AAIB
Air Accidents Investigation Branch

AAIB Bulletin 4/2015

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AAIB Special Bulletins and Interim Reports

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AAIB Bulletin S1/2015 *SPECIAL*

SERIOUS INCIDENT

Aircraft Type and Registration:	Saab AB Saab 2000, G-LGNO
No & Type of Engines:	2 x Allison AE 2100A turboprop engines
Year of Manufacture:	1995 (Serial no: 2000-013)
Location:	Approximately 7 nm east of Sumburgh Airport, Shetland
Date & Time (UTC):	15 December 2014 at 1910 hrs
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 3 Passengers - 30
Injuries:	Crew - None Passengers - None
Nature of Damage:	Minor damage to radome and APU exhaust
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	42 years
Commander's Flying Experience:	5,780 hours (of which 143 were on type) Last 90 days - 108 hours Last 24 hours - 5 hours
Information Source:	AAIB Field Investigation

The Investigation

The serious incident, which, occurred at 1910 hrs on 15 December 2014, was notified to the Air Accidents Investigation Branch shortly after 1100 hrs on Tuesday 16 December 2014. Representatives of the manufacturer's flight safety department assisted the AAIB in the investigation.

This Special Bulletin is published to provide details of the initial facts. It includes information gathered from the flight crew, the flight data recorder, and recordings of ATC radar and RTF communications. The investigation is continuing and a final report will be published in due course.

Synopsis

The flight crew decided to discontinue their approach to Runway 27 at Sumburgh Airport because of weather ahead. As it established on a southerly heading the aircraft was struck by lightning. The commander made nose-up pitch inputs but perceived that the aircraft did not respond as expected. After reaching 4,000 ft amsl, the aircraft pitched nose-down to a minimum of 19° and the applicable maximum operating speed (V_{MO}) was exceeded by 80 KIAS with a peak descent rate of 9,500 ft/min. The aircraft started to climb after reaching a minimum height of 1,100 ft amsl. Recorded data showed that the autopilot had remained engaged, and the pilots' nose-up pitch inputs were countered by the autopilot pitch trim function, which made a prolonged nose-down pitch trim input in an attempt to maintain its altitude-tracking function.

History of the flight

The aircraft was serviceable with no relevant deferred defects prior to the flight. Weather forecasts for Sumburgh predicted thunderstorms with rain, snow, and hail, and winds gusting up to 60 kt, during the afternoon and early evening. The aircraft and crew operated one uneventful rotation between Aberdeen and Sumburgh and then departed Aberdeen for the third sector, with the commander as pilot flying. The aircraft was loaded with 3,000 kg of fuel, sufficient for the round trip. The flight plan required 1,828 kg of fuel.

As the aircraft flew towards Sumburgh, the co-pilot obtained ATIS information Tango, which stated that Runway 27 was in use, the wind was from 290° at 34 kt, gusting to 47 kt, visibility was 4,700 m in heavy rain and snow, and the lowest cloud was FEW at 700 ft aal; the QNH was 991 hPa.

The aircraft was vectored towards an ILS approach to Runway 27. As it established on the base leg, the approach controller informed the flight crew that the visibility was now 3,300 m in moderate rain and snow, and that the runway was wet. The aircraft, in clean configuration, descended to 2,000 ft amsl and established on the localiser approximately 9 nm east of the airport. The aircraft's weather radar showed a convective cloud cell, 'painting' red, immediately west of the airport, and the commander decided to discontinue the approach, informed the controller, and turned the aircraft onto a southerly heading. The autopilot remained engaged with heading select and altitude tracking[1] modes selected.

As the aircraft rolled out on the heading, it was struck by lightning, which entered the airframe at the radome and exited at the APU exhaust (in the tail). 'Ball lightning' appeared briefly in the forward cabin immediately before the lightning strike.

Footnote

[1] In altitude tracking mode, the autopilot maintains the appropriate altitude or, if disturbed, endeavours to return the aircraft to it.

The commander informed the co-pilot that he (the commander) had control of the aircraft and began making noseup pitch inputs, which he augmented with nose-up elevator trim inputs using the pitch trim switches on the control yoke. The co-pilot transmitted a MAYDAY to ATC, and the controller offered the flight crew "ALL OPTIONS" for an approach or diversion.

The aircraft climbed, but the commander perceived that his increasingly aggressive control column inputs did not appear to be having the expected effect. The co-pilot also applied nose-up pitch inputs and pitch trim inputs, but similarly perceived that the aircraft was not responding as expected. Pitch and roll mis-trim indications were presented on the primary flight displays (PFDs) in the form of a 'P' and an 'R' for the respective condition. Both pilots considered the possibility that they had lost control of the aircraft, perhaps because of a failure of the fly-by-wire elevator controls following the lightning strike.

The commander instructed the co-pilot to select the elevator emergency trim switch on the flight deck overhead panel. This was done, but had no effect, as the system had not detected the failure condition necessary to arm the switch.

As the aircraft reached 4,000 ft amsl, the pitch attitude tended towards nose-down and a descent began. Invalid data from one of the air data computers then caused the autopilot to disengage. The pitch trim was, by this time, almost fully nose-down, and the aircraft continued to pitch nose-down and descend; full aft control column inputs were made. The peak rate of descent was 9,500 feet per minute at 1,600 ft amsl, pitch attitude reached 19° nose down, and the highest recorded speed was 330 KIAS[1].

The pilots maintained nose-up pitch inputs and the aircraft began pitching nose-up. Nearing the minimum height achieved of 1,100 ft amsl, the ground proximity warning system fitted to the aircraft generated 'SINK RATE' and 'PULL UP' warnings. The commander applied full power, and the aircraft began climbing. He was still under the impression that elevator control response was not normal, and instructed the co-pilot to select the pitch control disconnect. The co-pilot queried this instruction, because the pitch control did not appear to be jammed, and the commander selected the disconnect himself. This disconnected the two elevator control systems from each other; each control column remained connected to its respective (on-side) elevator.

The climb continued and the aircraft diverted to Aberdeen. The flight crew ascertained that the aircraft responded to pitch inputs made on either or both control columns. The diversion and landing were uneventful.

Footnote

1 The aircraft's V_{MO} varies with altitude and the maximum value is 276 KIAS at 21,400 ft; V_{MO} below 4,000 ft amsl is 250 KIAS.

Description of the aircraft

The Saab 2000 is a twin-engined turboprop aircraft designed to carry up to 53 passengers. The aircraft type was certified in 1994 and 63 have been built. It has a fly-by-wire elevator and rudder control system and a conventional mechanical system for roll control. It has a fixed horizontal stabiliser and no elevator trim tabs. Pitch trim consists of elevator movement without associated control column movement.

Autopilot system

The aircraft is fitted with a Rockwell Collins FCC-4003 autopilot system. This system controls the aircraft in pitch by mechanically moving the control column via an electric servo, and by sending pitch trim signals to the digital control system to move the elevator to offload the servo and allow the column to centralise in trimmed flight. When the autopilot is engaged the letters 'AP' are displayed on the PFDs and the autopilot engage lever is in the ENGAGED position.

The autopilot can be disengaged in the following ways:

- pressing the disengage button on either control yoke
- moving the autopilot lever on the centre pedestal to DISENGAGED
- moving the standby trim switches on the centre pedestal
- pushing the power lever go-around palm switches

The autopilot will disengage if it receives invalid system input data. Autopilot disengagement is accompanied by an audible 'cavalry charge' alert, which continues until an autopilot disengage button is depressed.

The pitch trim switches on the control yoke are inhibited when the autopilot is engaged and moving these switches will not cause the autopilot to disengage. If the pilot tries to move the control column while the autopilot is engaged the pilot can overpower the autopilot servo, but the autopilot remains engaged and opposing elevator trim may result. For example, if altitude tracking mode is engaged and the pilot pulls the column aft, the pilot will feel a higher force than if the mode were not engaged, and the autopilot will trim nose-down to regain the selected altitude. This will also result in a 'P' being displayed on the PFD and, if the pilot's inputs are maintained continuously for at least 10 seconds, a PITCH TRIM caution message will appear on the EICAS[1] with an associated flashing amber Master Caution light and a single aural chime, but the autopilot will remain engaged.

Footnote

[1] EICAS = Engine Indicating and Crew Alerting System.

Aircraft examination

A detailed inspection of the aircraft revealed minor damage to the radome and APU exhaust which was consistent with a lightning strike. Functional tests of the elevator control system and autopilot system did not reveal any faults. The aircraft has since flown in service without any flight control or autopilot problems.

Analysis

Analysis of the meteorological data showed that the aircraft was struck by triggered lightning which caused only minor damage. Although the pilots' actions suggested that they were under the impression the autopilot had disengaged at the moment of the lightning strike, recorded data showed that it had remained engaged. The pilots' nose-up pitch inputs were countered by the autopilot pitch trim function, which made a prolonged nose-down pitch trim input in an attempt to maintain its altitude tracking function until it disengaged. This accounted for the perception that the control response was not normal.

Safety action

The manufacturer

On 24 February 2015 the aircraft manufacturer published '*Operations Newsletter No.6'*, informing Saab 2000 operators of the circumstances of this serious incident, and clarifying the operation of the autopilot as follows:

'**Autopilot operation**

Autopilot disengage:

Manual control inputs will not cause the autopilot to disengage and the main trim switches are disabled when the autopilot is engaged. Consequently, operation of the main pitch trim switches will not have any effect on aircraft trim nor cause the autopilot to disengage.

Disengaging the autopilot is normally done by pushing the disconnect button on either control wheel.

Manual activation of the following will also cause the autopilot to disengage:

- Autopilot engage/disengage lever
- Go-around button
- The standby pitch trim switches

Autopilot disengage will trigger disengage warning (cavalry charge). The autopilot disengage warning is cleared by a push of the autopilot disconnect button located on the control wheel.

Autopilot mistrim

Conflicting manual control column inputs with the autopilot engaged will cause the autopilot trim to occur in the opposite direction of the control input, causing a mistrim situation. This will result in a 'P' for pitch and/or 'R' for roll appearing on the Primary Flight Display. If the situation is maintained, an AP PITCH MISTRIM or AP ROLL MISTRIM caution message will appear on the EICAS1 with associated flashing amber Master Caution light and a single aural chime. The autopilot will remain engaged.'

The operator

The operator notified the AAIB that it has put in place 'Mitigations to prevent an unsafe condition occurring when a pilot inadvertently applies an override force to the flight controls'. It provided a detailed description of these measures as follows:

Notice to Aircrew (NOTAC)

NOTAC 123/14 was issued to all [the operator's] SAAB 2000 pilots on 23 December 2015 advising to ensure that the autopilot is disconnected in the event of experiencing control abnormalities:

Background

The Saab 2000 autopilot does not disconnect when overpowered or when the control wheel pitch trim switches are operated. If the autopilot is engaged and the autopilot is overpowered it is possible to fly the aircraft and not be aware that the autopilot is engaged. However, in this situation, the autopilot pitch trim will operate to compensate for pilot input and can lead to increased control forces.

Action

In the event that increased control forces are experienced, pilots should ensure that the autopilot is disengaged.

Pilot Briefings

On the 19 December 2014 all SAAB 2000 pilots received a briefing on the incident. These briefings were either face-to-face or via telephone and included the reasons behind the NOTAC.

Operator Conversion Training

Following Type Rating Training all pilots new to the SAAB 2000 undergo 8 hours of simulator conversion training on [the operator's] procedures. All pilots are now exposed to this condition in the simulator and the corrective action required.

Triennial Training

All [the operator's] SAAB 2000 pilots will be exposed to this condition and the corrective actions required in the simulator during recurrent training on a three yearly cycle.

Revision to Autopilot Standard Operating Procedures (SOPs)

The operator has proposed changes to its standard operating procedures (SOP) to improve autopilot engagement state awareness:

At any time the autopilot disconnects automatically or manually

Pilot Flying - Presses autopilot disconnect button (Even if disengagement has been automatic) and announces "AUTOPILOT DISCONNECT"

Pilot Monitoring - Confirms autopilot has disconnected by checking autopilot engagement indication and switches/paddles and announces "AUTOPILOT DISCONNECT"

Further investigation

The AAIB investigation has not identified any technical malfunction which might account for the incident. The investigation continues; exploring crew training, autopilot design requirements, the human-machine interface, including the autopilot system and other human factors of relevance to the incident.

Published: 2 March 2015

AAIB Field Investigation Reports

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

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

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

ACCIDENT

Aircraft Type and Registration:	Boeing 737-476(SF), EI-STD
No & Type of Engines:	2 CFMI CFM56-3C1 turbofan engines
Year of Manufacture:	1990
Date & Time (UTC):	29 April 2014 at 0128 hrs
Location:	East Midlands Airport
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left main landing gear, left wing and engine
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	38 years
Commander's Flying Experience:	4,279 hours (of which 377 were on type) Last 90 days - 114 hours Last 28 days - 10 hours
Information Source:	AAIB Field Investigation

Synopsis

During the landing rollout at East Midlands Airport, as the aircraft's speed reduced through 60 kt, the co-pilot handed control to the commander who then made a brake pedal application to disengage the autobrake system. The aircraft shuddered and rolled slightly left-wing-low as the lower part of the left main landing gear (MLG) detached. The MLG inner cylinder had fractured through its chrome plated section, approximately 75 mm above the axle, allowing the left mainwheels and brakes to detach.

The cause of the fracture was stress corrosion cracking and fatigue propagation within the high strength steel substrate, leading to ductile overload failure. This was as a result of a small but significant area of localised heat damage to the chrome plating, leading to the exposure of the substrate to a corrosive environment. The exact source of the heat could not be determined.

History of the flight

The aircraft was scheduled to operate three commercial air transport (cargo) sectors: from Athens to Bergamo, then to Paris Charles de Gaulle, and finally East Midlands.

The aircraft's flap load relief system was inoperative, which meant that the maximum flap position to be used in flight was 30, rather than 40º. This defect had been deferred in the aircraft's technical log and it had no effect on the landing of the aircraft. Otherwise, the aircraft was fully serviceable.

The co-pilot completed the pre-flight external inspection of the aircraft in good light, and found nothing amiss. The departure from Athens was uneventful, but a combination of factors affecting Bergamo (including poor weather, absence of precision approach aids, and work in progress affecting the available landing distance) led the crew to decide to route directly to Paris, where a normal landing was carried out.

The aircraft departed Paris for East Midlands at 0040 hrs, loaded with 10 tonnes of freight, 8 tonnes of fuel (the minimum required was 5.6 tonnes), and with the co-pilot as Pilot Flying.

Once established in the cruise, the flight crew obtained the latest ATIS[1] information from East Midlands, which stated that Runway 27 was in use, although there was a slight tailwind, and Low Visibility Procedures (LVPs) were in force. They planned to exchange control at about FL100 in the descent, for the commander to carry out a Category III autoland. However, as they neared their destination, the weather improved, LVPs were cancelled, and the flight crew re-briefed for an autopilot approach, followed by a manual landing, to be carried out by the co-pilot. The landing was to be with Flap 30, Autobrake 2, and idle reverse thrust.

The final ATIS transmission which the flight crew noted before landing stated that the wind was 130/05 kt, visibility was 3,000 metres in mist, and the cloud was broken at 600 ft aal.

The commander of EI-STD established radio contact with the tower controller, and the aircraft was cleared to land; the surface wind was transmitted as 090/05 kt. The touchdown was unremarkable, and the autobrake functioned normally, while the co-pilot applied idle reverse thrust on the engines.

As the aircraft's speed reduced through approximately 60 kt, the co-pilot handed control to the commander, who then made a brake pedal application to disengage the autobrake system. However, the system remained engaged, so he made a second, more positive, brake application. The aircraft "shuddered" and rolled slightly left-wing-low as the lower part of the left main landing gear detached. The commander used the steering tiller to try to keep the aircraft tracking straight along the runway centreline, but it came to a halt slightly off the centreline, resting on its right main landing gear, the remains of the left main landing gear leg, and the left engine lower cowl (Figure 1). The co-pilot saw some smoke drift past the aircraft as it came to a halt.

The co-pilot made a transmission to the tower controller, reporting that the aircraft was in difficulties, after which the co-pilot of another aircraft (which was taxiing from its parking position along the parallel taxiway) made a transmission referring to smoke from the 737's landing gear. The commander of EI-STD had reached the conclusion that one of the main landing gear legs had failed, but as a result of the other pilot's transmission, he was also concerned that the aircraft might be on fire.

The commander immediately moved both engine start levers to the cut-off positions, shutting down the engines. Three RFFS vehicles had by now arrived at the adjacent taxiway

Footnote

[1] Automatic Terminal Information Service.

intersection, and their presence there prompted the commander to consider that the aircraft was not on fire (he believed that if it were, the vehicles would have adopted positions closer by and begun to apply fire-fighting media).

Figure 1

View of aircraft and detached section of lower left MLG

The RFFS vehicles then moved closer to the aircraft and fire-fighters placed a ladder against door L1, which the co-pilot had opened. Having spoken to fire-fighters while standing in the entrance vestibule, the commander returned to the flight deck and switched off the battery. The flight crew were assisted from the aircraft and fire-fighters applied foam around the landing gear and engine to make the area safe. The commander had taken the Notoc[2] with him from the aircraft, and informed fire-fighters of the dangerous goods on board the aircraft.

Communications

A variety of factors caused some communications, between ATC and other agencies, not to flow as smoothly as might have otherwise been the case. These difficulties centred mostly on lack of clarity in communications, non-standard terminology (or different terminology used by different agencies), confusion in lines of communication between agencies, and lack of appropriate prioritisation of communications tasks. The airport, and other agencies, reviewed these matters, and the action taken is summarised under ‘Safety actions’.

Recorded data

The aircraft was fitted with a 30-minute Cockpit Voice Recorder (CVR) and a Flight Data Recorder (FDR) that captured more than 40 hours of flying.

Footnote

[2] Notice to Captain: the document detailing dangerous goods in the freight.

Due to limitations of the FDR parameter requirements and faults associated with parameters that the installation should have recorded, there were no operational parameters relating to vertical forces, brake pressures, or autobrake usage.

The aircraft was also equipped with a Quick Access Recorder (QAR). This recorded the same data as the FDR and suffered the same parameter problems.

Recordings of radar and radio transmissions from East Midlands Airport were supplied to the AAIB.

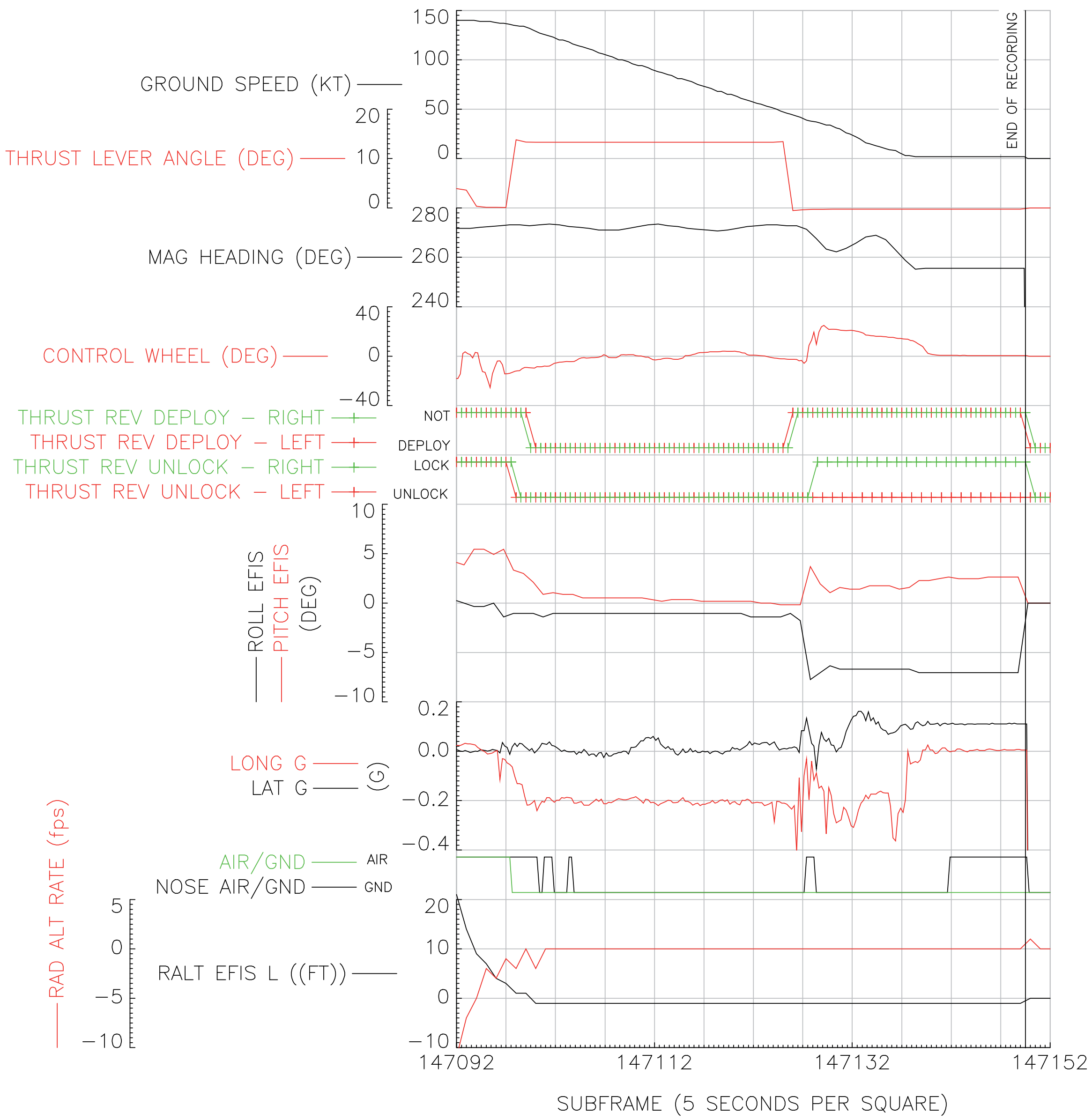


Figure 2
Pertinent FDR parameters

The aircraft took off at a recorded time of 0040:46 hrs and touched down at 0128:59 hrs. Figure 2 is a plot of the pertinent recorded parameters for the landing. There was no valid normal-acceleration parameter, but the derived closure rate with the runway does not indicate a heavy landing. The thrust reversers were deployed. There were no valid recorded brake-parameters but the longitudinal acceleration during the landing roll was very uniform. A brief spike in longitudinal acceleration was recorded as the aircraft groundspeed reduced through 52 kt. This was followed 2.25 seconds later by a larger spike in longitudinal acceleration and then oscillations with a frequency too high for the parameter to follow accurately. After approximately one second of these oscillations in longitudinal acceleration, a clockwise control wheel input was recorded, associated with a change in attitude which peaked at 7.7° left-wing-down and 3.7° nose-up pitch.

