel system during takeoff.

History of the flight

The pilot prepared for a flight from Gloucester to Cherbourg. He supervised refuelling of the aircraft, during which both tanks were filled almost to full. Pre-flight checks were normal, and included a change of fuel tank before takeoff, in accordance with normal procedures. The aircraft taxied for Runway 27 with the pilot and two passengers on board. Based on figures supplied by the pilot, the aircraft's takeoff mass was 2,836 lb, just below the maximum weight of 2,900 lb. The weather conditions were fine and calm.

The takeoff appeared normal, with the aircraft accelerating and lifting off as expected. Takeoff power was 38" manifold pressure (MP). After raising the landing gear, the pilot

© Crown copyright 2014

moved the throttles to select climb power of 33” MP. However, he sensed a much greater actual power reduction and the aircraft started to sink. He moved the throttles fully forward and the aircraft responded with increasing airspeed and climb rate, although the turbo overboost light illuminated for two to three seconds. Responding to this, the pilot reset 38” MP, but again sensed a power loss.

The pilot selected full power again as the aircraft flew at slow speed towards trees at the edge of a golf course, about 550 m from the departure end of the runway. The pilot again tried reducing to climb power, but again felt there was a greater loss of power. He selected the other fuel tank with the selector valve, and felt that the power being produced started to increase. As he did so, the aircraft clipped the tree tops. The aircraft continued across an open area and clipped another tree top about 150 m further on, but then began a climb away to circuit height. The aircraft was turned downwind and landed without further incident.

The pilot reported that the apparent loss of power was not accompanied by any unusual engine noises or rough running, and that the engine appeared to run normally and produce normal power levels after the fuel tank selector was changed to the other tank.

Airport operator’s report

The airport operator provided a report on its own investigation, which was confined to the operational aspects of the accident. In the report, the duty Air Traffic Control Officer (ATCO) described the takeoff roll as “sluggish”, after which the aircraft was seen to climb only slowly until it disappeared from view behind trees, at which point the ATCO sounded the crash alarm. Shortly afterwards, the aircraft reappeared back in view, climbing on a south-westerly heading. A weather observation made at the time gave a surface wind of 2 kt from 280° and an OAT of 17°C. From eye-witness accounts and debris from the trees found on the ground, the investigation confirmed the pilot’s report that the aircraft had struck trees in two locations.

Technical investigation

The aircraft’s maintenance organisation conducted a technical investigation, the findings of which were made available to the AAIB on request. The investigation centred on the fuel gascolator. Although the unit appeared in satisfactory condition and was correctly installed, it was found that, using hand pressure, the gascolator bowl would rock in the fore and aft direction, relative to the filter housing. With the unit static, when the fuel supply was turned on there were no fuel leaks and the fuel drain valve operated normally. However, when the bowl was then rocked slightly fore and aft, the fuel leaked freely down the outside of the bowl, indicating an unsatisfactory seal.

When the gascolator was dismantled, it was found that the upper housing was distorted. This was thought to have been caused by forces exerted over time by the bail wire assembly (the assembly held the gascolator bowl in place). The distortion had the effect of pulling the sealing face for the square section seal out of flat. Examination of the seal itself showed an uneven ‘footprint’, confirming the uneven sealing. It was assessed that mechanical loads on the gascolator arising from pre-flight fuel sampling and vibrations during aircraft

© Crown copyright 2014

operation would have been sufficient to produce fuel leakage, which only an excessive seal preload force could have prevented.

The technical investigation concluded that a combination of the distorted upper housing, vibrations during the takeoff roll, and a high fuel flow produced a situation whereby air was ingested into the fuel system with consequential fuel starvation. It was observed that power checks at a nominal 2,000 rpm prior to flight would not have highlighted the problem as fuel flow would be relatively low at that power setting.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	EV-97 TeamEurostar UK, G-CDNI
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: 2321)
Date & Time (UTC):	26 June 2014 at 1032 hrs
Location:	Cranfield Airport, Bedfordshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to left main landing gear, left wing tip and tail bumper
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	495 hours (of which 62 were on type) Last 90 days - 59 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on Runway 03, following a normal approach at 60 mph with two stages of flap selected. The pilot stated that the flare was high and resulted in a heavy landing, after which he slowed the aircraft to taxi speed, as normal. However, after taxiing down the runway for about 100 yds, the left main landing gear collapsed and the left wingtip contacted the surface. The aircraft came to rest on the edge of the runway, having swung through 90º. Its two occupants were uninjured.

The pilot believed that he misjudged the flare and then did not take the appropriate corrective action, probably due to confusion between which hand was on the control column and which was on the throttle, which, in this instance, was opposite to the arrangement in the aircraft he normally flew on training flights.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Ikarus C42 FB80, G-DCDO
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2010 (Serial no: 1008-7115)
Date & Time (UTC):	2 July 2014 at 1520 hrs
Location:	Dunkeswell Airfield, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Burst front tyre and damage to nosewheel fork and nose gear mountings
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	154 hours (of which 38 were on type) Last 90 days - 20 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was on final approach when the pilot realised that the runway had a considerably displaced threshold. He applied power to adopt a shallower glidepath in order to land in the correct area but misjudged the subsequent touchdown, which was heavy and caused the aircraft to bounce. After a go-around and further landing, the pilot found that the nosewheel tyre had deflated and the landing gear leg had been damaged.

History of the flight

The pilot was returning to Old Sarum after a flight to Land's End. He decided to land at Dunkeswell to refuel and commenced an approach to Runway 17. During base leg and turning finals, he had been looking at the start of the tarmac surface but, on final approach, he realised that the actual runway threshold was considerably displaced (roughly the first half of the runway was disused, Figure 1). As he still had some distance to travel to the correct threshold before touchdown, he applied power to arrest the rate of descent. This had the effect of making the glidepath much shallower and the pilot believes it led him to flare too high. The aircraft stalled and he tried to recover by pushing forward on the control column to lower the nose but the aircraft struck the ground heavily and bounced back into the air. The pilot "caught the bounce" by applying power and went round for a second approach and successful landing. He suspects that the nosewheel tyre may have deflated during his first attempt and that further damage may have been caused by the second landing.