The aircraft slowed to a stop over the next 10 seconds with the longitudinal acceleration varying around the -0.2 g figure associated with the original period of steady braking. Shortly after the aircraft came to a stop, the master caution was triggered. Both the FDR and CVR recordings stopped approximately 11 seconds after the aircraft stopped. The last recorded attitude shows the aircraft stabilised at 7.0° left-wing-down and 2.6° nose-up pitch, with the nose gear weight on wheels sensor indicating AIR instead of GROUND.

The thrust reversers were recorded as 'not deployed' just before the onset of the longitudinal acceleration oscillations. This was followed by the right reversers registering the 'lock' state; however the left reversers remained in the 'unlock' state due to the aircraft resting on the engine.

Aircraft description

The Boeing 737-400 Series 476 is a low-wing, pressurised aircraft with retractable tricycle landing gear. The accident aircraft was manufactured in 1990 and operated in a passenger configuration on the Australian CAA register. Between November 2012 and February 2013, it was converted to SF (Special Freighter) configuration for its current operator, transferred to the Irish Aviation Authority (IAA) register and re-registered as EI-STD. During the conversion work the left and right main landing gears were replaced with recently overhauled units.

The aircraft held a valid Certificate of Registration and Airworthiness, issued by the IAA on 26 February 2013. Other than the inoperative flap load relief system, there were no significant defects recorded in the aircraft technical log.

Landing gear

The Boeing 737 landing gear consists of two MLG assemblies located inboard of each engine nacelle and aft of the rear spar and a nose gear assembly located below the aft bulkhead of the flight deck. All three assemblies are fitted with double wheels. Landing loads are taken on air-oil (oleo) shock absorbers within the landing gear struts and consist of an inner and outer cylinder constructed from high strength steel alloy. The outer cylinder is attached to retraction, drag and weight carrying struts. The bottom of the outer cylinder incorporates a gland seal assembly through which the inner cylinder passes. The inner cylinder carries the axle, wheels and brake assemblies and its upper end is fitted with a sliding bearing assembly to maintain inner and outer cylinder concentricity. The two cylinders are prevented from rotating within each other by a torque link and anti-shimmy damper assembly.

The landing gear is retracted and lowered hydraulically, with a facility for emergency lowering by mechanical means. The gear is locked down by a hydro-mechanical folding strut mechanism. Both sets of mainwheels are fitted with multi-disc hydraulic brake units with antiskid protection, an autobraking system and a parking brake.

Autobrakes

The aircraft is equipped with an automatic braking system designed to relieve pilot workload. The system works in conjunction with the speed brake and antiskid system to provide braking with feet off the brake pedals during landing. The pilot can transfer from auto to manual braking at any time by depressing the brake pedals.

Damage to aircraft

The crew had just selected manual braking from autobrake during the latter stages of their landing rollout and heard the loud "bang" as the lower section of the left MLG detached. The aircraft tilted and continued to slow, veering left before coming to a gentle stop.

Marks and damage to the runway surface indicated that the aircraft had travelled 115 m with its weight on the left engine nacelle and left MLG outer cylinder, from the position where the left MLG had failed. A debris trail, consisting mainly of composite material, was deposited on the runway, along with a large oil stain where the MLG lower section had detached. The aircraft's path described a gentle curve diverging to the left, away from the runway centreline. The aircraft had come to rest with its nosewheel off the ground and its weight borne on the right MLG, the remains of the left MLG and the underside of the left engine nacelle.

The left MLG inner cylinder had fractured through the chrome portion approximately 75 mm above the axle. The fracture was horizontally across the full diameter of the inner cylinder and exhibited a discoloured thumbnail-shaped feature on its surface. This feature was on the forward face of the MLG, approximately in line with the level at which the inner cylinder protrudes from the outer cylinder with aircraft weight on wheels. The upper torque link arm had failed and the antiskid system wiring harness, conduit and brake pipes had parted. The left mainwheels, brake units and axle assembly came to rest approximately 27 m behind the aircraft, to the left of the centreline.

The detached MLG tyres were found to be correctly inflated, but had cuts and abrasions in the sidewalls and on the tread.

Impact damage was sustained by the inboard edge of the left inboard flap and track rollers. The flap trailing edge was distorted and delaminated, exposing the internal honeycomb structure and the mainplane composite trailing edge root fairing was holed, with a section missing. There was also evidence of tyre rubber scuffs on the flap, root fairing and fuselage in the vicinity of the damage. The left engine bypass duct and casing was damaged and the low pressure (LP) fan could not be rotated. Subsequent further inspection found the engine pylon was distorted on its mountings in the mainplane, although this relaxed and the LP fan became free to rotate as the aircraft was airbag-lifted during the salvage operation.

Tests and research

The remains of the left MLG were removed from the aircraft and, along with the detached axle and wheels, were recovered to the AAIB hangar at Farnborough for examination. The lower gland seal nut locking plate had abraded through as it travelled along the runway and the gland nut had been forced to rotate, tightening and jamming it in place. The wheels and brakes were removed from the axle and the inner cylinder tube was extracted by cutting the top from the outer cylinder because of the jammed gland nut. The inner cylinder guide bearings and locking collar were present, correctly assembled and undamaged. The wheel hubs, bearings, tyres and brake assemblies were inspected after disassembly and found to be undamaged and in good condition, except for running surface cuts and sidewall abrasions to the tyres. Dimensional checks were also carried out as far as possible, taking into consideration the possibility that the structures were distorted during runway abrasion and inner cylinder breakup.

High magnification visual examinations were initially carried out and microsections were prepared through the fracture in order to analyse the steel structure in the immediate vicinity using a scanning electron microscope (SEM). To examine the steel substrate surface further the chrome plating was chemically removed, so as not to cause additional mechanical damage to any features beneath the chrome.

Findings

The left MLG internal and external dimensions were found to be within acceptable tolerances, as detailed in the Boeing Component Maintenance Manual (CMM), despite the runway abrasion. Material conformity checks showed that the elemental composition of the inner cylinder was consistent with 4340M steel which was within the specified hardness limits. The chrome thickness on the lower section of the cylinder was 200-210 µm thick, compared to 160-170 µm at the upper section. The chrome met the required 16 micro-inch surface finish specified by the manufacturer.

The visual examination under magnification of the outer chrome plated surfaces of the inner cylinder revealed extensive crazing of the chrome plating. This phenomenon is known as ‘chicken wire’ cracking and was apparent over the majority of the surface. Small flakes of the crazed chrome plating had detached from the substrate material at the edge of the fracture face, leaving an imprint of the crazing in the form of ferrous oxide tracks (Figure 3).

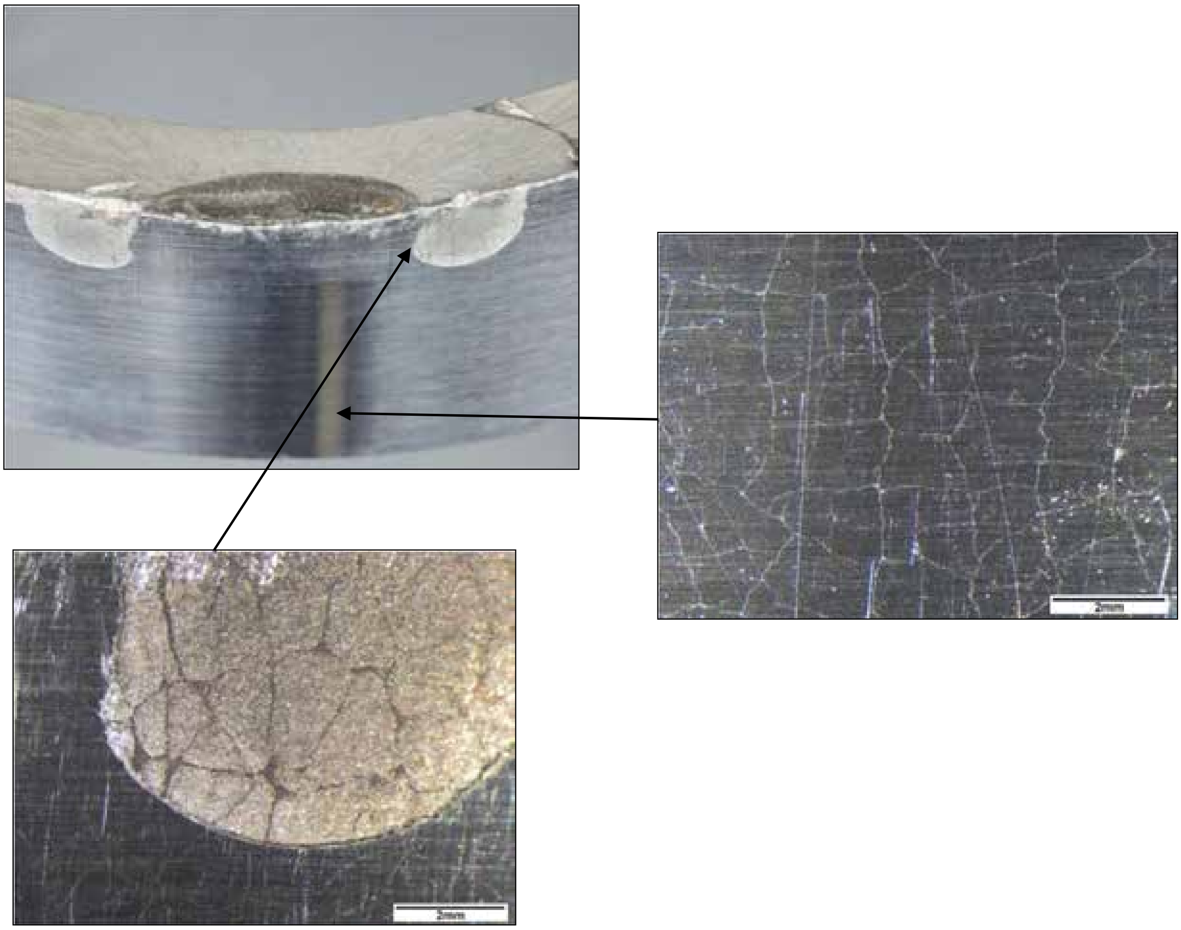


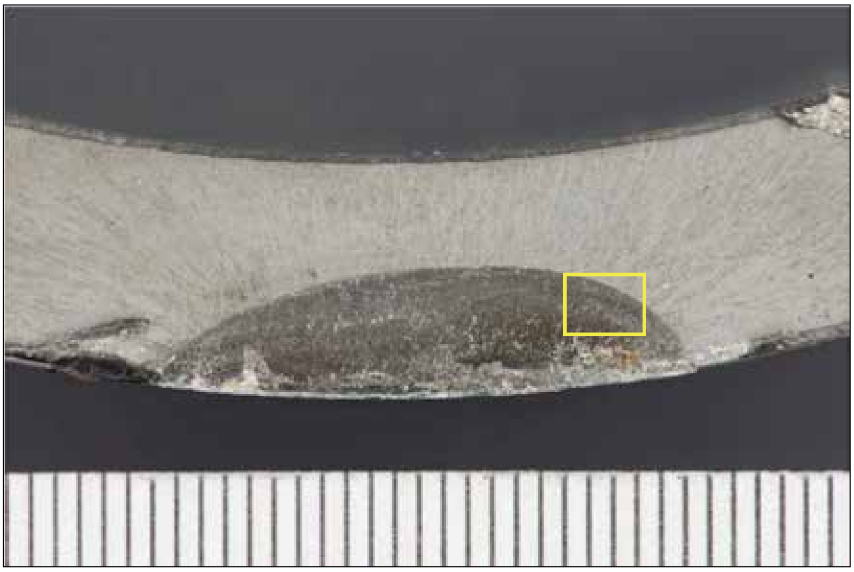
Figure 3

Chrome plate flake area and ferrous oxide tracks left by the chicken wire cracking

The fracture face showed three distinct failure mechanisms in the grey 'thumbnail' area of the fracture (Figure 4). The majority of this area exhibited stress corrosion. Further into the material there was evidence of fatigue and the remainder of the fracture face showed the characteristics of ductile overload.

As the investigation progressed it was also found that the ferrous oxide tracks on the substrate were present beneath the chrome which was exposed to the elements, but not on the upper area normally surrounded by oil in the outer cylinder.

The inner cylinder area above the fracture face on the portion of the cylinder which had been forced up into the outer cylinder during the runway abrasion exhibited circumferential helical bands in the chrome plate. When the chrome was removed, these marks were also present on the steel substrate. Metallurgical analysis revealed localised heating damage correlating to the bands.



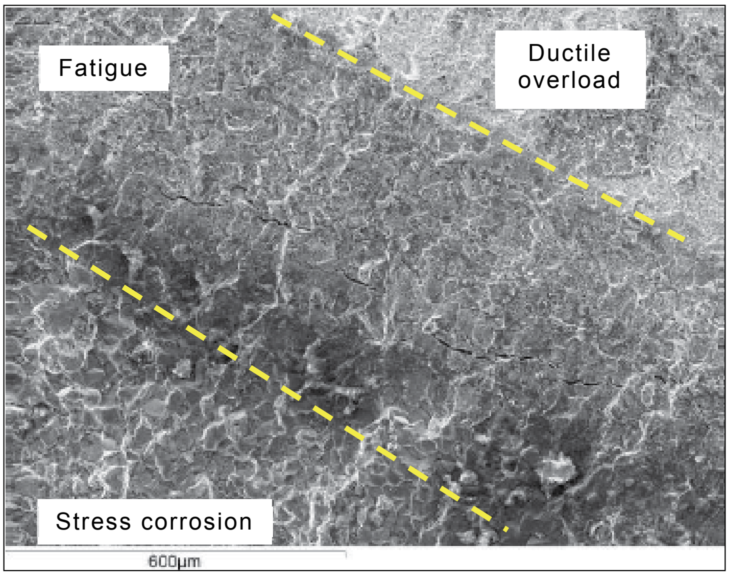


Figure 4
Fracture surface map

With the chrome plating removed, a very distinctive area of ferrous oxidation became apparent on the surface of the steel, just beneath the area of fatigue cracking (Figure 5). In addition, in the same area, there was also evidence of chrome combining with the steel.

Metallurgical examination of the microsection through the fracture face showed an area in the substrate steel of over and undertempered martensite, consistent with localised heating. The hardness profile through this section also confirmed this finding. Prior to removal of the chrome, hardness checks were carried out; these showed that the chrome decreased in hardness in the vicinity of the fracture face. Figure 6 shows the disposition of the martensite.

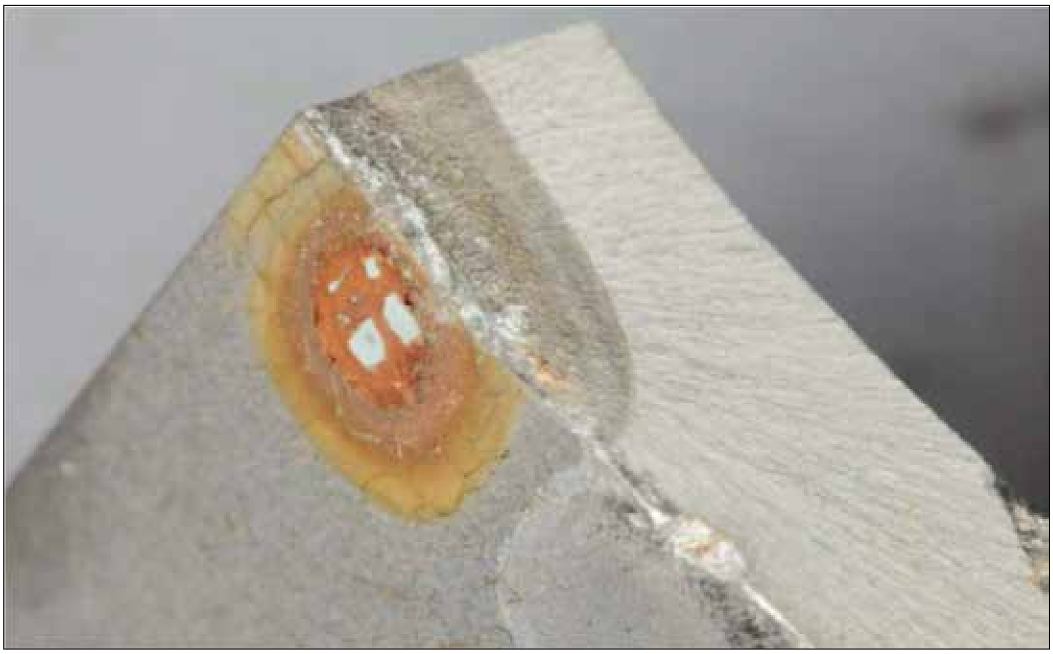


Figure 5

Ferrous oxidation on the substrate beneath the chrome plating (after longitudinal microsection)

The features linked to the fracture face and the helical banding were the only places on the inner cylinder steel substrate which showed localised heating. Areas of the steel substrate away from the fracture face, banding and with an absence of ferrous oxide chicken wire tracks showed no evidence of heating or material distress.

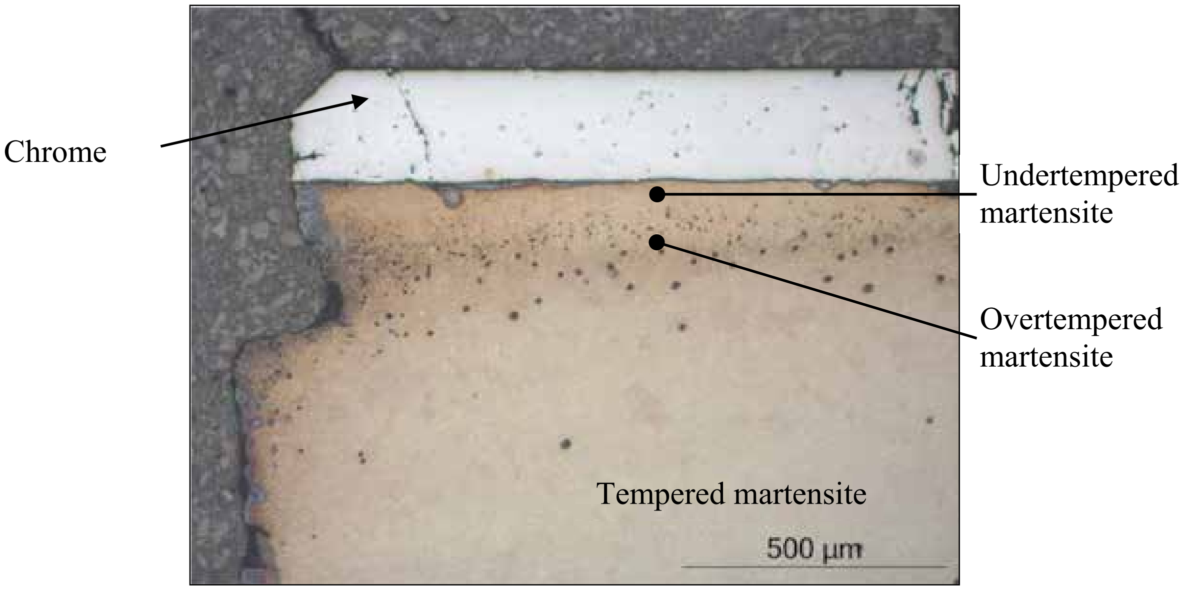


Figure 6

Fracture surface metallurgy

MLG history

The left MLG assembly was overhauled between December 2012 and the end of January 2013 and released to service on FAA Forms 8130-3, dated 23 & 25 January 2013. The work included re-chrome plating and refinishing of the inner cylinder which was carried out in accordance with Boeing CMM 32-11-11 Revision 109, dated 1 November 2012. Since installation on EI-STD during conversion to freighter, the MLG had accrued 878 landing cycles. The most recent maintenance on the MLG was task B32-10-00-A-1, a visual check of oleo/drag/side struts and associated hardware for condition and security of installation. This was a 500-cycle repeat inspection and was carried out 27 April 2014 on a 2A Check at 41,344 aircraft cycles. The aircraft had accrued a further 3 cycles by the time of the accident on 29 April 2014.

Since conversion there were no significant events recorded against the MLG, wheels or brake assemblies.

Additional observations

During the on-site examination of the aircraft it was found that the antiskid wiring loom connecting socket had parted between the connector shell and conduit union, with no apparent damage to screw threads. The shell was attached to the airframe portion of the connector, its three cables having been pulled out of the seal gland and connecting pins. Further examination showed that the connecting socket had parted under the tensile load applied on its protective conduit at the point when the MLG inner cylinder separated. Under magnification, very minor damage was apparent on approximately 25% circumference of the single male start thread of the aluminium alloy connector shell. The conduit steel female union was undamaged. This minimal damage to the thread implied that the shell and conduit union were attached by less than one thread.

The right MLG antiskid conduit and connector was inspected and found to be intact, but the connector shell and conduit union also appeared engaged only by a single thread.

The connector and conduit union was visually examined on another Boeing 737 aircraft and found to be fully threaded together on both sides of the aircraft. It is therefore considered to be an anomaly in the case of EI-STD.

Although an unsatisfactory assembly condition, found on the post-accident examination, it had no effect on the operation of the aircraft braking system and therefore had no bearing on the accident.

Analysis

Operational aspects

The landing was unremarkable until the commander's brake pedal applications to disconnect the autobrake. The recorded data showed that these applications were of normal magnitude, and did not contribute to the failure of the landing gear leg.

Engineering aspects

Wheel and axle detachment

The brake pedal application to deselect the autobrake is likely to have imparted a short duration increased drag load to both MLG. This load was not excessive, but was enough to overload the already weakened structure of the left MLG inner cylinder. The braking load would have created a bending moment on the inner cylinder putting the material at the leading face of the inner cylinder, at the point where it protrudes from the outer cylinder, under tension in the vicinity of the stress corrosion cracking.

The axle, wheels and brakes assembly is of substantial weight and, after inner cylinder fracture, would have been partially restrained momentarily by the torque links, brake pipes and electrical harnesses. Although there were no witnesses to observe the separation of the MLG axle and wheel assembly, damage to the flap and fuselage fairings and the damage to the ancillary components is consistent with detachment being violent and rapid. It was noted that the wheels and tyres had protected the fracture face; their size and position prevented the fracture surface from contacting other parts of the aircraft or the runway, therefore leaving unadulterated metallurgical evidence.

Recent inspection

Daily MLG checks and the inspection carried out two days before the accident did not reveal any defects with the MLG. Whilst chicken wire cracking can in some circumstances be seen with the naked eye, it is very difficult to detect without significant magnification and a suitable light source held at a suitable angle. It is even more difficult to detect in situ because only a relatively small portion of the inner cylinder chrome surface is visible with the aircraft weight on wheels and this area is usually covered in oil residue, brake and runway dust and grit. It is therefore not surprising that the cracking was not detected prior to the accident.

Metallurgical findings

The forensic examination of the fracture face identified stress corrosion cracking, fatigue and ductile overload failure mechanisms. The small areas of chrome plate at the centre of the ferrous oxidation had resisted the electro-chemical removal process. The reason for this was that the corrosion beneath the chrome was severe enough not to allow electrical continuity between the steel substrate and the chrome, thus inhibiting the process. This indicates that this was the most probable position where the corrosion and therefore damage was most severe and the most likely initiator of the stress corrosion cracking in the steel substrate leading to the fatigue failure. It is possible that damage was as a result of very high temperature localised heating of the chrome plated surface which also affected the substrate beneath. This senario is supported by the presence of the martensitic area in the substrate steel as shown by the examination after microsection through the fracture surface. However, this is the only area of localised heat damage other than the helical banding. Therefore, it can be concluded that the chicken wire cracking is likely to have been caused by a grinding anomaly during the finishing process, but that it was not severe enough to impart heat damage into the steel substrate. The source of the heat which caused the damage to the steel substrate could not be identified with any degree of certainty.

Conclusions

The damage to the flap system, fuselage, and MLG equipment was attributable to the detachment of the left MLG axle, wheel and brake assembly. The damage to the MLG outer cylinder, engine and nacelle was as result of the aircraft settling and sliding along the runway.

The left MLG axle assembly detached from the inner cylinder due to the momentary increase in bending load during the transition from auto to manual braking. The failure was as a result of stress corrosion cracking and fatigue weakening the high strength steel substrate at a point approximately 75 mm above the axle.

It is likely that some degree of heat damage was sustained by the inner cylinder during the overhaul process, as indicated by the presence of chicken wire cracking within the chrome plating over the majority of its surface. However, this was not severe enough to have damaged the steel substrate and therefore may have been coincidental. Although the risk of heat damage occurring during complex landing gear plating and refinishing processes is well understood and therefore mitigated by the manufacturers and overhaul agencies, damage during the most recent refinishing process cannot be discounted.

The origin of the failure was an area of intense, but very localised heating, which damaged the chrome protection and changed the metallurgy; ie the formation of martensite within the steel substrate. This resulted in a surface corrosion pit, which, along with the metallurgical change, led to stress corrosion cracking, fatigue propagation and the eventual failure of the inner cylinder under normal loading.

Safety actions

Although it is not clear how or when the chrome plating damage occurred, the landing gear overhaul company has carried out a comprehensive review of their processes as a precaution.

The airport operator issued a safety bulletin to air traffic controllers reminding them of emergency communications protocols and procedures, undertook a review of internal emergency communications procedures, and planned investment in new communications equipment, in order to enable better and more automated communications.

ACCIDENT

Aircraft Type and Registration:	1) Boeing 737-8AS, EI-ENL 2) Boeing 737-8AS, EI-DLJ
No & Type of Engines:	1) 2 CFM56-7B turbofan engines 2) 2 CFM56-7B26 turbofan engines
Year of Manufacture:	1) 2011 (Serial no: 35037) 2) 2005 (Serial no: 34177)
Date & Time (UTC):	28 June 2014 at 0546 hrs
Location:	London Stansted Airport
Type of Flight:	1) Commercial Air Transport (Passenger) 2) Commercial Air Transport (Passenger)
Persons on Board:	1) Crew - 6 Passengers - 161 2) Crew - 6 Passengers - 178
Injuries:	1) Crew - None Passengers - None 2) Crew - None Passengers - None
Nature of Damage:	1) Right winglet detached 2) Right tailplane damaged and severe damage to APU installation
Commander's Licence:	1) Airline Transport Pilot's Licence 2) Airline Transport Pilot's Licence
Commander's Age:	1) 39 years 2) 49 years
Commander's Flying Experience:	1) 12,200 hours (of which 6,200 were on type) Last 90 days - 264 hours Last 28 days - 80 hours 2) 16,408 hours (of which 12,857 were on type) Last 90 days - 232 hours Last 28 days - 62 hours
Information Source:	AAIB Field Investigation

Synopsis

The right winglet of a taxiing Boeing 737-8AS detached when it collided with the tail of another Boeing 737-8AS being pushed back from the apron at London Stansted Airport. Both aircraft were manoeuvring in accordance with ATC instructions. The APU of the aircraft being pushed back was severely damaged and some fuel leaked onto the apron. There was no fire and all persons onboard later disembarked without injury.

The controller had not appreciated that the pushback approval he had issued conflicted with his earlier instruction to another aircraft and there was no monitoring or warning system to alert him. The pilots of the taxiing aircraft did not discern that the controller's instructions caused confliction and only noticed the other aircraft's movement at the last moment. Hand signals were used as the pushback team had no headset to communicate with the pilots on the flight deck. There was no guide person to check for hazards to the rear and right of the aircraft that was being pushed.

Since the accident, safety actions have been taken by the operator, the air traffic control agency, the regulator and the ground handling company. There are therefore no AAIB Safety Recommendations.

History of the flight

EI-ENL had been flown from its base at Hahn Airport, Germany and had landed on Runway 22 at London Stansted Airport. It was a dry morning, visibility was good, and the wind was from 230º at 5 kt. After vacating the runway via the high speed link NR (Figure 1) the co-pilot checked in on the Ground radio frequency and the aircraft was instructed to take the second left turning onto Taxiway J and to hold short of Taxiway C. Later the Ground controller instructed EI-ENL to proceed via the 'C West' line to park on Stand 43R.

Figure 1

Partial taxiway diagram for London Stansted Airport

After passing Taxiway Z, the co-pilot shut down the right engine in accordance with the operator's Standard Operating Procedures (SOP). While he was doing this, EI-DLJ requested permission to "push and start" from Stand 44R. The Ground controller approved this request and in so doing repeated the stand number clearly and instructed EI-DLJ to push onto the 'C West' line. He then added that engine start could be delayed until the aircraft was established on the 'C West' line. The crew of EI-ENL did not discern that another aircraft was being given a pushback instruction that conflicted with their own routing. Onboard EI-DLJ, the crew were completing their pre-flight preparations and therefore they were not monitoring taxi instructions given on the Ground frequency when EI-ENL received parking instructions.

The pushback crew for EI-DLJ comprised a tug driver and a headset operator[1]. There was no headset immediately available, so the headset operator informed the commander, who opened his side window so that he might be able to supplement his hand signals with verbal instructions. The headset operator remained on the left side of the aircraft to maintain visual contact with the commander. When the tug driver was passed the '*brakes released*' signal, he saw EI-ENL on Taxiway J but lost contact with it as he started the pushback. The APU generator remained the prime source of electrical power for EI-DLJ.

A pier obscured the controller's view of Stands 43 and 44 and only the fins of aircraft on the 'C West' line could be seen from the Visual Control Room (VCR) (Figure 2). The crew of EI-ENL saw a B737 on Stand 44R as they turned onto the 'C West' line but they did not appreciate that it was commencing pushback. After completing the turn, the co-pilot looked to his right and realised that the tail cone of the other B737, was now moving towards him. He told the commander to stop and the commander started to turn left, away from the conflict, and to apply the brakes. Three and a half seconds after the co-pilot started speaking, the winglet of EI-ENL impacted the leading edge of the right horizontal stabiliser on EI-DLJ. The winglet was forced under the tail cone of EI-DLJ where it penetrated the APU bay and fragmented. The pilots of EI-ENL felt the aircraft "touch" before they brought it to a halt a few metres further on.

Figure 2

A view from the VCR looking towards Stands 43 and 44 with a Boeing 737 parked on Stand 44R and another taxiing along the 'C West' line

Footnote

[1] Although there was no headset available the ground crew member in charge of the pushback was referred to as the headset operator.

The tug driver had seen EI-ENL re-appear behind EI-DLJ and braked hard but could not prevent the collision. The impact of the winglet caused the APU on EI-DLJ to fail and a small amount of fuel to leak onto the ground. Onboard, the crew felt a thump, the aircraft stopped suddenly and some electrical services failed. The headset operator shouted to the commander that another aircraft had hit the tail and the pilots heard a radio call from an Operations vehicle (Ranger 2), which had followed EI-ENL onto C West. Seven seconds after the collision, Ranger 2 announced, "EMERGENCY, AGI[2] IN THE CHARLIES, AIRCRAFT AGAINST AIRCRAFT". The commander of EI-DLJ made a Public Address (PA) instructing the passengers to remain seated. He ascertained from the headset operator that a quantity of fluid had leaked onto the ground but he understood that the flow had ceased and that there was no sign of fire.

In response to the radio call from Ranger 2, the Ground controller looked towards C West but he only saw the fins of the two stationary aircraft in close proximity to each other. He then initiated the airport's AGI procedures using a landline and after that he instructed other aircraft on his frequency to stand by, so that fire vehicles would have a clear route to the incident. Approximately three minutes after the collision he was relieved of the Ground position by another controller.

The pilots on EI-ENL also heard Ranger 2 declare the emergency. Two attempts to speak to the Ground controller were made, but no reply was received.[3] The commander then called the No 1 cabin crew member by interphone and said "...WE HIT SOMEBODY. COULD YOU TELL THE PASSENGERS TO PLEASE REMAIN IN THEIR SEATS."

Some three and a half minutes after the collision, the crew of EI-ENL started the APU and the commander made a PA in which he reiterated his instruction for the passengers to remain seated. On completion of the PA, the pilots responded to a radio call from the replacement Ground controller, who asked if any aircraft was evacuating. They transmitted that they were not evacuating passengers. They were then instructed to monitor the RFFS frequency (121.6 MHz), and to shut down their engines. The left engine was shut down some five minutes after the collision and, just over a minute later, the No 1 cabin crew called the commander on the interphone. He told the commander that he had a good view of what had happened but there was no exchange of information between them concerning the aftermath of the collision or damage that was apparent.

At the time of the accident a watch handover was taking place in the fire station. The oncoming Fire Station Manager had heard the AGI announced over the tannoy system. He reached the scene of the accident along with the first fire tender within two minutes of the collision. He saw what he initially thought to be hydraulic fluid beneath the tail of EI-DLJ but the leak had ceased. After assessing the damage to both aircraft, he upgraded the incident to an accident. This entailed an enhanced response from the local emergency services.

The two B737s were later towed onto their respective stands and all persons onboard disembarked without injury.

Footnote

2 AGI – Aircraft Ground Incident.
3 These transmissions were not heard by the Ground Controller as he was having a conversation on the land line.

Recorded information

The FDR and CVR from EI-ENL contained a complete record of the accident. The CVR from EI-DLJ recorded the period of the crew's pre-departure preparations, ATC instructions and pushback up until the collision, at which time the CVR system stopped recording when electrical power provided by the APU was lost. The FDR on EI-DLJ was not operating at the time of the pushback as neither engine had been started. Salient parameters from EI-ENL's FDR included groundspeed.

CCTV footage of the collision was available from a camera located at the far end of the adjacent terminal building near to Stand 53, which is about 180 m from Stand 44R. The position of the camera meant that the vertical stabiliser of EI-DLJ could be observed as EI-ENL taxied along Taxiway J before turning right to follow the 'C West' line. The CCTV images provided the relative positions of both aircraft when the pushback of EI-DLJ commenced, and through alignment with the CVR, the point that the crew of EI-ENL became aware that EI-DLJ was moving. Figures 3 and 4 are composite images, illustrating the relative positions at two points. The CCTV was used to corroborate the recorded groundspeed of EI-ENL. ATC recordings and ground surface movement radar records were also available.

The maximum groundspeed of EI-ENL was just less than 30 kt as it proceeded along Taxiway J. Approaching Apron Z, speed began to reduce and was about 10 kt at the start of the turn onto the 'C West' line. It was at this point that EI-DLJ's pushback manoeuvre started. A left turn by EI-ENL was evident just after the cockpit passed abeam the tail of EI-DLJ, which extended approximately 9 m beyond the stand parking limit line when the aircraft collided. The application of EI-ENL's brakes was not a recorded parameter but the aircraft's speed did not reduce until after the collision. The aircraft stopped with its empennage almost abeam that of EI-DLJ and displaced approximately 1.5 m to the left of the 'C West' line (away from Stand 44R).

The FDR record for EI-ENL continued for five minutes after the collision, ending when the left engine was shut down and about 90 seconds after the APU had been started. Flight deck and cabin crew communications, along with PA announcements from the flight deck and radio communications with ATC and RFFS, were recorded by the CVR until it was manually stopped 10 minutes after the accident[4].

Analysis of the CCTV footage, in conjunction with stand and aircraft dimensions and final position of EI-DLJ at impact, indicated that the aircraft had been pushed back approximately 22 m from its parked position at an average ground speed of about 1.3 m per second (2.9 mph).

Footnote

4 The CVR circuit breaker was pulled by the crew in accordance with the operator's procedures in order to preserve the recorded data.

Figure 3

Relative position of EI-ENL when EI-DLJ push back commenced (composite image)

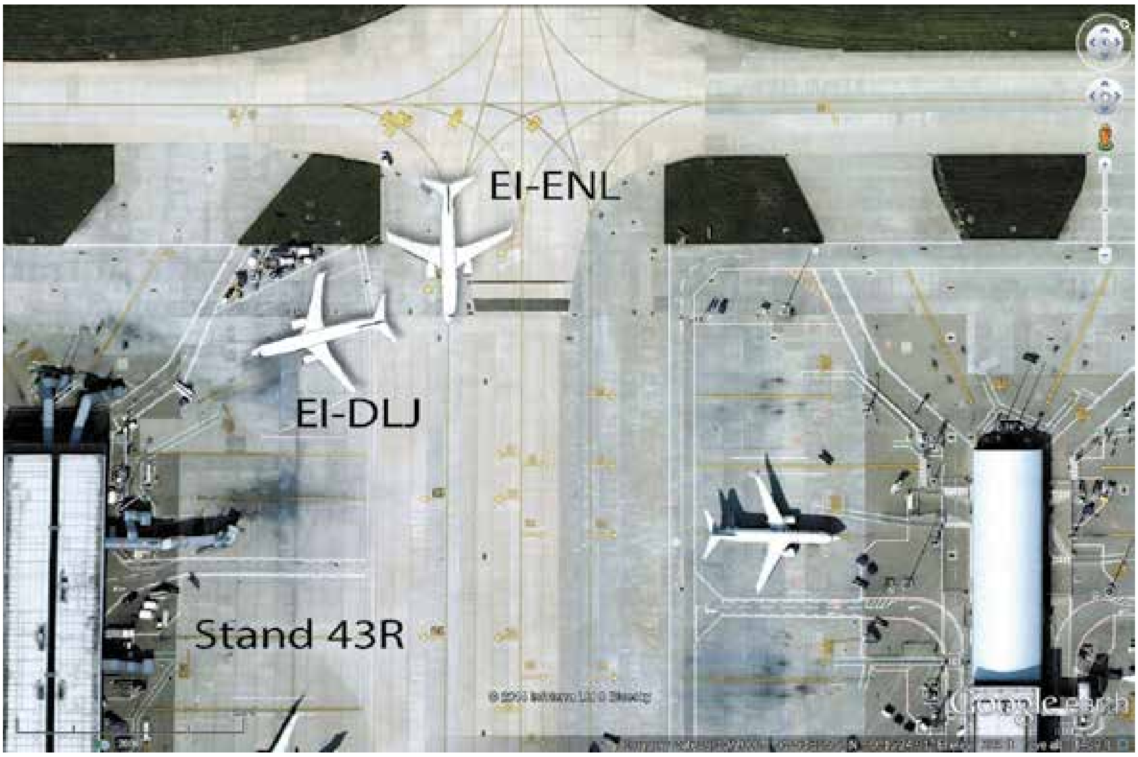


Figure 4

Position of EI-ENL when co-pilot observed EI-DLJ moving (composite image)

Damage to the aircraft

The right winglet of EI-ENL had struck the right tailplane of EI-DLJ before piercing its APU bay and severely damaging the APU. The winglet detached and remained embedded in the bay (Figure 5). The APU's automatic shutdown[5] process operated and closed the fuel shut-off valve on the forward bulkhead of the APU bay, preventing a fuel leak which would have been substantial.

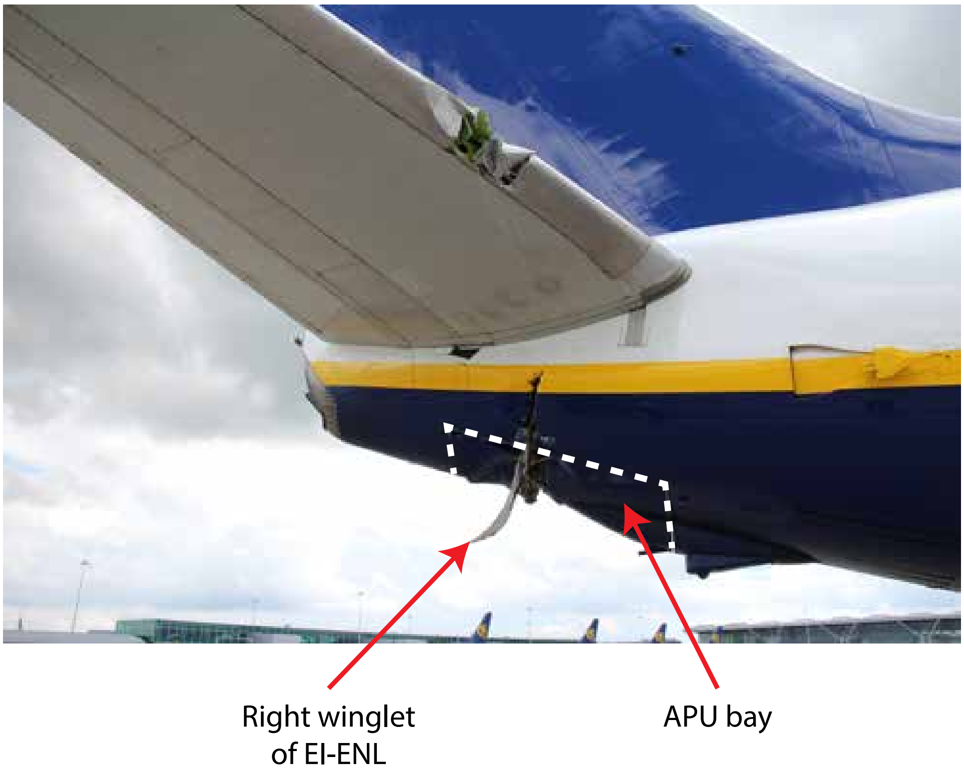


Figure 5

Right winglet of EI-ENL embedded in the APU bay of EI-DLJ

The APU was significantly damaged by the winglet (Figure 6). The impact severed main casings, fuel and oil pipes as well as causing damage to its mountings and bay. A small quantity of fuel and lubricating oil escaped, but there was no fire.

Footnote

[5] The APU has fully automatic shutdown protection provided for overspeed, low oil pressure, high oil temperature, APU fire, fuel control unit failure, EGT exceedence and other system faults monitored by the electronic control unit.

Figure 6
Underside of APU after removal, showing extent of the damage

ATC environment

The ATC Watch in the VCR consisted of five people. The Ground controller began work at 0455 hrs alongside the previous Watch. The other four members of his own Watch were due to start at 0600 hrs, although they had all reported to the VCR by 0546 hrs. In addition to the Watch Manager, there was one controller assigned to the Air position (Tower frequency), one who was about to open the Delivery position[6] and an additional person who later took control of the Ground position after the accident.