© Crown copyright 2014

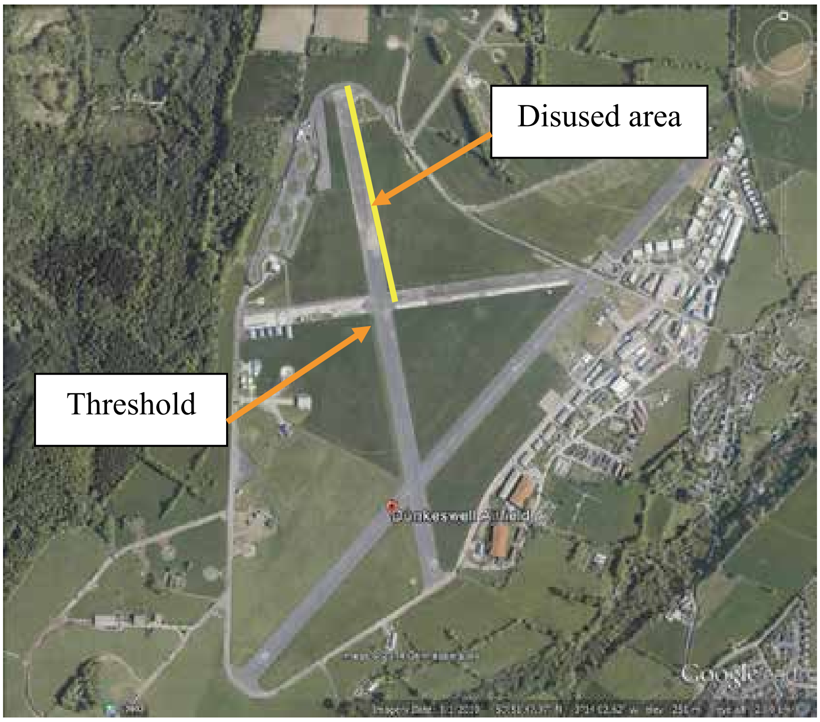


Figure 1

Dunkeswell Airfield showing displaced threshold of Runway 17

The pilot was aware of time pressures and the need to refuel and return to Old Sarum and he believes this lead him to execute a hurried approach and landing. He regrets that he had instinctively lowered the nose in response to the imminence of a stall rather than apply power to go around as soon as he recognised the high flare. He was particularly disappointed with his performance as he had had the opportunity to note the displaced threshold on Runway 17 when he stopped at Dunkeswell on the way to Land’s End.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Mainair Rapier, G-MZNU	
No & Type of Engines:	1 Rotax 503-2V piston engine	
Year of Manufacture:	1998 (Serial no: 1174-0898-7-W977)	
Date & Time (UTC):	22 June 2014 at 1320 hrs	
Location:	Lansil Golf Course, Lancaster, Lancashire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Minor)	Passengers - 1 (Minor)
Nature of Damage:	Damage to pod and wing keel	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	55 years	
Commander's Flying Experience:	287 hours (of which 107 were on type) Last 90 days - 9 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

While flying in the cruise at a height of 2,000 ft the engine began to run rough and then stopped. The pilot carried out a forced landing in a field of wheat during which the aircraft decelerated rapidly and rolled forward onto its side. The pilot and passenger, who both sustained minor injuries, exited the aircraft unassisted.

The pilot reported that following the accident the fuel filter was found to be blocked with very fine silt. Silt was also found in the bottom of the metal fuel container that had been used to refuel the aircraft. In addition, corrosion products from the inside of this container, that had started to deteriorate, may have contaminated the fuel. When refuelling the aircraft the fuel was normally poured through a strainer but it is believed that the size of the mesh in the strainer was not sufficient to catch the debris.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	P&M Aviation Quick GTR, G-MABL	
No & Type of Engines:	1 Rotax 912-UL piston engine	
Year of Manufacture:	2012 (Serial no: 8635)	
Date & Time (UTC):	26 May 2014 at 0820 hrs	
Location:	Farway Common Airfield, Devon	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - 1 (Minor)
Nature of Damage:	Damage to wing and propeller	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	49 years	
Commander's Flying Experience:	2,270 hours (of which 93 were on type) Last 90 days - 22 hours Last 28 days - 13 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and airfield information from the airfield owner	

The pilot prepared for a local flight from Farway Common Airfield. The airfield has two grass runways, designated 10/28 and 18/36; both 550 m long. There was a light and variable wind favouring Runway 10 and the grass surfaces were wet. The runway had an uphill slope, gaining approximately 50 ft elevation along its length. G-MABL was the last of a group of four microlights to take off and the only one of the group carrying a passenger.

Takeoff on Runway 10 was normal until the microlight encountered what the pilot described as a significantly waterlogged area, which caused it to lose speed. It then encountered a surface undulation and became airborne at low airspeed. The pilot was unable to correct a roll to the right and the microlight struck the ground, coming to rest on its right side.

The pilot reported that she had not appreciated the full extent of the surface water, having landed the previous day on the other runway, which had better drainage. She considered that the adverse effect of this on takeoff performance, and allowing the microlight to become airborne at too low an airspeed, were causal factors.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 15, G-MYZK
No & Type of Engines:	1 Rotax 582-40 piston engine
Year of Manufacture:	1996 (Serial no: 7157)
Date & Time (UTC):	1 August 2014 at 1830 hrs
Location:	Near Wheatley Hill, Co Durham
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to fuselage pod and wing
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	852 hours (of which all were on type) Last 90 days - 25 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The microlight was landing at a farm airstrip at the end of a local training flight. The weather was showery and the grass surfaces were wet. There was a light wind from the southwest, and the microlight was landing in an easterly direction, with a slight tailwind. As the microlight decelerated on the grass airstrip, after a normal landing, the instructor asked his inexperienced student to apply the wheel brakes, which could only be operated by the front seat occupant. As the brakes were applied, the microlight appeared to enter a skid and ran off the right hand edge of the prepared surface, before entering a ditch, which ran alongside the airstrip, and tipping forward onto its nose. The cockpit area sustained moderate damage but neither occupant was injured and both were able to vacate the aircraft.