The Ground controller was responsible for Delivery and Ground control, providing ATC departure clearances as well as controlling aircraft from the start of pushback until they approached the runway and arriving aircraft that had vacated the runway. His responsibilities[7] included the issue of information and instructions to aircraft under his control to prevent collisions with vehicles, obstructions and other aircraft on the manoeuvring area and, on the apron, to assist in preventing collisions between aircraft[8]. It is not common practice at UK airports for the actions of a Ground controller to be continuously monitored by anyone else.

Footnote

6 On weekdays the Delivery position had to be opened by 0530 hrs but there was no such constraint at weekends as traffic levels were lighter.
7 The Manual of Air Traffic Services Part 1 (CAP 493) lays down ATC responsibilities in the UK.
8 The 'C West' line at Stansted was on the manoeuvring area and the parking stands were on the apron. A line on the ground, known as the 'tail of stand line' separated Stand 44R from the manoeuvring area.

Aids available to the Ground controller included a monitor for the Advanced Surface Movement Guidance and Control System (A-SMGCS)[9] and two screens that displayed Electronic Flight Progress Strips (EFPS)[10] (Figure 7). Transponding aircraft and vehicles were displayed on the A-SMGCS by a secondary return that showed their callsign. However, within the confines of a parking stand the A-SMGCS showed only primary radar returns, making it difficult to differentiate aircraft from ground vehicles or fixed objects. On the EFPS, each strip carried details for a particular aircraft and the controller used an interactive pen to control the strips. The left screen (Figure 7) showed all the aircraft that had been issued with ATC clearances or were under the authority of the Ground controller.

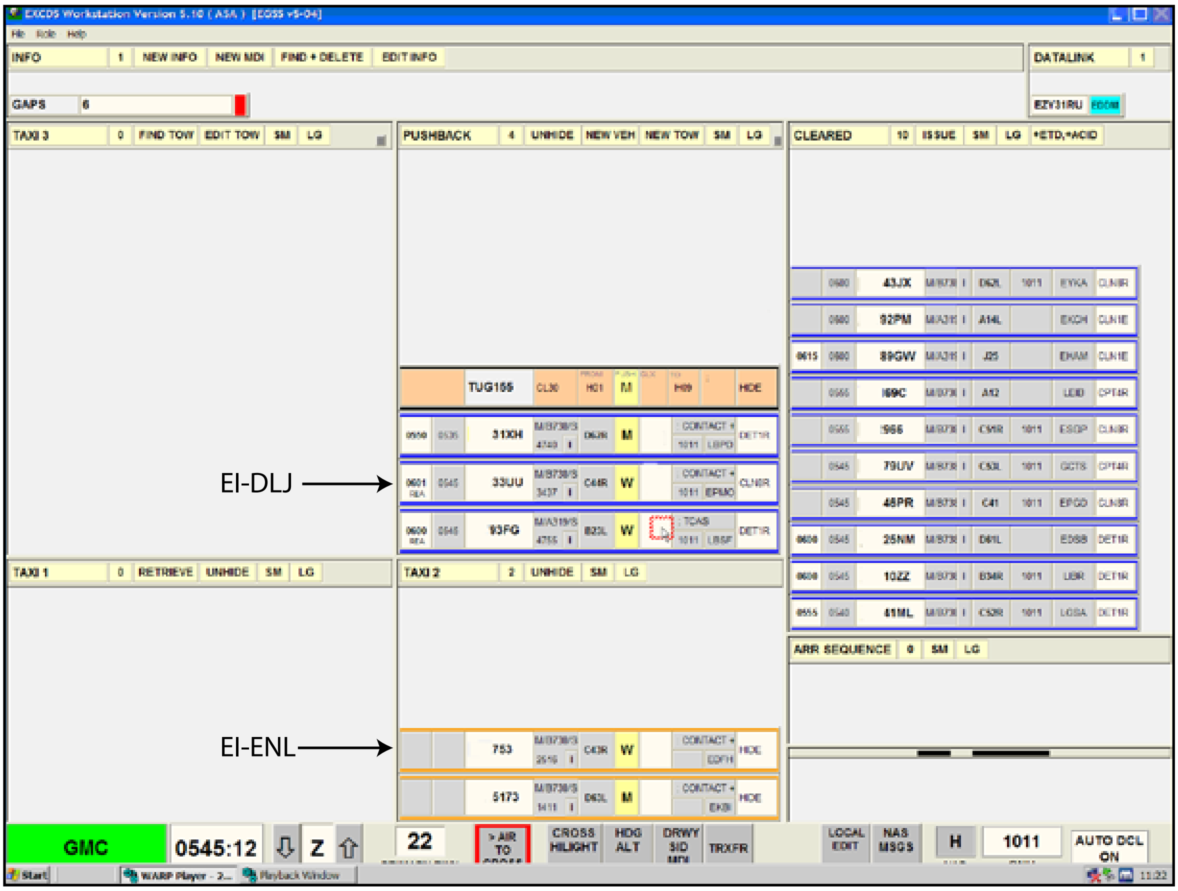


Figure 7

The left EFPS screen just before the collision (operators' identifiers removed)

When an aircraft requests push and start, the controller notes the aircraft's position and Calculated Takeoff Time (CTOT) from its progress strip. Before issuing his instructions the controller checks if there are any aircraft pushing or taxiing which could cause confliction. The interactive pen[11] is then used to move the strip from the 'Cleared' bay in the right column of the left EFPS screen into the 'Pushback' bay in the centre column.

Footnote

[9] A surface movement radar that incorporated transponder mode S information.
[10] A-SMGCS and EFPS are used at other UK ATC units and are not unique to London Stansted Airport.
[11] On Figure 7 the arrow inside a red box indicates the location of the interactive pen.

The controller's situational awareness relies on his integration of information gained by looking outside, by monitoring the A-SMGCS and by checking the EFPS. Figure 7 shows that as EI-ENL taxied in, its strip appeared along with that of one other aircraft in the 'Taxi 2[12]' bay of the left hand screen. The data on the strip included the radio callsign, the allocated stand (C43R) and a 'W' for the 'C West' line. Before EI-DLJ requested push and start, there were several progress strips in the 'Cleared' bay but only three other strips in the 'Pushback' bay. It was these three strips along with the two strips in the 'Taxi 2' bay that needed to be checked before EI-DLJ was given instructions. The right EFPS screen (not illustrated) showed the scheduled departures that had not yet been given a departure clearance. There was a steady stream of departure clearances to be given over the radio; the controller's workload was therefore almost continuous.

Shortly before EI-DLJ requested 'push and start', another operator's aircraft (in the 'B' cul-de-sac), had been given pushback instructions. This aircraft had the same scheduled departure time as EI-DLJ but had been allocated a CTOT that was one minute earlier. Because there was time to spare before the CTOT, the controller had offered this other aircraft the option to delay engine start until established on its taxi line. He told EI-DLJ to 'push and start' onto the 'C West' line and then made a separate transmission "IF YOU WANT TO DELAY YOUR START UNTIL YOU ARE ON THE LINE, THAT'S FINE." This offer was acknowledged by the co-pilot of EI-DLJ.

Automatic Dependent Surveillance Broadcast (ADS-B)

ADS-B technology allows the exchange of GPS-derived positional information using transponders. The integration of ADS-B with TCAS and EGPWS is currently at a development stage but it has the potential to warn pilots of impending collision with structures or other buildings when moving on the ground. ADS-B is likely to assist ATC through the creation of enhanced surface movement tools.

Ground controller

The Ground controller gained his validation in March 2012. He had a good night's rest and commented later that he felt alert and cheerful when he commenced his duty at 0455 hrs. He had worked the previous day from 0600 hrs until 1230 hrs but had been off the day before that. The traffic level on the Ground frequency had been busy but was below the level where he deemed it necessary for the Delivery position to be opened, for another person to provide the departure clearances on a separate frequency.

When EI-ENL began taxiing in, it followed an aircraft of a similar type which had been instructed to give way to an outbound aircraft routing through Taxiway C. All three aircraft belonged to the same operator, with EI-ENL's callsign ending 753, while the preceding one ended 5173. The controller's procedure when approving a pushback request was first to check the strips of incoming aircraft (in the 'Taxi 2' bay), but he considered it possible that, when EI-DLJ asked for pushback, he had confused EI-ENL with one of the other aircraft.

Footnote

12 Taxi 2 was the bay used to show all arriving aircraft that were under control of the Ground controller.

The controller did not see the collision and it was the radio call from Ranger 2 that alerted him to the accident. He saw the tails of the aircraft close together but had no CCTV facility in the VCR to assist him. After acknowledging the call from Ranger 2, he immediately used the dedicated landline to inform the RFFS, airport operations and the combined control centre of the event.

Airfield operations vehicle (Ranger 2)

An Airfield Operations vehicle, radio callsign “Ranger 2”, was following EI-ENL towards Stand 44R, to conduct a routine audit of the aircraft’s turnaround. The driver stated that he was in the vicinity of Stand 45R (on Taxiway J) when he heard a bang and saw debris and leaking fluid to the rear of EI-DLJ. He continued onto the ‘C West’ line and made the radio announcement that an AGI had occurred.

After parking his vehicle in front of EI-ENL, the driver tried to indicate to the pilots that they should shut down both engines. He did this by pointing at the right engine only and made a cutting motion with his other hand. He was unaware that the right engine had already been shut down during taxi-in and, as he did not perceive a response to his signal, he gained the impression that the pilots were ignoring his instruction. He then went over to EI-DLJ’s tug to assess the situation there before closing the ‘C’ cul-de-sac to any traffic that was not responding to the emergency.

EI-ENL crew actions and comments

Prior to the collision

This was the first flight of the day for the crew of EI-ENL. Both the commander and the co-pilot said they had good quality sleep and felt well rested at the start of their duty. They both heard and understood the instructions given to them by the Ground controller after they had landed. Stand 43R was not where they were used to parking when inbound from Hahn Airport, Germany, but they had been told to anticipate this stand and had checked the routing on their charts.

While taxiing along Taxiway J, the co-pilot completed the After Landing Checks and the pilots engaged in intermittent conversation about an aircraft they saw which was leased to their operator and about other airport activity. They later commented that this was one of the busiest airports on their current schedule and in their conversation they had remarked how efficiently the traffic was controlled there. The co-pilot shut down the right engine, just as EI-DLJ requested pushback. Although neither pilot was talking when the controller approved the pushback from Stand 44R, they did not discern that the controller’s instructions caused confliction.

Before they turned right into the ‘C’ cul-de-sac, the co-pilot noticed the B737 parked on Stand 44R but he did not see its red anti-collision beacon illuminated[13] or that it had a tug attached and was ready to push. He confirmed to the commander that they were

Footnote

[13] The co-pilot noted that anti-collision beacons on other aircraft are sometimes turned on before the aircraft is fully ready to push back.

turning on the correct taxi line and then transferred his attention towards Stand 43R. He saw that it was unobstructed and that ground crew were awaiting their arrival. It was then that he looked right and began to realise that the B737 on Stand 44R was pushing towards them.

He later observed that, because the aircraft on Stand 44R was not being pushed back at right angles to the taxi line[14], the perspective made it difficult for him to pick up relative movement of EI-DLJ against the pier behind it. He and the commander noted that, when there is no road behind the stand, the spacing between taxiing aircraft and parked aircraft can seem minimal and an aircraft being pushed back may quickly encroach the taxiway. With respect to ATC taxi instructions, they commented that once they received unconditional approval to taxi somewhere, their mindset was that the route would be clear. They likened it to a green traffic light but stressed that they were still vigilant for aircraft and vehicles which could cause conflict.

The collision

When the co-pilot told him to stop, the commander took evasive action by turning left away from the danger and braked sharply. The co-pilot saw the winglet hit the tail of the other aircraft but did not state what had happened. They both felt a small amount of movement as the two aircraft collided. After stopping and applying the park brake, they heard an emergency being declared over the radio. They realised they had collided with another aircraft but perceived the impact to be minor. There were no unusual cockpit indications so the commander and co-pilot took time to evaluate the situation. After two unsuccessful attempts to contact the Ground controller, the commander called the No 1 cabin crew, to ensure that the passengers remained seated. There was no discussion regarding the nature or whereabouts of any damage.

The cabin crew had sensed the aircraft braking sharply to a halt. The cabin crew at the rear of the aircraft heard a noise but the window in the right service door was misted-up so they unstrapped and looked out of a cabin window. They saw part of the winglet lying on the ground and some fluid under the tail of the other aircraft so they informed the No 1 crew member, who was at the front of the cabin. The No 1 crew member did not believe that the fluid was from EI-ENL and he had made a PA to reassure the passengers before the commander called him.

EI-ENL had stopped close to Stand 43R with the nose only marginally left of the 'W' line. The commander later said that because the impact had not been dramatic, he had deemed that an evacuation was not needed and his focus was on preventing panic by the passengers which might have led to injury. The commander later commented that the situation was akin to the routine scenario of having been halted just short of a stand and waiting for further instruction. This was not discussed with the co-pilot and the commander was not then aware of what damage there was.

Footnote

[14] See Figure 3 to view the angular difference between the lead-in line for Stand 44R and the 'C West' line.

One minute after the collision they saw a vehicle (Ranger 2) stop and the driver indicate that the right engine should be shut down[15]. As that engine had been shut down earlier, no action was taken but the co-pilot suggested starting the APU. The commander responded by asking if there was any fluid leaking and he was told that there was not. He was then informed (2.5 minutes after the collision), that the winglet had been cut off. There was no further exchange of information[16] about the damage although the commander did say "ok, we're stopped. what else can we do?" He later observed that it did not "feel" like an emergency situation and, with no QRH drill to be carried out, their attention became focussed on activity outside the aircraft.

In reviewing the accident, the pilots agreed that they could have worked better together to agree a course of action. They felt that initially their reactions were affected by the lack of build-up to the accident and the startling effect that it had on them. The operator had an easy-to-remember mnemonic (PIOSEE[17]) to aid crews in their decision-making process; they believed that they covered the elements of it but that they could have done so more efficiently. The commander felt there was no need for an evacuation, therefore his priority was to reassure the passengers and make sure they remained seated. Discussion with the cabin crew, to gain their perspective of the event and the possibility of any damage, took place six minutes after the collision. By this time the APU had been started and contact had been made with the RFFS on 121.6 MHz. The pilots later commented that the RFFS told them to standby for a damage assessment but that they were then left to wait for a long time. It was around 30 minutes later that EI-ENL was towed onto Stand 43R and those onboard disembarked normally.

Rules of the air

The UK Rules of the Air Regulations 2007 apply to all aircraft within the UK. Rule 42 refers to right of way on the ground and states at paragraph 2:

> *'Notwithstanding any air traffic control clearance it shall remain the duty of the commander of a flying machine to take all possible measures to ensure that his flying machine does not collide with any other aircraft or vehicle.'*

Paragraph 4 then states:

> *'Vehicles and flying machines which are not taking off or landing shall give way to vehicles towing aircraft.'*

Footnote

[15] Ranger 2 was unaware that the right engine had been stopped before the collision.
[16] The pilots recollected that the commander climbed across the console to see out of the co-pilot's window at some stage and that the co-pilot took a photograph that he showed to the commander. However, they thought that these actions took place later, after the left engine had been shut down.
[17] See *Operator's procedures.*

EI-DLJ crew actions

The crew of EI-DLJ had reported for duty at 0500 hrs, for a 0545 hrs departure to Warsaw. They were completing their pre-flight preparations and did not hear EI-ENL being given taxi instructions to Stand 43R.

When pushback commenced, neither pilot was aware of EI-ENL's position. After moving a few metres the headset operator indicated that they could commence engine start but the commander declined this option. They then felt a "thump" and the aircraft stopped suddenly. The commander later said that he did not regard it as a dramatic event and thought that it was a tug-related problem, until some of the electrics failed. The headset operator shouted to tell him they had hit another aircraft. When this was reinforced by the radio call from Ranger 2, the commander made a PA to reassure the cabin occupants. Soon after that he unlocked the cockpit door in order to converse directly with the cabin crew.

The front door emergency slides were disarmed and the airstairs were lowered but the commander kept the rear doors armed because he was told there was fluid on the ground. He believed that the fluid had stopped leaking and that it had come from the other aircraft. With no signs of fire he saw no need to evacuate the aircraft but he wanted the rear slides to be available if circumstances deteriorated[18]. The APU and the Inertial Reference Systems[19] were then turned off and when the fire service arrived on the scene, the commander monitored frequency 121.6 MHz.

The cabin crew, who were standing at the time, felt a bump when the aircraft collided but it was not of sufficient force to cause them to stumble. They noticed an electrical power disruption but that was not unusual. The passengers were kept onboard for approximately 45 minutes but none of them seemed to be alarmed, even though damage to the other aircraft was visible.

Pushback procedures

The Operator stipulated in its Operator's Manual (OM), that headset communications were obligatory for all pushbacks, except where there was a ground intercom malfunction[20].

With no headset available, standard ICAO hand signals were used to communicate with the pushback crew. At Stansted there was a need to augment these so the pushback crew would know which line the aircraft should push to. The local practice was to make a 'W', using the thumb and index fingers of both hands together to indicate the 'W' line. There was no such signal for the 'E' line or the 'M' line so the practice was to raise one finger to indicate the 'first' line, two fingers for the 'second' line or three fingers for the 'third'. These non-standard signals were not published anywhere for the benefit of pilots unfamiliar with the airport.

Footnote

[18] The disarming of the front emergency slides would have impaired the use of the right front door as an emergency-exit had an evacuation been later initiated.
[19] The Inertial Reference System alarm in the nosebay could be heard because the commander's side window was open. The alarm indicated that the aircraft was being powered by the batteries only.
[20] The OM omitted to mention that a headset might not be used when there was a lightning risk.

The Operator's Ground Operations Manual (GOM) stated that three ramp personnel, including a 'wingman', were required for all pushbacks and that they must be correctly positioned before pushback commenced. The manual indicated that local procedures could apply at certain airports but there was no indication that the 'wingman'[21] might be dispensed with at Stansted.

The OM Part A informed aircraft commanders that, whilst they retained full command during pushback, the headset operator[22] was in charge of the pushback manoeuvre and was responsible for the safety of the aircraft, the tug and any other people or objects in the immediate vicinity. This was supported in presentations used by the ground handling company to train pushback personnel. These presentations also stressed that a 'guide person' had to be in position before a pushback commenced. The headset operator was instructed to:

> *'ALWAYS make a visual check around the aircraft and taxiway to ensure the intended pushback path is clear before giving the "brakes released" signal'*

to the tug driver. If the headset failed, the headset operator was instructed to stand on the left side of the aircraft, in line of sight of the captain, and to remain in this position to ensure no break in communication.

The ground handling company required a radio to be fitted and working in the pushback tug and that a pushback could not take place:

> *'without communication between the ground control tower and the pushback tug.'*[23]

However, tug drivers did not know an aircraft's radio callsign, hence they could only try to listen to instructions when the relevant stand number was quoted. The aim of having drivers monitor the radio was to enable them to hear any conditions issued by ATC when pushback instructions were given.

The training material used by the ground handling company addressed the need for tug drivers to be aware of other aircraft and the position of the pushback aircraft's tail and wingtips. A recent risk assessment by the company indicated that headset operators should crouch down to look under the wings to check that the route is clear. There was a stated intention by the company to audit this process and to train tug drivers to query ATC pushback instructions if necessary. The company did not provide guidance about what their staff should do if a ground collision occurred.

The handling company reported that, since December 2012, a verbal agreement with the operator had allowed pushbacks from stands, with no roadway behind, to be conducted by

Footnote

[21] The ground handling company referred to the 'wingman' as the 'guide person', 'roadman' or 'back of stands road person'. Throughout the remainder of this report the term used is 'guide person'.
[22] The headset operator was referred to in the OM Part A as the 'ground Crew Chief'.
[23] The presumed intent of this statement was that the tug driver had to be able to hear ATC communications.

only two people. Consequently the guide person had been dispensed with for Stand 44R and for several other stands. The operator stated that no such agreement had been made.

After the accident, pushback trials were conducted on Stand 44R using a guide person positioned to the right and rear of an aircraft. It was concluded that the geometry of this stand (Figure 3) meant the tug driver tended to lose sight of the guide person when the nose of the aircraft was moved left. To stay in sight of the tug driver, the guide person would have to move towards the front of the aircraft as the pushback proceeded.

The pushback team

The pushback team consisted of the tug driver and the headset operator. They reported to their team leader who was responsible for dispatching the aircraft but did not assist with the pushback. The team leader normally supplied the headset for use during a pushback but this team leader's headset had been taken away seven months previously as it was required for training purposes. He stated that he had been unable to obtain a replacement from the ground handling company.

The team leader normally goes to the next aircraft when a pushback commences. On this occasion, however, he was about to have a break, so he remained in his vehicle adjacent to the stand. He saw the other taxiing B737 (EI-ENL) and when it turned he realised there could be a collision. He saw the headset operator raise his arms and thought that he was signalling an emergency stop but the signal to the pilot was for clearance to start the left engine. The team leader pressed the horn of his car but failed to attract the attention of his team members and he witnessed the ensuing collision. He then ran to an emergency phone and asked for RFFS attendance. Airfield Operations and RFFS vehicles arrived promptly but he noted that the other aircraft kept an engine running for four or five minutes.

The tug driver had started work at 0430 hrs and this was his second pushback of the day. He had worked an early shift the previous day but for the three preceding days he had been on a late shift. He found the transition from late shifts to early shifts difficult. He would normally be in the tug to listen out for mention of the relevant stand number on the radio so that he could hear the instructions that were given. However, prior to this pushback he had been busy preparing the aircraft and he was not in the tug when ATC gave the pushback instruction. This was not unusual as he often had to load last minute baggage. He had been trained to be vigilant before starting a pushback and it was his expectation that it was safe to pushback an aircraft once ATC had issued a "clearance".

When the anti-collision light on EI-DLJ came on, the pilot signalled 'W' to the headset operator and held up one finger to indicate the first taxiway. The tug driver looked left and saw an aircraft on Taxiway J but he later commented that he thought it was going too quickly to turn into the 'C' cul-de-sac. Due to the angle of the stand centreline he had to turn the tug right initially, to manoeuvre the tail of the aircraft towards the 'C West' line. He lost sight of the other aircraft at this point and did not see it again until it emerged to the right of EI-DLJ's tail. He rapidly applied his brakes but at the same time he felt the aircraft rock in reaction to the collision. The collision sent him into a state of shock such that he did not know what to do.

The headset operator had worked the same shift pattern as the tug driver. He stated that he conducted one or two pushbacks each week without a headset and that at the start of the pushback he was blind to the left side of the aircraft. He first saw the nose of the other B737 when it went past the tail of his aircraft, just before the collision. After EI-DLJ stopped, he remained in position. He could see oil and debris at the rear of his aircraft. His team leader re-appeared and they waited for assistance to arrive.

The trials conducted after the accident indicated that, even if there had been a guide person stationed to the rear of the aircraft on the right side, they would probably have been unsighted from the other two members of the pushback team and would have been unable to communicate visually with them in the event of an emergency.

Operator's procedures

The OM Part A instructed pilots to wear radio headsets from the start of pushback until the top of climb and from top of descent until engine shutdown on stand. During these periods a 'Sterile Cockpit' procedure was to be followed, with conversation restricted to matters directly relating to the safe operation of the aircraft, to allow both pilots to give maximum attention to the ATC frequency.

The Standard Operating Procedures (SOP) manual stated that the commander was always to be the Pilot Flying (PF) during ground operations and he was responsible for ground taxiing. The Flight Crew Operating Manual (FCOM) Vol 1 noted that the Pilot Monitoring (PM) was to monitor taxiing and the OM Part A stated that 10 kt was the maximum permitted taxi speed when turning through 45º or greater.

The Operator's SOP was to shut down the right engine before parking on stand. This was a standard fuel-saving practice and was subject to the pilots' familiarity with the airport and the complexity of the taxi procedures. The memo which explained this procedure stated that during engine-out taxi procedures, the crew's attention should be focussed on taxiing the aircraft and that sterile cockpit procedures must be observed during this critical phase.

Decision making

Many operators train their crews to use a particular mnemonic as an aid to their decision-making processes when they encounter difficult or unusual situations. The mnemonic advocated by this operator was P.I.O.S.E.E.: P - Problem (define the problem); I - Information (gather information); O - Options (identify options); S - Select (select the most appropriate option); E - Execute (implement the selected option) and E - Evaluate (establish if the problem has been solved). The Operator noted in its training material that:

> *'Unexpected events can impose a "startle factor" which may impose significantly in the decision making process. Unannunciated problems may not be identified as such and a P.I.O.S.E.E. process may not be carried out because the problem is subtle.'*

Interaction between flight deck and cabin crew during ground incidents

Both the OM Part A and the Safety and Emergency Procedures (SEP) manual provided guidance to crew regarding communication in the event of an incident in the cabin while taxiing. Cabin crew (normally the No 1), were instructed that if they needed to contact the flight crew urgently, because of an incident in the cabin, they should do so via the interphone. They were also instructed to report all '*abnormal incidents*' to the flight crew immediately.

The reference in OM Part A to the initiation by the flight crew of emergency communications with the cabin, came under the heading of '*Emergencies in Flight'*. Pilots were to make the PA call '*No 1 to the flight deck immediately.*' and the No 1 cabin crew was to respond by proceeding immediately to the cabin interphone and await a call from the flight deck. However, the SEP manual stated the No 1 was to go to the interphone and call the flight deck, saying *'Cabin to flight deck, No 1 standing by*'. The SEP manual also stated that if this call was given on the ground, both the No 1 and the No 2 should pick up an interphone and report that they were standing by. They would then expect to be given a NITS[24] briefing.

The OM did not specify any other drills relating to an aircraft which stopped unexpectedly while taxiing or being pushed back. In the event of a rejected take off, however, the SEP manual stated that once the aircraft had come to a complete halt or had taxied clear of the runway, the No 1 cabin crew member should make a specific PA before calling the commander on the interphone and saying *'Cabin to flight deck, No 1 standing by*'.

Analysis

During the investigation it became clear that the crews of both aircraft followed the instructions and taxi routes given to them by the Ground controller.

Air Traffic Control

The potential for a collision was created when the Ground controller inadvertently gave approval for EI-DLJ to push back from Stand 44R onto the 'C West' line, before the inbound taxiing aircraft, EI-ENL, had passed behind and parked on the adjacent stand.

When the crew of EI-DLJ requested pushback, the Ground controller did not check EI-ENL's progress strip on the EFPS, showing that EI-ENL was taxiing to Stand 43R. This may have been because the controller was confused by some callsign similarity between EI-ENL and another aircraft. Lack of monitoring of the Ground controller's actions and the inability of the EFPS to generate an alert when two aircraft are instructed to use the same portion of taxiway were contributory factors.

Footnote

[24] The NITS acronym is commonly used for communications between flight and cabin crew in emergency situations. The N stands for Nature of the emergency, the I for Intention, T for Time available and S for Special instructions.

The Ground controller can monitor aircraft movements visually but, in this case, his view of Stand 44R was obscured by an intervening pier and there was no CCTV available within the confines of the stand to assist. The A-SMGCS is a useful tool for the controller but only displays primary radar returns in parking areas, making it difficult to differentiate aircraft from ground vehicles and fixed objects.

The inbound aircraft

Rule 42 of the Rules of the Air places responsibility for preventing collision on the ground with the aircraft commander, irrespective of air traffic instructions. In this instance, with increased situational awareness, the crew of the EI-ENL might have prevented the collision if they had picked out the approval of EI-DLJ's pushback on the radio or if they had spotted that EI-DLJ was starting to move as they began to turn into the cul-de-sac. However, once the turn was underway, the geometry of the stands and the perspective view from their moving aircraft made it difficult for this crew to perceive the movement of EI-DLJ. Review of the flight data showed that the inbound aircraft was taxiing at approximately 10 kt at the time of the collision which was the maximum permitted speed for that part of the route.

After landing, the flight crew of EI-ENL did not adhere with the operator's 'Sterile Cockpit' policy. However, they were not conversing at the time pushback instructions were given to EI-DLJ and were in a position to identify the conflicting instructions given by the Ground controller. There was no clear reason why the crew did not identify the confliction but they did later observe that Stansted was busier than other airports on their schedule.

The pushback team

The effectiveness of the pushback team appears to have been limited in two principal areas. One was that the headset operator did not have a headset available, and thus needed to use hand signals to communicate with the pilots in EI-DLJ. If a headset had been used for the pushback of EI-DLJ, the headset operator would have been on the right side of that aircraft and the non-standard hand signals would not have been required. From this position he might have spotted EI-ENL's turn in time to halt EI-DLJ within the confines of its stand. Standing on the left side of the aircraft, he could only have seen EI-ENL's turn by regularly crouching down to look underneath the hull of EI-DLJ.

The other principal limitation was that the pushback team did not include a guide person. The exclusion of such a guide person had been the standard procedure at Stansted, for stands with no roadway, since December 2012. The ground handling company stated that a verbal agreement to this effect had been made with the operator but the operator disagreed. Trials conducted after the collision indicated that, had there been a guide person stationed to the rear of the aircraft on the right side, they may have been out of the line of sight of the other two members of the pushback team and unable to communicate visually with them.

It is possible that the tug driver and headset operator were suffering some effects of tiredness due to their recent transition from a late to an early shift pattern.

After the collision

The crews of both aircraft realised almost immediately that there had been a collision and the ground vehicle, Ranger 2, made a prompt radio declaration of an AGI. The airport's RFFS reacted in an appropriate and timely manner to reach the scene of the collision. A period of seven minutes then elapsed until the 'incident' was upgraded to 'accident' status.

In EI-ENL, the inbound aircraft, the commander did not seek information from the cabin crew about damage caused in the collision. He considered there was no need for an immediate evacuation and his priority was to reassure the passengers and ensure they remained seated. There was no QRH drill covering the situation and the pilots did not engage in a sustained dialogue to analyse the situation and assess their options; they did not make best use of the mnemonic P.I.O.S.E.E. to assist them in their thought processes. In reviewing the accident, the commander and co-pilot both commented that they were startled by the collision, as there had not been any build-up to the accident that might have prepared them for coping with its aftermath. This also appears to have led the crew to delay shutting down the left engine until they had started the APU, not appreciating at that stage that the idling left engine could be a hazard to personnel attending the incident.

In EI-DLJ, the aircraft that pushed back, the commander was aware there was spilled fluid at the rear of the aircraft but, with no sign of fire, an evacuation was not needed. However, when the forward door emergency evacuation slides were disarmed to allow deployment of the integral airstairs, the slides on the rear doors remained armed for around 45 minutes, until passengers disembarked.

Safety actions

As a result of this accident, a number of organisations have taken safety actions:

The operator

The operator decided to introduce a "Cabin Crew Standby" call, to be used when flight crew become aware of something of concern on the ground that is not immediately life-threatening. The use of this call will alert the cabin crew to the fact that the flight crew are dealing with an unusual situation and that an evacuation may become necessary.

Pilot training for ground incidents has been enhanced and an event of this nature was included in the Winter 2014-15 recurrent simulator training scenario.

The OM has been changed to indicate that hand signals, for pushback, are only to be used if the headset breaks immediately prior to pushback or when thunderstorms or lightning are forecast.

The OM now refers to the ground personnel involved in a pushback manoeuvre as the Headset Operator, the Tug Driver and the Guide Person. The operator is committed to pass this information to the ground handling companies which it employs.

Air Traffic Control

NATS (National Air Traffic Services) Stansted conducted a unit investigation and the controller involved received further training before returning to normal duties.

The report produced by NATS Stansted recommended that development of EFPS should be explored, to find out if it could highlight when more than one aircraft has been given an instruction to use the same cul-de-sac taxi line. This idea has since been incorporated into a nationwide project to evaluate surface management tools at UK airports. NATS is reviewing available technology, and methods for monitoring and checking the instructions given by Ground controllers, with the aim of quickly resolving any errors that are made. The project encompasses the control of aircraft pushbacks and the extra difficulties that exist when there is no headset communication between the flight crew and the ground team. Consideration is being given to the concept of having "Standard Pushback" procedures for each stand and to the idea of passing radio instructions for pushback directly to the tug driver. The project aims to identify an enhanced surface management tool which will provide conflict resolution and for this to be trialled at a major UK airport.

NATS Stansted has now mandated that the Delivery position be opened at 0530 hrs at weekends as well as on weekdays, subject to periodic review and a proviso regarding traffic levels.

A range of local initiatives have been put in place to highlight the lessons from this accident to controllers and to try to ensure that ATC and the ground handling companies have a common understanding of how pushback manoeuvres should take place.

The regulator (Civil Aviation Authority)

The Ground Handling Operational Safety Team (GHOST) is a multi-disciplined CAA and industry group that is set up to address and share lessons that arise from ground handling issues. At a meeting in October 2014, the team acknowledged the need for better standardisation of pushback procedures and terminology and for tug drivers to receive thorough RTF training and to be made aware of the callsign of the aircraft that they are to push back.

The Ground Handling Company

Following the accident the ground handling company changed its procedures to ensure that a guide person is employed for all pushbacks at London Stansted Airport. The guide person is to be on the opposite side of the aircraft from the headset operator, who is to remain in view of the tug driver.

The company issued an '*Airside Notice*' which emphasised the requirement for headsets to be used at all times (unless lightning is forecast). However, the shift manager may provide specific approval for a single pushback operation to take place following failure of a headset.

The same '*Airside Notice*' stated that the tug driver should be in the tug and listen to the radio from five minutes before the expected pushback time. Since the notice was issued, the company has concluded that this practice may be difficult to implement at all times and it is under review.

The company intends to ensure that pushback team members are trained on the actions to take in the event of a ground collision.

ACCIDENT

Aircraft Type and Registration:	Cessna F150l, G-YIII
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1972 (Serial no: 827)
Date & Time (UTC):	14 June 2014 at approx 1225 hrs
Location:	Near Hucknall Airfield, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers – 1 (Fatal)
Nature of Damage:	Aircraft Destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	293 hours (of which 240 were on type) Last 90 days - 4 hours 30 minutes Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft failed to reach normal circuit height after takeoff probably because of a partial loss of engine power. The aircraft continued flight at low altitude and airspeed before stalling, and an incipient spin entry resulted in the aircraft striking the ground vertically nose-down.

History of the flight

Both the pilot and passenger (who also held a PPL) had arrived at Hucknall Airfield in the morning. Separately they had met and spoken with other club members and it was reported that there was nothing unusual in their behaviour.

The accident pilot had initially gone to the club hangars, located on the north side of the airfield, to collect G-YIII. The chief flying instructor saw him conducting the daily 'Check A' with reference to a check list before taxiing the aircraft to the clubhouse located on the south side of the aerodrome.

Another pilot (Pilot B) took over the aircraft after having conducted a pre-flight inspection. He later informed the AAIB that he had not visually checked the fuel contents before his flights because: he was certain the accident pilot would have done so as part of the 'Check A', the aircraft were "always" refuelled before being put in the hangar and the fuel gauges were indicating full when he started his set of flights.

Pilot B then flew two separate flights of solo circuit training lasting 50 and 35 minutes respectively. He reported that the aircraft had no defects and had performed normally throughout these flights.

Immediately before the accident flight the chief flying instructor, who was talking to the passenger outside the club buildings, noted that the accident pilot was conducting a pre-flight inspection. The pilot and passenger then boarded the aircraft. The air-ground radio operator noted the off-blocks[1] time as 1215 hrs and watched the aircraft take off, apparently normally. He then immediately turned his attention to other aircraft and was later uncertain if G-YIII had completed a circuit. He was expecting a downwind radio call to be the next communication from G-YIII and, when no call was received, began to be concerned. He was visually scanning the circuit pattern when he received a radio call from a local Air Ambulance helicopter reporting that it was responding to an aircraft accident near the aerodrome.

Eyewitnesses

At 1225 hrs several eyewitnesses, primarily located in vehicles on the M1 motorway, contacted the emergency services reporting an aircraft accident. The eyewitnesses were later interviewed and their reports were broadly similar with none being significantly contradictory. The condensed eyewitness statements included below are representative.

Eyewitness A was on a footpath in a field to the west of Hucknall Airfield near the end of the disused concrete runway. Initially he saw the aircraft very low, tracking from his left to right towards the south. The engine noise was constant and did not sound unusual to him. The aircraft appeared to be gaining height gradually but when it was to the south of him it commenced a left turn which progressed through 360° while the aircraft descended. The aircraft then pitched down and continued nose first into the ground.

Eyewitness B and C were outside farm buildings to the west of the M1 motorway. Eyewitness B had some experience of single engine piston aircraft as a passenger and thought the aircraft engine sounded "weak, as if there was no power". B and C then saw the aircraft low to the east and believing it was in distress and likely to crash ran to cross the motorway via a farm access bridge. When they reached the crest of the bridge, a distance of about 280 m from their original location, the aircraft was still airborne, low and to the east of them, before it disappeared from view. They assumed the aircraft had crashed and commenced a search for the accident site, arriving shortly after eyewitness D.

Eyewitness D was on the motorway bridge later crossed by Eyewitness B and C. He saw the aircraft and heard the engine noise which he described as normal throughout. The aircraft was initially heading towards him before turning through 360° to the left. He then lost sight of the aircraft before hearing an "odd" noise at the same time as the engine noise stopped. He assumed the aircraft had crashed and ran to the scene of the accident. He arrived within minutes of the crash and with other witnesses attempted to render first

Footnote

[1] Indicating the time at which the aircraft first moved under its own power.

aid to the occupants, but it was obvious that both occupants had sustained fatal injuries. Having alerted the emergency services, and noting a strong smell of fuel combined with electrical noises from the aircraft, they withdrew a short distance to await professional assistance.

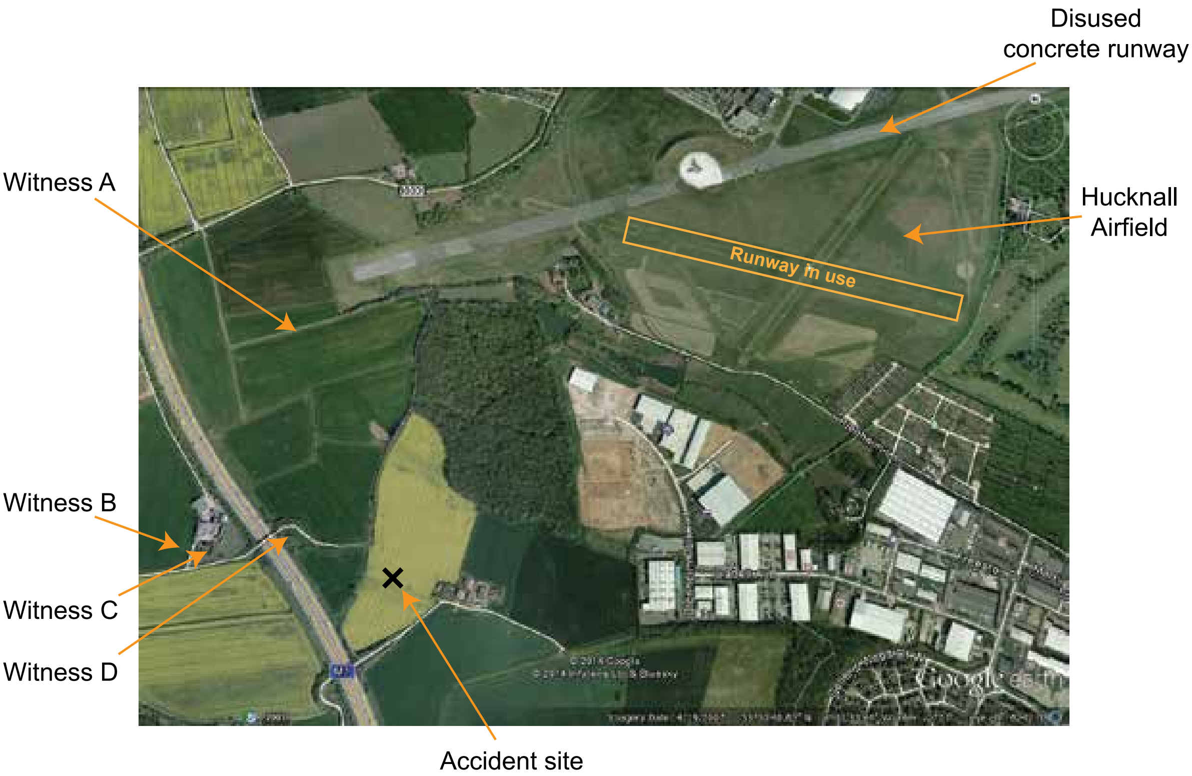


Figure 1
Overview map

Aircraft height estimation

In an attempt to refine the height estimates, Eyewitness A and B were interviewed in the locations from which they had seen the aircraft. They were provided with an electronic tablet device with a camera, screen and geo-referenced aiming mark, and asked to place the crosshairs where they recalled seeing the aircraft at various points during its flight. (Figure 2 is an example of the presentation). Estimates of the aircraft height were then made using trigonometry. The aircraft height of the aircraft as first seen by these witnesses was calculated to be about 100 ft.

Recorded data

No electronic devices that recorded useful information were found at the accident site. Radar recordings were examined but did not show any secondary radar activity related to this aircraft. A contact was detected by the East Midlands Airport primary radar flying a left hand circuit from Runway 29 between 1219:20 hrs and 1222:50 hrs. However, this was of a complete circuit and no radar recordings of a flight between Runway 29 and the accident site were found.

Figure 2

Exemplar of witness height estimation imagery.
The aircraft track was reported as from left to right in this image

The lack of a recorded primary radar track associated with a flight path between the runway and the accident site indicated that the aircraft was flying at an altitude below the line-of-sight (LOS) capability of the radar, or with a ground speed slow enough to be rejected by the ground radar as clutter (approximately 50 kt). The LOS limit due to terrain in the area between the runway and the accident site is approximately 300 ft agl.

Video

A vehicle on the southbound M1 was equipped with a forward facing video camera. The camera captured part of the accident sequence and the driver of the vehicle provided this to the AAIB via Nottinghamshire Police. It showed the aircraft initially in flight to the west of the motorway. The aircraft could be seen flying generally straight for around eight seconds before it commenced a left turn. The aircraft appeared to have turned through approximately 90° before rolling sharply to the left and entering a vertical rotating descent. The aircraft passed out of sight behind the motorway embankment having completed about 360° of rotation.

Analysis of the video indicated that the aircraft was approximately 100 ft above the ground when it first appeared on the video recording and peaked in the climb at a height of approximately 200 ft. The video recording was of insufficient quality for a more accurate analysis. The estimated flight path of the aircraft indicated by the video is given in Figure 3.