The instructor believed the loss of directional control had occurred as a result of the aircraft skidding on the wet grass.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Pegasus Quik, G-CEMZ
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2007 (Serial no: 8280)
Date & Time (UTC):	29 June 2014 at 1210 hrs
Location:	Hunsdon Airfield, Hertfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to wing, propeller, pod and fairings, nosewheel assembly destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	941 hours (of which 933 were on type) Last 90 days - 28 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

On landing, the aircraft ran off the runway, overturned and was extensively damaged. The nosewheel appeared to have partly disintegrated at touchdown, possibly as a result of a deflated tyre.

History of the flight

The pilot reported that, following a flight of approximately 25 minutes, a normal approach was made to Runway 03 with the aircraft trimmed at an airspeed of about 60 to 65 mph. The wind was from the north-west at about 8 to 10 kt, ie about 35 to 45° to the runway direction. After crossing the runway threshold, the pilot moved his feet clear of the foot throttle after reducing power to idle, as he had been taught during training. The touchdown was firm, but not excessively so, and took place initially on the rear wheels, followed almost immediately by the nosewheel.

It was immediately apparent to the pilot that something was wrong. The aircraft was impossible to steer, a high frequency severe oscillation was transmitted through his feet and the engine power suddenly increased. He tried to reach down to turn off the magneto switches, but as he was trying to steer the aircraft and to hold the wing control A-frame at the same time, he was unable to do so before the aircraft ran off the runway into the rough grass on the right. It then overturned, sustaining extensive damage, and the engine

© Crown copyright 2014

stopped. The pilot checked his passenger before switching off the fuel selector and master switch, but was unable to switch off the magnetos himself. They were switched off by an instructor who attended the scene.

Conclusion

On examination, it was found that the right side of the nosewheel had disintegrated. Most of the pieces of the wheel were found at or near the touchdown point. Marks on the runway suggested that the rim of the wheel, rather than the tyre, may have made contact with the ground. It was concluded that the tyre was possibly deflated at touchdown, although it had appeared inflated during the pre-flight examination and the takeoff roll had felt normal.

© Crown copyright 2014

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-SLAK	
No & Type of Engines:	1 Jabiru 2200A piston engine	
Year of Manufacture:	2002 (Serial no: 0122-T600N-075)	
Date & Time (UTC):	19 June 2014 at 1800 hrs	
Location:	Wing Farm Airstrip, Wiltshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to fuselage, empennage, left wing and strut	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	48 years	
Commander's Flying Experience:	87 hours (of which 14 were on type) Last 90 days - 15 hours Last 28 days - 15 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot had operated from Wing Farm earlier in the day and intended to take off again with a passenger for a flight around the local area. He had used Runway 09 on his previous flights but, as he was carrying out his pre-takeoff checks, he saw that the wind direction had shifted to favour Runway 27 and he began his takeoff roll from the latter. The aircraft accelerated along the 500 m grass runway but, after about 10 seconds, the pilot became concerned that the nose of the aircraft did not feel as light as he was used to. He glanced down at the engine tachometer and this indicated normal rpm but he decided to abandon the takeoff. However, as he closed the throttle, he realised the aircraft was airborne and, fearing a bounce from his estimated height of about 10 ft, he opened it again. This did not prevent the aircraft from landing heavily and it pitched forwards and came to a halt inverted.

After exiting the aircraft the pilot realised that the wind had returned to an easterly direction. He believes that a lack of experience of this situation was the main cause of the accident.

© Crown copyright 2014

Miscellaneous

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

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

© Crown copyright 2014

BULLETIN CORRECTION

Aircraft Type and Registration:	Aero L-29 Delfin, G-BYCT
Date & Time (UTC):	20 May 2014 at 1300 hrs
Location:	Near Cranfield Airfield, Bedfordshire
Information Source:	Aircraft Accident Report Form

AAIB Bulletin No: 8/2014, page 71 refers

The pilot had provided the AAIB with the incorrect flying hours for the last 90 days, which had then been published in the AAIB monthly report. The flying hours for the **last 90 days**, which have been incorrectly stated as 3 hours, should be corrected to read **30 hours**.

The online version of this report was corrected on 10 September 2014.

© Crown copyright 2014

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

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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

Published September 2011.

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

Published November 2011.

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

Published February 2014.

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

Published June 2014.

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

Published September 2014.

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

http://www.aaib.gov.uk

© Crown copyright 2014

GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)

lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

AAIB Bulletin 10/2014

Air Accidents Investigation Branch