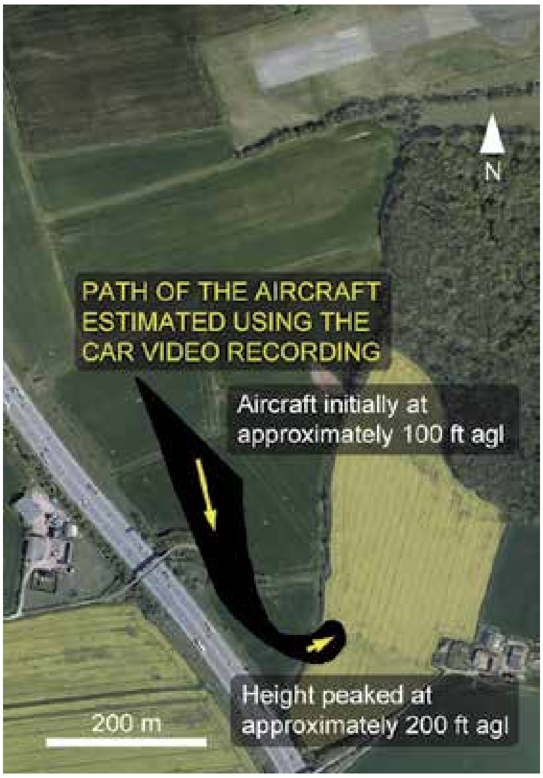


Figure 3

Path of the aircraft estimated from analysis of the car video recording

Pilot information

The accident pilot had commenced flying training in 2001 and all his flying had been based at Hucknall Airfield. He held a JAA PPL(A) valid until Sept 2016. His single engine piston (SEP) aircraft rating was valid until 5 September 2014 and his most recent biennial flight review was conducted on 30 June 2012. He had completed 35 minutes of circuits with an instructor on 5 April 2014 as part of a biennial flight review but the weather had precluded completing this exercise. He held a Class 2 medical certificate valid until 6 September 2014

The pilot and passenger had flown together nine times in the previous 12 months.

Passenger

The passenger was an experienced pilot with a UK PPL(A) first issued in 1974. He held a current EASA PPL (A) issued on 19 December 2013 with an SEP rating valid until 31 March 2016.

He held a Class 2 medical certificate valid until 30 January 2015. His latest logbook indicated a total of 758 hrs flying experience. His recent flying had been mainly on a Robin 221 aircraft and he last flew the accident aircraft on 21 December 2013.

Weather

The UK Met Office provided details of locally recorded weather and an aftercast for the surrounding area. At 1200 hrs a weather station at Watnall (about 1.5 km west of the accident site) recorded visibility of 10 km, wind from 330° at 7 kt, temperature 19.5° C and dewpoint 15.3° C. The cloud was reported as scattered at 1,600 ft and broken at 4,900 ft.

Other pilots operating locally reported that the wind was northerly at 5 to 10 kt. The sky was overcast at a height of between 1,100 ft and 1,500 ft. The wind had mainly favoured Runway 04 during the morning but had changed to favour Runway 29 before the accident flight departed.

Airfield information

Hucknall has two intersecting grass runways to the south of a large disused concrete runway. Runway 29 has a declared length of 776 m and ends at the edge of the concrete runway. An air-ground radio service was provided from a glazed structure on the roof of the clubhouse.

Pathology

Post-mortem examinations were conducted by a forensic pathologist and his report was reviewed for the AAIB by a specialist aviation pathologist. He reported that both occupants had received broadly similar injuries, the crash forces were beyond the range of human tolerance. No additional or alternative safety equipment would have been likely to affect the fatal outcome of the accident.

The aviation pathologist provided the following summary:

> *'No medical or toxicological factors have been found which could have had a bearing on the cause of this accident.'*

Fuel

Airfield refuelling records show that G-YIII was last refuelled with 58 l of Avgas on 8 June 2014 by the pilot involved in this accident.

Aircraft weight and balance

The Owner's Manual for G-YIII was provided by the operator. The aircraft basic weight was noted as 1,151 lb, maximum takeoff weight (MTOW) 1,600 lb and the maximum fuel weight 135 lb.

The aircraft had operated in the circuit for at least 90 minutes since being fully refuelled, and based on information published by the manufacturer was assumed to have about 65 lbs of fuel remaining. The pilot and passenger had a combined weight of approximately 340 lbs and no items of significant mass, such as flight bags, were being carried. Therefore the weight of the aircraft on takeoff for the accident flight was calculated to be approximately 1,556 lb.

CAA change sheet 1 issued February 1993 was incorporated in the Owner's Manual and noted a performance decrement for the aircraft to increase the takeoff distance required by 15% and decrease the scheduled rate of climb by 160 ft/min.

This information indicated that at MTOW, at an ambient temperature of 20°C, G-YIII should have been capable of sustaining a 500 ft/min rate of climb.

Engineering

Initial examination

The aircraft came to rest in a crop field approximately six metres from a line of overhead cables in a near vertical attitude, (Figure 4). It was resting on its nose and there was no evidence that it had made contact with the ground prior to this point.

Figure 4
Accident site on AAIB arrival

The aircraft had experienced significant compression of the forward fuselage which forced the engine upward, breaking the lower engine mounts. Both wing leading edges were compressed and both fuel tanks had ruptured. Approximately five litres of fuel were recovered from each fuel tank. The extent of the leading edge compression was more pronounced on the left wing, and the rear fuselage had been bent to the right during the impact sequence. One propeller blade was bent backward under the engine, the remaining blade was unbent. There was no evidence of leading edge damage or chordwise scoring or witness marks on either propeller blade.

The continuity of all of the flying control circuits was confirmed, with the exception of one of the left aileron control cables, which had failed. The pre-impact position of the engine controls could not be determined. The emergency services confirmed that when they reached the accident site both occupants had been wearing seat belts, the mounting points for which had failed.

Aircraft records

Examination of the aircraft records indicated that its maintenance complied with current requirements. They showed that the engine had been overhauled in October 2011 and had operated for 719 hours since overhaul. A compression check was carried out in November 2013 with no defects recorded.

Carburettor heat

In order to provide protection against carburettor icing, the aircraft type is fitted with a carburettor heating system. The cockpit CARB HEAT selector is connected to a rotating flat plate valve in the air intake by a cable and lever arm. When the selector is moved to the ON or HOT position, the cable pulls the lever arm rearward, rotating the valve forward, preventing cold air from entering the carburettor and allowing air heated by the exhaust manifold to flow into the carburettor to melt any ice present.

Detailed examination

Examination of the fracture surface of the failed aileron control cable indicated that the cable had failed in overload and that there was no evidence of progressive failure of the cable. There was no evidence of a pre-impact restriction within the control circuits.

Analysis of the fuel recovered from both fuel tanks confirmed that it met the specification for AVGAS and no evidence of contamination was found. The engine fuel filter was full of fuel and free from contamination.

Due to mechanical damage the engine, carburettor and magnetos could not be operationally tested. The magnetos were therefore disassembled. There was no evidence of corrosion within the units and no defects were identified which would have prevented their normal operation.

The carburettor was removed from the engine and disassembled. No evidence of pre-impact contamination or restriction of the air intake filter was found. The carburettor air intake body had been deformed during the impact, clamping the carburettor heat valve in the COLD or OFF position. The carburettor acceleration pump was found to operate normally and fuel was present in the carburettor bowl. No pre-impact defects were identified which would have prevented the carburettor from operating normally.

After removing the ignition plugs, the engine could be rotated freely and the accessory drive train functioned correctly. A compression check confirmed that the number one cylinder had low compression compared to the number two and three cylinders, and the number four cylinder had no compression. Inspection confirmed that the lack of compression was due to impact related damage.

ATSB report

The Australian Transport Safety Bureau (ATSB) conducted a review of events involving partial power loss on takeoff over a ten year period[2]. Of 242 events considered, 9 resulted in fatalities compared to no fatalities following total power loss in the same period. The ATSB commented that:

> *'15 of the 242 occurrences resulted in a loss of control. More than half of these loss of control accidents resulted in fatalities.'*

And:

> *'the initial actions taken by the pilot do not necessarily affect the final outcome – what is more important is that the primary focus be on maintaining airspeed to prevent stalling.'*

Analysis

The pilot held the appropriate licence and medical certificate, and was in recent flying practice and in good health. The passenger was not required to hold any licence but also held the correct licence and medical certificate to operate the accident aircraft.

There was nothing unusual in the pre-flight activities. Accident damage meant that it was impossible to be certain of the fuel state, but the fuel on the accident site, the refuelling records and time operated indicated that, probably, sufficient fuel remained to conduct the flight safely.

When the aircraft became airborne there was nothing to attract the continued attention of witnesses on the airfield, suggesting that at this stage the flight was proceeding normally. The departure was sufficiently routine that witnesses were not certain if the aircraft had completed a circuit or not.

The first evidence of anything unusual was the sighting by Witness A of the aircraft flying low, approximately 100 ft agl, tracking south from the area of the disused concrete runway. This approximate height and track was independently confirmed by car camera footage and other witness statements.

There was no reason for the aircraft to be in this location during normal flight operations and nothing to suggest that either the pilot or passenger would deliberately choose to operate the aircraft in this way. In the absence of deliberate action it is likely the aircraft was at this height because of a performance issue.

The aircraft weight at the time of the accident was slightly below its MTOW; even at MTOW the aircraft should have been capable of climbing at approximately 500 ft/min. The airframe was found to be complete at the accident site and the flaps were up. There was no evidence

Footnote

[2] http://www.atsb.gov.au/publications/2010/avoidable-3-ar-2010-055.aspx

of a pre-impact restriction or defect within the flying control circuits and no other airframe defect which could have had a significantly detrimental effect on aircraft performance.

The lack of rotational damage to the propeller was consistent with the engine operating at low power at impact. Although damage prevented testing, no evidence was found of a pre-impact defect within the engine or its fuel and ignition systems which would result in abnormal engine operation.

The environment was conducive to the formation of carburettor icing at low and moderate power settings. The position of the carburettor heat valve in the damaged air intake indicated that the carburettor heat system was in the OFF or COLD position during the impact sequence. Carburettor icing would affect the performance of the engine, reducing the available power and causing rough running. Carburettor icing could have formed after power checks and before departure. Carburettor icing may be more likely when operating from damp grass and there is some evidence that, while the grass was not wet it may have been damp. Eyewitness A and D reported the engine noise as constant, which is not entirely consistent with carburettor icing having formed.

No single reason was identified for the aircraft not performing in the expected manner, but insufficient power was available to climb away from the ground or operate at a safe speed.

The suggested action following an engine failure on take off is to land within 30° left or right of the aircraft heading. This course of action is most obviously indicated when an engine failure is total, but more complex for the pilot to determine when the engine continues to run but is not developing full power. Witness B described the engine as running but sounding as if it was developing no power. Witness A reported that the aircraft was climbing, but slowly.

The final manoeuvre described by the witnesses and seen on the video is a stall and wing-drop entry into an incipient spin. This loss of control at low height gave no prospect for recovery and the evidence from the accident site indicated that the aircraft struck the ground in a steep nose-down attitude while rotating to the left.

Whereas a forced landing may result in aircraft damage or injury, a stall and spin at low height frequently results in a vertical impact and fatal injuries. Maintaining flying speed in the event of power loss enables the pilot to maintain control of the aircraft, even if this results in a forced landing on a suboptimal surface. Several AAIB investigations indicate that loss of flying speed leading to a stall and spin at low height will result in fatal injuries.

Conclusion

The aircraft stalled and entered an incipient spin, probably following a partial loss of engine power the cause of which could not be determined.

ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BNDE	
No & Type of Engines:	1 Lycoming O-235-L2C piston engine	
Year of Manufacture:	1979 (Serial No: 38-79A0363)	
Date & Time (UTC):	20 August 2014 at 1834 hrs	
Location:	Near Padbury, Buckinghamshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Fatal)	Passengers - N/A
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	3,027 hours (of which more than 80 hrs were on type) Last 90 days - 28 hours Last 28 days - 13 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft was flying in the vicinity of the town of Buckingham when it entered a spin from which it did not recover. The pilot sustained fatal injuries in the impact.

History of the flight

Background

The pilot had leased the aircraft, a Piper PA-38 Tomahawk, G-BNDE, for a period of three months, commencing in early June 2014. He kept the aircraft at Elstree Aerodrome and flew it regularly on local flights, landing away at a number of different airfields. Global Positioning System (GPS) data later showed that on some flights he would fly directly to the destination whereas on others he would spend additional time en-route, flying around an area. Since the lease had started he had flown approximately 20 hours in this aircraft.

Flights on 20 August

At 0933 hrs on 20 August 2014 the pilot departed in G-BNDE from Elstree on a flight to Turweston Aerodrome, where he landed at 1126 hrs. He spent about half an hour on the ground there, during which he spoke with several acquaintances and refuelled the aircraft with 40 litres of Avgas (10.5 USG). At 1156 hrs he departed and flew in a southerly direction, landing at White Waltham at approximately 1300 hrs.

The pilot spent some time at White Waltham and then 'booked out' in the airport office for a flight to Elstree. The time of departure shown on the booking-out sheet was 1800 hrs local (1700 hrs UTC). However, at 1655 hrs, just before he left, he made a telephone call to 'Elstree Tower' to advise them that he would not be returning with the aircraft that day.

The pilot went out to the aircraft and tried to start it but discovered that the battery was flat. He returned to the airport office to seek assistance, advising them he had left the Master switch ON and the battery was flat. A locally-based maintenance organisation were able to assist him and used a battery booster starting aid to start the aircraft. The pilot, in conversation, asked the maintenance personnel how long they thought it might take for the battery to charge. They replied that, typically, after about an hour of flight time the battery would be fine.

The pilot took off from White Waltham at 1708 hrs and headed in a northerly direction. South of Buckingham he started flying in an approximately circular pattern with a 2 nm to 3 nm radius and continued for almost an hour, remaining between 2,500 ft and 4,700 ft amsl (the base of controlled Class A airspace in the area is 5,500 ft amsl). During this time the pilot made a number of calls on his mobile telephone. A plot of the track of the aircraft, from White Waltham to Buckingham, is shown in Figure 1.

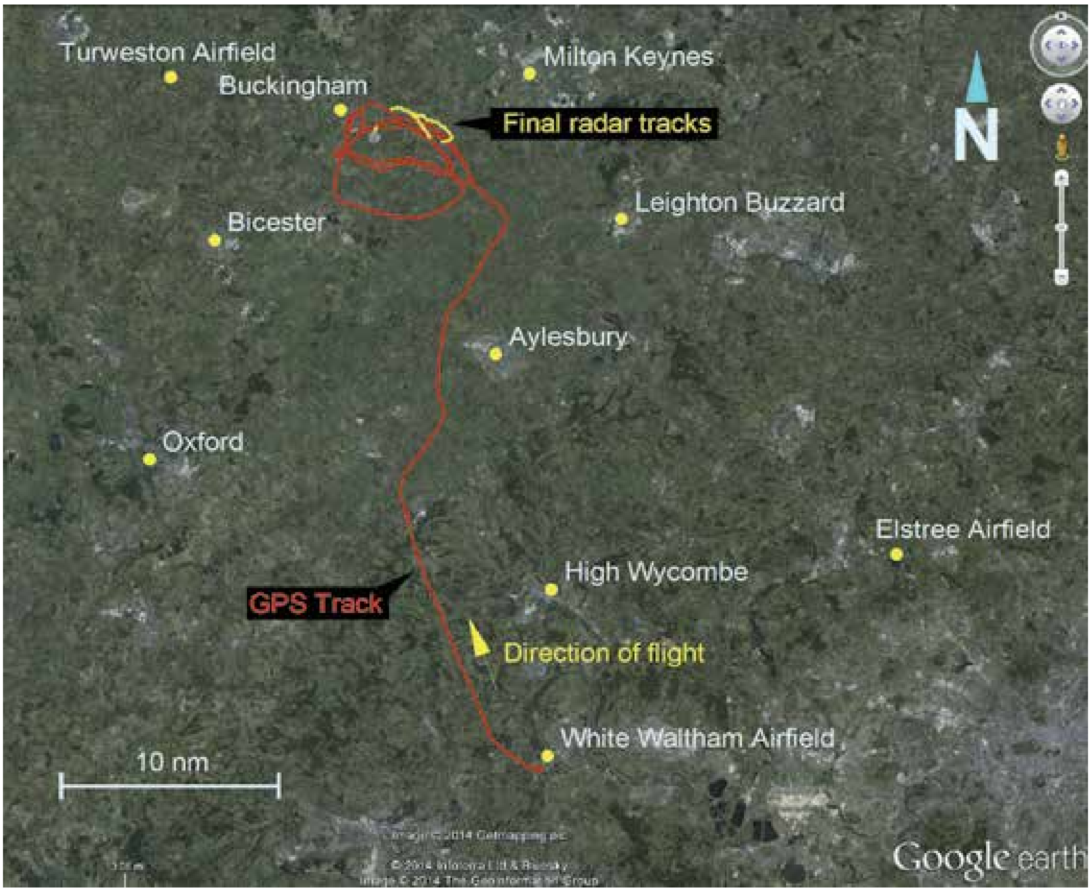


Figure 1

Combined GPS and radar track of flight from White Waltham

At 1831 hrs the pilot attempted to make a telephone call to a relative but it did not connect. Twenty-five seconds later a text message was sent to the same relative, stating that control of the aircraft had been lost and it was “going down”. Some two minutes later the pilot broadcast a MAYDAY call on the Farnborough Radar North frequency, stating that the aircraft had gone into a spin. Farnborough responded to the MAYDAY call but the reply crossed with a further communication from the pilot, giving his position and ending abruptly.

A number of witnesses near Padbury saw the aircraft descend rapidly, spinning or spiralling until it went out of view. The subsequent impact with the ground destroyed the aircraft and the pilot sustained fatal injuries.

Meteorological information

On the 20 August 2014 the weather conditions for visual flight were good. There was a weak pressure pattern across the United Kingdom with a light north to north-westerly airflow. An aftercast from the Met Office indicated the 2,000 ft wind was north-westerly (approximately 315°) at 10-15 kt and at 5,000 ft approximately 280º at 12 kt.

Pilot information

The pilot was an experienced fixed-wing general aviation pilot and held a helicopter licence, which he had recently renewed. He had held a UK PPL (A) since 1982 and a CPL(A) since 2005. It was recorded in his logbook that within the last two years he had undertaken some aerobatic training, mainly in a Cessna 150 Aerobat. He had in the past owned and flown a Cessna Citation aircraft as well as a variety of light single and twin piston-engine aircraft. Most recently he had owned a share in a Bölkow Bo 209 Monsun aircraft, which has an aerobatic capability. He was in current flying practice.

Pathology information

A post-mortem examination was performed on the pilot by a forensic pathologist and his report was reviewed by a pathologist with additional aviation expertise. This concluded that the cause of death was multiple injuries sustained in the impact. There was no evidence that disease, drugs or alcohol could have caused or have contributed to the death, or to loss of control of the aircraft.

Witness information

A number of people had met and spoken with the pilot through the course of the day. They described his behaviour as unremarkable; he appeared chatty, friendly and relaxed.

There were several witnesses who saw and heard the aircraft just before the impact. Two witnesses saw it enter into a descending spiral from apparently normal flight, several others first noticed it when it was already in a descending spin or spiral. They commented that it went though a number of turns before going out of view. The engine was heard to be running by several witnesses; they mentioned that it cut in and out during the spin.

Accident site

When the emergency services arrived at the accident site they reported a "sputtering" noise emanating from the aircraft. This apparently ceased after a member of the fire crew turned off switches, probably the combined Battery Master/Alternator switch, the anti-collision beacon and the fuel boost pump.

Aircraft impact

The aircraft had come to rest in an upright attitude on a grassy area at the edge of a field. There were no marks on the ground other than faint impressions from the wing leading edges; it was clear that the aircraft had rotated slightly to the left after the impressions had been made. The tail of the aircraft was lying against a hedge that bordered the field and the nature of the damage to the foliage also indicated a left rotation of the aircraft as it came to rest. This, with the damage to the airframe, was consistent with the aircraft having struck the ground in a left spin, with a wings-level nose-down attitude of 20º to 25º. The landing gear had been flattened against the aircraft underside and the mass of the empennage had caused a crippling failure of the rear fuselage during the impact. This was indicative of a high vertical descent rate, typical of a spin, in which any horizontal velocity component is small.

Fuel tanks

The fuel in this aircraft type is carried in integral tanks in the inboard wing sections, in front of the main wing spar. These areas were punctured in the impact, allowing the tank contents to drain into the ground around the nose of the aircraft. There was an odour of Avgas at the site. The fuel selector was found halfway between OFF and the LEFT tank and the gascolator and carburettor had sustained severe damage in the impact, allowing the fuel to drain into the ground beneath the engine.

Propeller and engine

The propeller had come to rest in a horizontal position such that neither blade had penetrated the ground to any significant depth. The blades were undamaged apart from diagonal scuff marks, suggesting that the engine had been developing little or no power at impact. Very little oil was found in the engine and it was apparent that the casing had fractured around the base of the oil filler tube, allowing the oil to escape into the ground.

The mixture lever was found set to fully rich, the throttle lever was found at a mid-to-low setting and the carburettor heat control was approximately midway between hot and cold.

Aircraft structure

Examination on-site by the AAIB established that the aircraft had been structurally complete at impact, with all the extremities accounted for. It also established, after examination of the doors, latches and doorframes, that both cabin doors had been closed at the time of the impact.

Electrical system

Inside the cockpit, the only 'tripped' circuit breakers were the transponder and the alternator field supply. The transponder was set to 'STANDBY'. The magneto switch was in the OFF position; it is possible it was placed there by the first responders.

Recorded information

Sources of recorded information

Recorded information was available from two mobile phones[1] and one tablet computer[2] recovered from the aircraft (all three devices belonged to the pilot), ground-based primary[3] (without altitude information) radar records from sites at Bovingdon, Debden, Heathrow Airport and Stansted Airport and a ground-based radiotelephony recording of the MAYDAY transmitted by the pilot on the frequency of 132.800 MHz. A record of the mobile phone network logs was also obtained, providing timings of calls and messages sent and received from both of the recovered phones. The two mobile phones in total contained in excess of 1,000 voice call records and 10,000 Short Message Service (SMS) messages.

Tablet computer

The tablet computer contained a track log of the accident flight, with aircraft GPS-derived position, track, altitude and groundspeed recorded at a rate of once per second. The record started at 1653 hrs with the aircraft parked at White Waltham Airfield and ended at 1822:54 hrs, 11 minutes before the final radar record. The navigation software enables a pilot to enter routes. No active route had been selected for the accident flight.

The track log will end under the following conditions:

1. the navigation software application is closed by the pilot
2. the pilot manually exits from the moving map function within the navigation software
3. the tablet computer internal battery supply is depleted resulting in the device turning itself off
4. the pilot manually powers off the tablet
5. the navigation application closes due to an error.

Testing was later carried out on a tablet computer of the same model and the same version of operating system. It was found that, when the internal battery became depleted and the unit turned itself off, a particular data file would be updated with the corresponding date and time. This data file on the accident tablet was dated 22 August 2014, two days after the accident, indicating the tablet computer was 'on' at the time of the impact.

Footnote

[1] Apple-manufactured iPhone 5 model A1429 and iPhone 5S model A1457. The iPhone 5 was recovered from within a bag inside the aircraft. The iPhone 5S was found loose within the aircraft.

[2] Apple-manufactured iPad mini model A1490, operating a SkyDemon flight navigation software application.

[3] The aircraft transponder had not been selected by the pilot to transmit secondary radar Mode A or Mode C information.

Radar record

The radar records covered the time period from 1711 hrs to 1834:02 hrs, with data from Bovingdon, Debden, Heathrow Airport and Stansted Airport recorded once every five, six, four and four seconds respectively. There were several periods during the latter stages of flight when no radar records for G-BNDE were recorded. This can occur where the radar's computed groundspeed of a target aircraft reduces to less than 50 kt, at which point the radar system applies logic[4] to filter out the signal from being displayed and recorded. The absence of radar records can also occur when the radar return signal is weak or the aircraft descends below radar coverage. The radar coverage in the area near Buckingham was calculated to be approximately 1,450 ft amsl (about 1,200 ft agl).

Headset communications

The aviation headset[5] worn by the pilot incorporated wireless Bluetooth® technology that enabled voice calls to be made using a mobile phone, in addition to supporting ATC communications, using a wired connection to the aircraft radio system. The investigation established that the headset was 'paired'[6] with one of the pilot's mobile phones (iPhone 5S, model A1457) recovered from the cockpit. Call logs for the phone indicated that the pilot had been making and receiving voice calls during the accident flight and that he had sent an SMS text message from the same phone several minutes before the aircraft crashed. The headset enabled the pilot to accept incoming calls hands-free, but did not support either voice-activated dialling or dictated SMS text messaging. Accordingly, all outgoing phone calls and SMS messages would have required the pilot to access the phone physically.

Shortly after takeoff from White Waltham the pilot had attempted to make a phone call, but no network connection was available. Several minutes later, at an altitude of 2,200 ft amsl, he made several phone calls lasting a total of about two minutes. At 1734 hrs the aircraft was about 5 nm west of Leighton Buzzard and had climbed to an altitude of about 2,800 ft, when it started to manoeuvre in a series of turns, predominantly to the left (Figure 2).

At 1746 hrs, the pilot phoned the same person that he had spoken to earlier in the flight, with the call lasting about 90 seconds. The pilot then phoned someone else. Several of the calls to this person were connected for a brief period before the calls ended[7]; this is most likely to have occurred due to connectivity problems with the ground-based mobile phone network.

(Note: A Bulletin Correction was issued in the October 2015 Bulletin concerning the headset communications and can be found at the end of this report.)

Footnote

4 If the radar computed groundspeed of a target reduces to less than 50 kt a 'low speed flag' is set. After three consecutive low speed flags, the target is dropped. To re-establish the target and resume recording, the radar requires three consecutive periods where the low speed flag has not been set. The period is dependant on the scan speed of the radar.

5 Bose® manufactured model A20.

6 When wireless Bluetooth® communications are established between two devices, they are referred to as 'being paired'.

7 The recipient advised that the connections were lost shortly after having answered the call. The recipient tried to call the pilot back, but the calls were diverted automatically to voice mail.

Interpretation of recorded data

Although the radar data was incomplete, the tablet computer track log and radar tracks predominantly aligned, corroborating the accuracy of the two independent data sources. From the four radar heads, the one located at Bovingdon provided the most comprehensive coverage and closest correlation with the tablet computer track log. It was established that all data sources utilised the same UTC time base, which was acquired from GPS satellite signals. All times referenced are UTC (local time was UTC+1) and altitudes are above mean sea level (amsl).

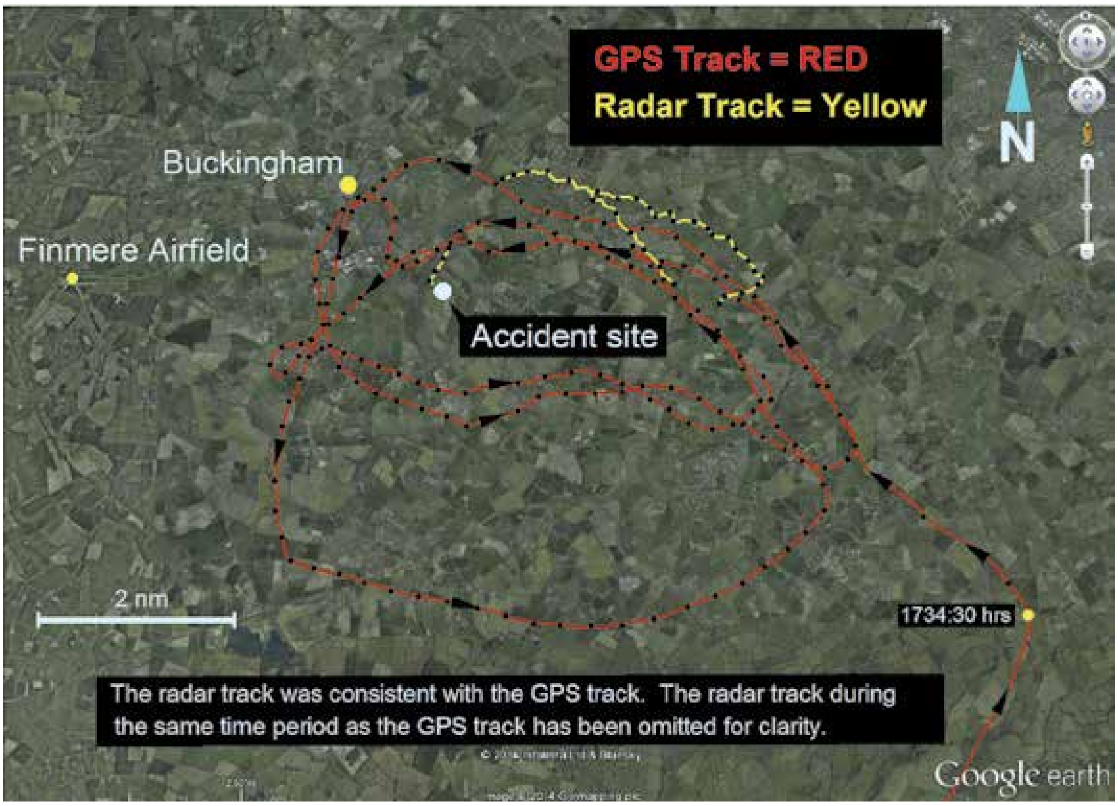


Figure 2

GPS and Bovingdon Radar track to the south and south-east of Buckingham

Final 12 minutes of flight

At 1822.54 hrs, the track log ended (Figure 3), with the aircraft recorded at an altitude of 4,360 ft and on a track of 319° T. Its airspeed based on an estimated wind at 5,000 ft of 280° at 12 kt would have been 52 kt. About 30 seconds prior to this the radar record had also stopped, probably due to a computed groundspeed below 50 kt. At 1825:10 hrs the radar record was re-established. Shortly after, at 1831:03 hrs, the pilot attempted to phone a relative's mobile phone, but the outgoing call failed[8] to connect with the mobile network[9].

Footnote

[8] Cellular radio antenna signals may extend in vertical lobes up to several thousand feet above the ground. The shape of the lobes means that an aircraft may transit in and out of signal coverage.

[9] There was no record that the pilot had previously called this relative from either of the two mobile phones or computer tablet although a number of SMS text messages had been exchanged.

Twenty-five seconds later, at 1831:28 hrs, an SMS message from the pilot's phone was sent to the relative's mobile phone, the text included the words *'… I'm in a plane out of control and it's going down …'.* The whole message consisted of 148 characters. At this time, the aircraft was positioned 1.8 nm to the north of where it later impacted the ground.

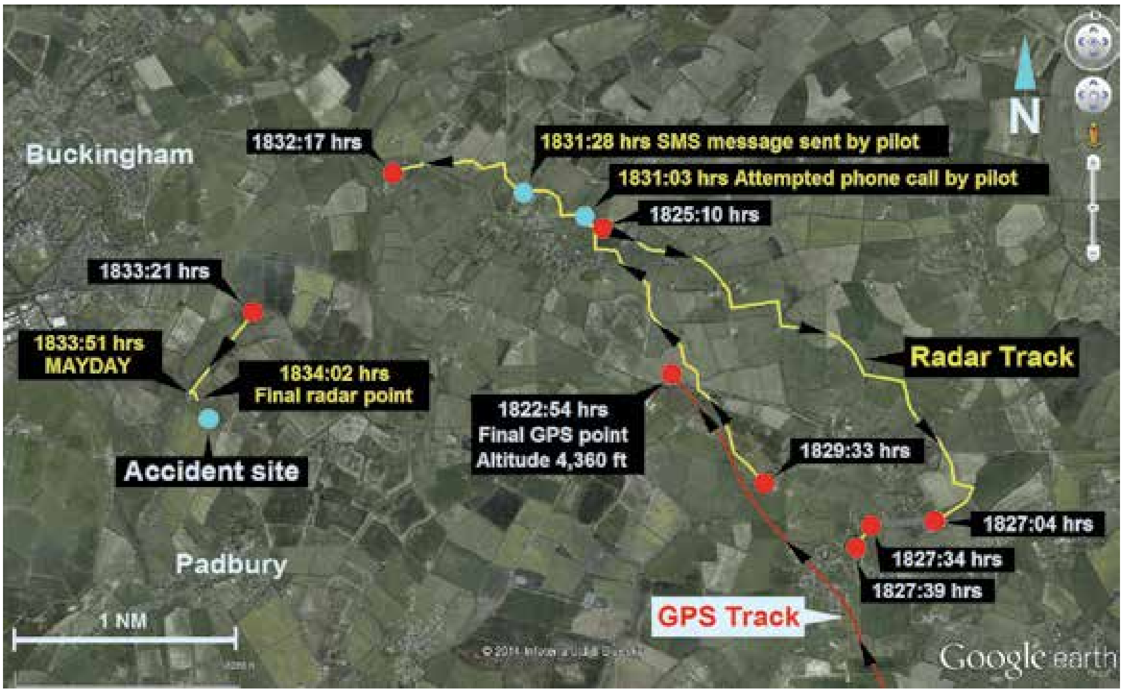


Figure 3

Final GPS and Bovingdon Radar track

The radar indicates that when the SMS message was sent, the aircraft's track was about 293° T and its average groundspeed was approximately 64 kt. Based on an estimated wind from 315° at 12 kt, the aircraft average airspeed would have been about 74 kt[10]. During the next 49 seconds the aircraft gradually turned to the left, onto a track of about 240° T. At 1832:17 hrs there was a further gap in the radar record.

At 1833:21 hrs the radar track recommenced with the aircraft positioned 0.9 nm to the south-west of the previous radar position. The aircraft remained for the next 25 seconds on a relatively constant track of about 210° with an average airspeed of approximately 64 kt.

At 1833:46 hrs the radar track deviated about 90° to the left, which was almost coincident with the pilot declaring a MAYDAY, stating "MAYDAY MAYDAY MAYDAY ER GOLF BRAVO NOVEMBER DELTA ECHO ER LOST CONTROL OF THE AIRCRAFT AND ITS GONE INTO A SPIN". The transmission lasted 8 seconds. The controller responded immediately, asking the pilot to set 7700 on the transponder. The pilot responded by confirming his approximate location before stating "I CANT CONTROL IT". This transmission was timed at 1834:07 hrs and lasted 1.4 seconds. No further radio transmissions were received from the pilot.

Footnote

[10] This is based on the aircraft being in level flight.

The final radar data point was recorded at 1834:02 hrs (during the period that the controller was responding to the MAYDAY), close to where the aircraft impacted the ground.

Calculation of airspeed

To estimate the airspeed of the aircraft during the final phase of flight, the radar data was corrected for the effect of the wind. This data is presented in Figure 4, which plots both the variation in calculated groundspeed and the corresponding aircraft track as individual points and five-point averages. The plot shows the estimated horizontal component of the aircraft's airspeed, based on the five-point average groundspeed, corrected for a wind from 315° at 12 kt. Given the lack of altitude information, a vertical speed component could not be included because there was no information as to whether the aircraft was climbing, descending or in level flight. Due to the variation in the recorded data, a consequence of the limitations of primary radar, the calculated airspeeds are not accurate enough to demonstrate airspeed at any specific point, but do show that, in general, the aircraft was flying at airspeeds below typical cruise speeds.

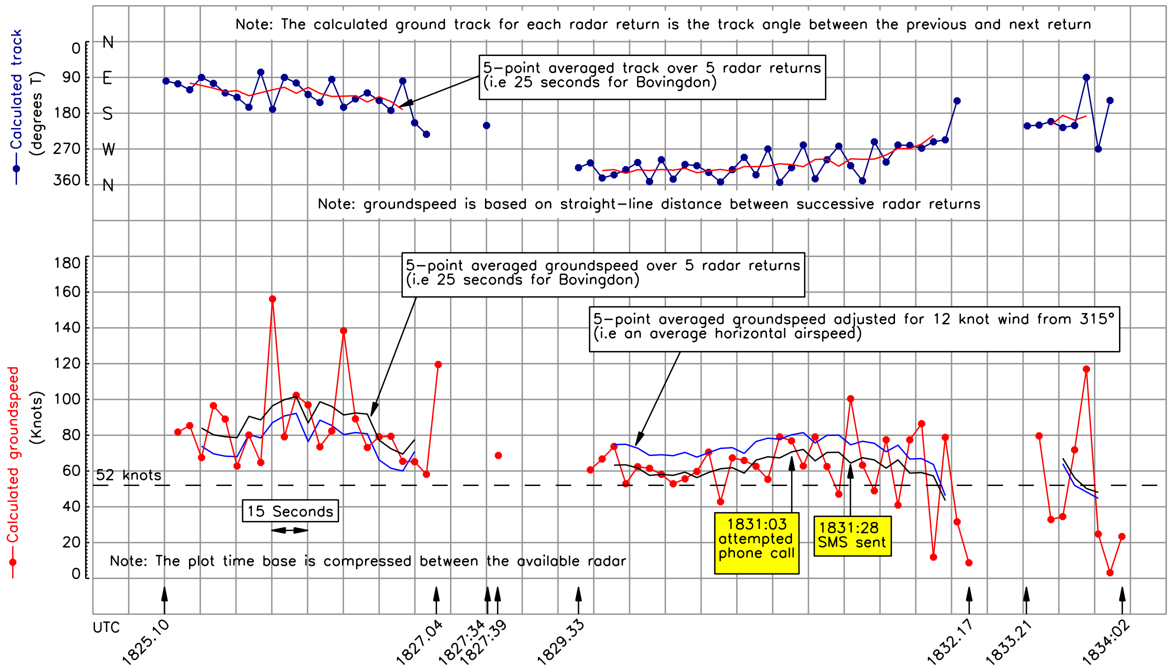


Figure 4

Calculated airspeed of G-BNDE based on radar data from Bovingdon

Previous flight records

In addition to the accident flight, the tablet computer contained track log records of 34 previous flights[11], which included the two flights prior to the accident on 20 August 2014. None of the track logs ended prior to the aircraft having landed. From the pilot's use of the navigation software, it was evident that he was familiar with the track log recording function.

Footnote

[11] The flights were between 6 June 2014 and 20 August 2014 and were to airfields and helicopter landing sites located in the south-east of England, with an average flight distance of about 60 nm. There was a good correlation of flight records, between the pilot's log book and the computer tablet.

During the flight from Elstree to Turweston on the morning of 20 August 2014, the pilot had flown circling manoeuvres just to the south of Buckingham, similar to those flown during the latter stages of the accident flight.

Previous use of mobile phones whilst in flight

There was no evidence that the pilot used either of the two telephones recovered from the wreckage for calls during the 34 flights contained on the computer tablet. There was one record of an SMS text message (consisting of 23 characters), sent during the flight from Elstree to Turweston on the morning of 20 August 2014. The message content was not related to the operation of the flight.

Aircraft information

General

The Piper PA-38 Tomahawk is a two-seat, all-metal aircraft, first produced in 1977. It was designed specifically for flight instruction but has also been widely used as a touring aircraft. Part of the design brief was to build in realistic spin recovery behaviour by requiring specific pilot input to recover from a spin. A spin may be entered unintentionally or intentionally, as an outcome of unbalanced flight close to the aerodynamic stall. The PA-38 is cleared for intentional spins provided that a full four-point shoulder harness is fitted and the flaps are fully retracted. A series of flight tests were carried out October 1979 by NASA Langley Research Center, to evaluate PA-38 Tomahawk spin behaviour and recovery.[12] From these tests, the average rate of descent was calculated to be of the order of 5,000 ft/min to 6,000 ft/min.

Airworthiness Directive, 83-14-08, issued in September 1983, mandated an additional pair of stall strips to be added to the inboard leading edge of the PA-38 wing to "*standardize and improve the stall characteristics*". G-BNDE had these strips installed.

An Aircraft Owners and Pilots Association (AOPA) Air Safety Foundation (ASF) review of stall-spin accidents in 2001 reported that the Piper PA-38 Tomahawk, was involved in proportionately more such accidents than other training aircraft.[13] However, the report noted that a high percentage of these were from an entry height of 1,000 ft or less, they were therefore unlikely to have been recoverable and were not related to any spin recovery characteristics.

This PA-38-112 has a Maximum Takeoff Weight (MTOW) of 1,670 lbs (758) kg. The fuel tanks have a usable fuel capacity of 30 USG (113.5 litres) when full, which gives in excess of 4 hours endurance. According to the approved Flight Manual, the stall speed of the aircraft in clean configuration at the MTOW, with inboard and outboard stall strips fitted, is 52 KIAS and with full flap, 49 KIAS. The speed for the best glide angle, to be adopted for a power-off landing, is 70 KIAS.

Footnote

12 Available at https://www.youtube.com/watch?v=xzFgqtPVCZ0
13 Available at http://www.aopa.org/asf/ntsb/stall_spin.html

Aircraft history

G-BNDE was owned by an aircraft maintenance company that had been approached by the pilot with a view to renting the aircraft for several months. This was agreed and the aircraft was given a 50 hour Inspection on 4 June prior to being handed over to the pilot two days later. The agreement stipulated that the aircraft should be returned within 50 flight hours or three months, whichever occurred first. The renting pilot based the aircraft at Elstree in Hertfordshire for this period.

In addition to the 50 hour check, the aircraft documentation included an Airworthiness Review Certificate valid until 27 December 2014. The aircraft and engine log books contained no entries after 2 May 2014, although approximately 6 hours were recorded on Technical Log sheets subsequently found in the aircraft, the last on 15 June. The pilot's log book indicated that he had flown approximately 20 flight hours since he took the aircraft on 6 June. This took the total time achieved by the aircraft and engine to 9,235 and 2,325 hours respectively.

The log books indicated that the aircraft had not flown between March 2011 and January 2014. During this period the engine underwent a repair, with this and an Annual Inspection being signed off on 20 December 2013. No defects had been recorded in the Technical Log.

Detailed examination of the wreckage

Flying controls

An examination of the primary flying controls revealed no evidence of a pre-impact disconnect. The manually operated elevator trim system, which moves the elevator against a bias spring, was similarly intact, although it was not possible to establish a trim position.

In the PA-38, the manually operated trailing edge flaps can be set at one of three detented positions (retracted, mid and full) by means of progressively raising a lever located between the seats. A spring-loaded button on the end of the lever operates a ratchet mechanism at the lower end of the lever. This essentially comprises a spigot which, when displaced by pressing the button, allows movement of the lever (and hence the flaps) by lifting the spigot out of its detent. Each detent consists of a hook-shaped cut-out in a slot and is shaped such that it prevents flap (and hence lever) movement, under pressure of air loads, towards the retracted position. The profile of the cut-out in the flap extension direction allows the spigot to ride out of the detent towards the next position, without having to depress the button when moving flap lever to (further) extend the flaps.

Examination of the mechanism revealed that the flaps were at the 'mid' position. Although a considerable degree of airframe distortion had occurred in the impact, it was still possible to move the flap lever and the flap operating linkage between the retracted and mid positions. Had the flaps been retracted prior to the accident, the lever would have been at its lowest position, close to the floor. Raising it to the 'as-found' position would have required the lever to have been struck by an object from underneath. Since there was nothing around the lever, either on the floor or on the lower part of the instrument panel that could have achieved this, it was concluded that the flaps had probably been at their mid position at impact.

Stall warning system

The aircraft was fitted with outboard and the additional inboard stall strips on the leading edges of the wings. It was equipped with a conventional 'vane-type' stall warning system, in which a vane-operated microswitch on the left wing leading edge causes a buzzer to sound in the cockpit when the local airflow exceeds a pre-determined angle of attack.

When electrical power was applied to the circuit, the buzzer did not sound on moving the vane. It was then found that the vane casing had been distorted in the accident such that it restricted the vane movement. After removing the casing the vane could be moved through its full range, which permitted physical and electrical confirmation of the microswitch's operation. The buzzer still failed to sound so, after establishing electrical continuity of the system wiring, the buzzer was removed from its location behind the instrument panel and a 12 volt power source applied across its terminals. The unit did not respond until it was tapped sharply on the bench; operation was, however, still intermittent. The buzzer comprised an electromagnet which, when energised by closure of the vane microswitch, acted on a thin metal diaphragm. It was observed that the casing displayed a small dent where it had come into contact with adjacent instruments that had partially detached during the ground impact. Opening the unit indicated that the distortion in the casing had slightly impinged on the diaphragm. This appeared to account for the intermittent operation during bench testing but the possibility of a fault in the stall warning system in flight could not be ruled out. A test of the stall warning forms part of the standard preflight check of the aircraft.

Airspeed indicator

The pitot head, which was located on the underside of the left wing, had been severely crushed as a result of the ground impact. However, the remainder of the system appeared intact and it was possible to attach a pitot tester to the pipe-work immediately aft of the pitot head; this allowed a basic calibration of the airspeed indicator (ASI). This test showed the instrument over-reading by up to 10% across the range. It was also observed that there was an off-set with zero pitot pressure applied, which suggested that the ASI internal mechanism had been damaged in the impact.

Electrical power supply to the cockpit

A charger and its associated cable were found connected to the DC outlet on the instrument panel. Neither the mobile phone nor the tablet was connected to the cable when the wreckage was examined on site, although it is possible that either device could have become detached during the ground impact.

In order to test the outlet itself, a 12 volt DC power supply was connected to the aircraft wiring in place of the battery. After switching the Battery Master to ON, it was found that, after inserting the charger into the outlet, a light on the charger illuminated and a mobile phone attached to the cable was charged normally. However, it was noted that the outlet socket displayed extensive surface corrosion and that the charger needed to be firmly inserted in order to obtain a satisfactory connection.

It was also found, after applying power to the instruments, that a loud grinding noise resulted. This was traced to the electrically-powered gyroscope in the turn and slip indicator. It was considered that this may have been the result of the gyroscope rotor bearings being damaged in the impact.

Engine and accessories

The engine was removed from the airframe and subjected to a partial teardown. As noted earlier, the carburettor was badly damaged and its associated air-box was severely crushed. Cutting open the box exposed part of the cable-operated flap; the position of the flap relative to a fold in the side panel of the box suggested that it may have been in the COLD position at the time the box was crushed.

The magnetos were removed from the engine and taken to a component overhaul facility where they were subjected to a bench test. The harnesses were removed from the magnetos and tested separately for electrical continuity and correct resistance. The magnetos were found to produce satisfactory sparks throughout the rpm range. The electrically operated fuel boost pump, which was located in the engine compartment downstream of the fuel selector, was removed at the same time as the engine. It was connected to an electrical supply and was found to operate normally. The fuel selector valve, as noted earlier, was found selected midway between OFF and LEFT tank. The valve, which comprised a suitably ported plastic cylinder, operated by the selector handle and located within the valve body, was dismantled and was found to reflect the selected position. This meant that only half the port area of the valve was exposed to the fuel outlet, which would restrict the flow at high engine power settings.

The cylinders were removed, with the pistons and combustion chambers being found in good condition. The big-end bearings were smooth in operation and there was no evidence of lubrication failure anywhere within the engine. Cutting open the oil filter revealed no metallic particles.

Analysis

Introduction

It was apparent, from the witness accounts and the on site evidence, that the aircraft had entered a spin from which it did not recover. The AAIB investigation focussed on whether factors such as weather, mechanical defect or training might have been causal or contributory in this spin.

Aircraft examination

The possibility of an engine failure was considered. Examination of the engine revealed no evidence of a mechanical failure beyond that the propeller showed little evidence of power at impact.

The fuel selector is designed against accidental operation. Although it is possible that the position of the fuel selector, as found, had been due to the rescue services, it is more likely to have been due to an attempt by the pilot to turn off the fuel.

The aircraft battery had reportedly become discharged whilst at White Waltham, perhaps due to the pilot leaving the Battery Master switch in the ON position. The emergency services reported a 'sputtering' noise coming from the aircraft on their arrival; this is likely to have been generated by one or both of the turn-and-slip indicator gyroscope and the electric fuel boost pump, and indicated that the battery at the time held a reasonable charge.

The stall warning horn could not be heard during the MAYDAY call transmitted by the pilot, when he advised that the aircraft was in a spin. The NASA flight test videos indicated that the warning horn operated intermittently, but with short gaps, while the aircraft was spinning in these tests. However, there is a possibility that this can be accounted for by differences in the stall warning vane rigging between airframes.

The flaps were found to be at the intermediate position and it was not possible to determine the reason. The radar data suggests that, for a period before the spin started, the aircraft was flying at less than normal cruise speed, but above the stall speed.

In summary, there was no indication that any mechanical defect was a factor in this accident.

Weather, training and aircraft characteristics

The weather conditions were benign and not likely to have been a contributory factor to the spin.

The pilot was experienced, in current flying practice and had undertaken aerobatic training previously, which would have included spin awareness and recovery. It is therefore likely that he would have recognised, and been able to recover from, a spin.

The time elapsed during the pilot's final radio transmissions, together with the rate of descent deduced from the NASA videos, suggested that the spin was likely to have started from a minimum height of 2,500 ft amsl, and probably higher.

The stall-spin behaviour of Tomahawk aircraft has been examined in the past and the data show it has been involved in a greater proportion of stall-spin accidents than other training aircraft. The data also shows that these are more probably related to stall entry at low level, rather than a failure to recover from a developed spin where sufficient height is available.

Actions of the pilot

There were a number of events which took place in the course of the afternoon which represented unusual actions on the part of the pilot.

It appears the pilot made a change of intended destination prior to leaving White Waltham. Having booked out for Elstree he subsequently called them to advise he would not be returning there; he did not book out to any other destination. After departing White Waltham and flying north for about half an hour, he flew in a large circular pattern for almost an hour. Although somewhat unusual, this may be explained by the need to re-charge the aircraft battery.

From the data available, it appeared that the pilot had not previously used either of the two mobile phones found on board for calls in flight and had sent only one previous SMS when in flight, earlier the same day. A number of calls were attempted during the final flight but most did not connect, probably because of limitations of the reception when in the air. However, the final SMS message did get sent.

The tablet computer track log ended at 1823 hrs, some 11 minutes before the final radar point was recorded. It could not be ascertained why it had ended; options included the pilot closing the navigation application or the application closing due to a system error. However, he had not selected it off during any of the previous 34 recorded flights.

A most unusual feature was the text message sent to the pilot's relative. If it was composed after the attempted telephone call to the same relative, then 148 characters were input within 25 seconds. To achieve this would require considerable dexterity, especially in an aircraft that may have been out of control.

At the time the SMS message was sent (1831:28 hrs) the aircraft was visible on radar and not lower than 1,450 ft amsl. The radar track indicates the aircraft then continued to turn to the left before the radar record stopped for 64 seconds. At 1833:21 hrs it showed the aircraft 0.9 nm to the south-west, maintaining a relatively constant track for the next 25 seconds, suggesting at least control of lateral flight at this time. Shortly after, the aircraft altered track, coincident with the pilot transmitting the MAYDAY in which he stated that the aircraft was in a spin.

The pilot had accumulated considerable experience in a variety of aircraft in the years that he had been flying. He was familiar with the Piper Tomahawk aircraft and was in recent flying practice. It was suggested in his final text message that he had lost control of the aircraft, to such an extent that he did not expect to survive. However, after this message was sent, the aircraft continued in flight for more than two minutes, before entering a spin from which it did not recover.

BULLETIN CORRECTION

Date & Time (UTC):	20 August 2014 at 1834 hrs
Location:	Near Padbury, Buckinghamshire
Information Source:	AAIB Field Investigation

AAIB Bulletin No 4/2015, Page 63 refers

This report stated that the pilot's headset enabled the pilot to accept incoming calls hands-free, but did not support either voice-activated dialling or dictated SMS text messaging.

Further inquiries have demonstrated that this model of headset **is** capable of supporting voice-activated dialling and dictated SMS text messaging hands-free when used in conjunction with the mobile phone the pilot was using.

This dictated SMS messaging function requires a data connection with a mobile phone network or Wi-Fi[1] network to operate. If the data connection is lost prior to completion and sending of a dictated SMS, the message is cancelled. It is not possible to interrupt a dictated message such that it can be completed later, or to use the function whilst a phone call is being made. Previously composed text cannot be copied to an SMS message using the hands-free function. Messages can also be dictated using the phone's microphone when a wireless headset is not connected.

The pilot had tried to make an outgoing call to a relative at 1831:03 hrs, but the call had failed to connect with the mobile network. This was followed at 1831:28 hrs by a 148-character SMS text message being sent from the pilot's phone to the same relative. A series of tests was carried out using the same model of headset and phone to determine if it was possible to send a dictated SMS within the available 25[2] seconds. When using the headset, a minimum of 46 seconds was required and without the headset, a minimum of 30[3] seconds was required. There was, therefore, insufficient time for the pilot to have dictated the message. This confirms that the message would have been composed and sent by physically accessing the phone.

This work corrects a detail in AAIB's factual reporting and does not change the analysis within the report.

Footnote

1 The message during the accident flight was sent over the mobile phone network.
2 The maximum amount of time between the failed call and the SMS being sent and is dependent on the phone having connected to the mobile network immediately after the failed call.
3 The time to send a dictated message is shorter when no headset is used as the dictation function does not read back the message before it can be sent.

AAIB Correspondence Reports

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

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

The accuracy of the information provided cannot be assured.

ACCIDENT

Aircraft Type and Registration:	Boeing 737-8AS, EI-EBR
No & Type of Engines:	2 CFM 56-78 turbofan engines
Year of Manufacture:	2009 (Serial no: 37530)
Date & Time (UTC):	17 December 2014 at 0605 hrs
Location:	London Luton Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Forward fuselage skin dented
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	Not applicable
Commander's Flying Experience:	Not applicable
Information Source:	Aircraft Accident Report Form submitted by the pilot

A baggage tractor struck the fuselage when approaching the forward cargo hold to load bags. The only occupants of the aircraft were the crew, who were unaware of the incident until an engineer informed them. There were scrape marks and dents extending more than one metre forward of the cargo hold on the right side of the forward, lower fuselage. The aircraft was removed from commercial service for several days to allow it to be repaired.

An investigation by the ground handling company established that the tractor had struck the aircraft when the driver attempted to load 20 bags quickly, without assistance and without the use of a belt loader vehicle. The company requires a belt loader to be used and the presence of a safety person before a vehicle approaches within three metres of an aircraft. After this accident the company re-assessed its handling processes and training procedures. All ramp staff were retrained and the auditing of turn-arounds was increased.

This accident was similar to one involving another Boeing 737-8AS (EI-EXF), at London Stansted Airport, on 3 December 2014.

ACCIDENT

Aircraft Type and Registration:	Boeing 737-8AS, EI-EXF	
No & Type of Engines:	2 CFM56-7B26E turbofan engines	
Year of Manufacture:	2012 (Serial no: 40322)	
Date & Time (UTC):	3 December 2014 at 0815 hrs	
Location:	London Stansted Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Forward fuselage skin damaged	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	Not applicable	
Commander's Flying Experience:	Not applicable	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

A baggage tractor struck the fuselage when approaching the forward cargo hold to offload bags, after all passengers had disembarked. The impact was felt by the crew, and the commander discovered dents and scrapes to the skin on the right, lower fuselage. This damage extended almost 1.5 m forward from the cargo hold bay and the aircraft was removed from commercial service for several days while it was repaired.

An investigation by the ground handling company established that the tractor struck the aircraft when the driver attempted to begin offloading bags, without assistance and without using a belt loader vehicle. The company requires a belt loader to be used and the presence of a safety person before a vehicle approaches within three metres of an aircraft. These procedures were not adhered to when the tractor driver tried to expedite the offload of an aircraft that had arrived ahead of schedule.

Company procedures were reviewed following this accident. The ground handling teams were re-briefed and their standards and processes were audited.

This accident was similar to one involving another Boeing 737-8AS (EI-EBR), at London Luton Airport, on 17 December 2014.

SERIOUS INCIDENT

Aircraft Type and Registration:	Convair CV-580, N151FL
No & Type of Engines:	2 Allison D13D CV-340-580STC turboprop engines
Year of Manufacture:	1953 (Serial no: 51)
Date & Time (UTC):	27 January 2015 at 1718 hrs
Location:	Owen Roberts International Airport, Cayman Islands
Type of Flight:	Commercial Air Transport (Cargo)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	5,584 hours (of which 4,759 were on type) Last 90 days - 161 hours Last 28 days - 39 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was approaching the airport on Grand Cayman when the crew noticed that the hydraulic system fluid contents were low. They delayed landing until the appropriate crew drills had been actioned. However, during the latter stages of the landing roll, the crew sensed a lack of brake retardation, directional control was lost and the aircraft left the right side of the runway onto the grass. There was no consequential damage.

History of the flight

As the aircraft approached Owen Roberts International Airport, the crew noticed that the hydraulic fluid contents were abnormally low. They advised Air Traffic Control that they would postpone the landing until they had completed the checklist for hydraulic fluid loss. Flaps could only be partially lowered and the landing gear was extended by free-fall.

On completion of the checklist, they checked that all the landing gears were down and locked and subsequently landed normally on Runway 26. The wind was from 320º at 8 kt gusting 12 kt. During the final stages of the landing roll, the crew sensed a lack of braking and no response from the nosewheel steering. They lost directional control and could not prevent the aircraft from leaving the paved surface to the right. It came to a halt on the grass some 150 ft from the centreline, approximately at right angles to the runway heading. There was no damage to the aircraft or injuries to the crew.

Hydraulic system description

A single Engine Driven Pump (EDP) or a backup AC electrical pump is used to pressurise the Main hydraulic system to power various services including flaps, brakes, nosewheel steering and landing gear retraction/extension. In the event of Main system failure (and to provide ground hydraulic power when the engines are not running) a DC electrical auxiliary pump can be used to pressurise the system.

In the event that a leak develops in the system, and the reservoir empties such that the main system no longer functions, operation of the AUX HYD PUMP switch starts the DC pump and operation of a Bypass selector isolates all components except the brakes, flaps and main entry door. The auxiliary system uses the last 2.5 US gallons of the reservoir and supplies sufficient fluid for one full flap extension and 15 normal brake applications. The aircraft's Flight Manual cautions against running the DC pump for more than 5 minutes due to possible overheating issues.

There is also an hydraulic accumulator which, when the Bypass selector is operated, supplies hydraulic pressure only to the brakes.

A further high-pressure air bottle can be used to release the landing gear uplocks to allow gear free fall and, if necessary, supply air pressure to operate the brakes in an emergency. Pressure sufficient for about eight brake applications is available with a fully charged bottle.

The company's checklist for HYDRAULIC FLUID/PRESSURE LOSS includes the following actions for 'IF FLUID LEVEL LOW OR DROPPING':

Bypass .... Up
AC Hydraulic Pump.............. Off
DC Hydraulic Pump.............. As required

It also contains the following warning:

> *'Use of the DC pump can deplete the reserve hydraulic fluid supply'*

Investigation

Upon examination, it was found that the right main landing gear actuator was leaking, which was the reason for the loss of hydraulic fluid. Operation of the Bypass selector in accordance with the checklist meant that nosewheel steering was no longer available and probably the remaining hydraulic fluid was exhausted by the partially successful attempt to lower the flaps. This left only the hydraulic accumulator and the emergency pneumatic pressure bottle to operate the brakes. However, it was found that a valve forming part of the anti-skid control box was defective. It was reported that this defect had the effect of inhibiting operation of the brakes when either the accumulator or emergency pneumatic systems were used to operate them.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-JEDM
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2003 (Serial no: 4077)
Date & Time (UTC):	19 January 2015 at 1014 hrs
Location:	Inverness Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 47
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	58 years
Commander's Flying Experience:	13,800 hours (of which 3,300 were on type) Last 90 days - 180 hours Last 28 days - 50 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft had landed and was instructed by Air traffic Control (ATC) to continue rolling to the end of the runway and take the exit to the right. As the crew turned the aircraft onto the taxiway, it entered an uncontrollable slide to the left and came to rest with all three landing gears on the grass. The aircraft's groundspeed was considered to have been a major factor in the loss of control.

History of the flight

The aircraft had landed on Runway 23 at Inverness following a flight from Manchester. ATC asked the crew to roll to the end of the runway and vacate at exit A1 (Figure 1); thereafter they were to taxi to the South Apron. The commander reported that the aircraft slowed with minimal braking required but, as he commenced the right turn at A1, he lost control of the aircraft. It slid sideways to the left, coming to rest on the grass, pointing parallel to the taxiway centreline, but with all three landing gears partly sunk into the soft ground. After requesting help from the rescue services, the crew shut down the engines and, after inspection of the landing gear by the Airport Fire Service, it was deemed safe to allow the passengers to disembark.

An Airport Operations Assistant, who was preparing to marshal the aircraft onto its stand on the South Apron, watched the aircraft land. He stated that he would normally have turned away and returned to his marshalling position, but said that he continued to watch because he felt that the aircraft was travelling unusually fast as it reached the end of the runway. He observed it turning right at A1 and heard the tyres squeal as it did so, raising the alarm when he realised it had gone onto the grass.

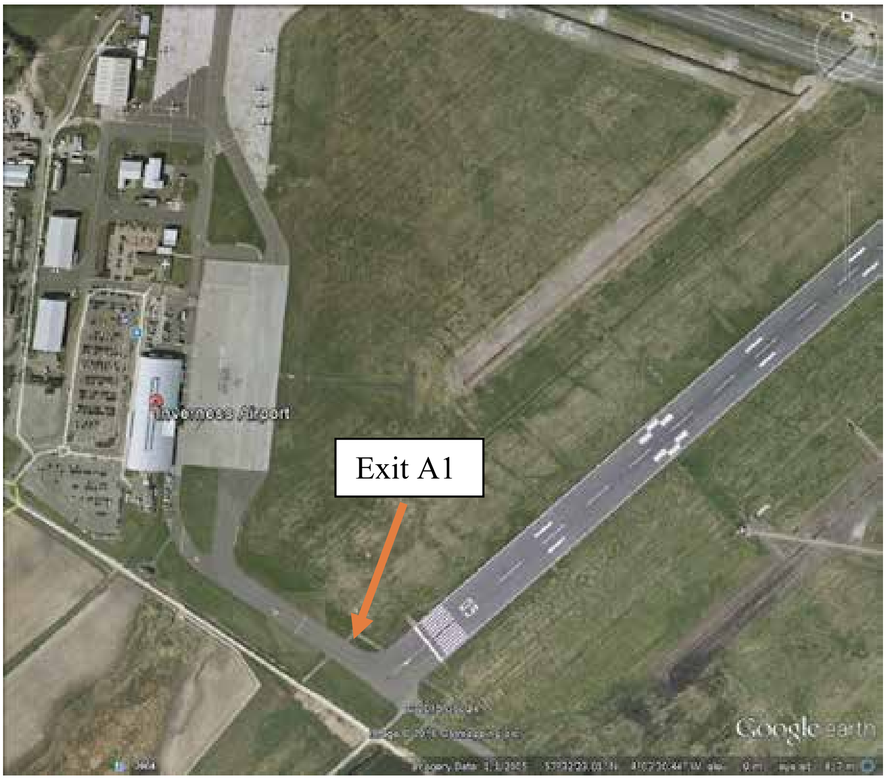


Figure 1

Aerial view of Inverness Airport showing location of exit A1

Analysis

The commander reported that he felt the paved surface was very wet with de-icing fluid, but there were still some icy patches and the fluid had made some of the white painted markings slippery. He conceded that he had been taxiing "slightly higher than normal taxi speed", but had been eager to vacate the runway.

The airport authority produced a detailed report on the incident, which was made available to the AAIB. It states that the runway and taxiways were de-iced between 0745 and 0847 hrs on the morning of the incident and that a subsequent inspection found no evidence of icy patches being present A test of the applied fluid using a refractometer gave it a freezing point of -24ºC. In addition, the painted markings were not judged to be 'slippy' and tyre marks were visible on the paved surface as the aircraft had turned onto the taxiway. The report concluded that the presence of these marks and the witness evidence that the tyres squealed as the aircraft cornered indicated that there should have been adequate friction between the tyres and the runway/taxiway surface.

A download of the aircraft's Flight Data Recorder indicated that there was minimal braking action applied during the landing roll and that, as the aircraft turned into exit A1, it had a groundspeed of 29 kt. No anomalies were found with the braking system.

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97A Eurostar, G-CCEM
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2003 (Serial no: PFA 315-13987)
Date & Time (UTC):	17 May 2014 at 1130 hrs
Location:	Oxenhope Airfield, West Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	G-CCEM: propeller, left wing, left side of fuselage G-MESH: right tailplane G-CDLK: right wingtip and aileron
Commander's Licence:	Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	506 hours (of which 3 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he had carried out a short local flight and some general handling lasting about ten minutes, before landing uneventfully on Runway 29. He then backtracked and lined up to take off again. During the takeoff run the aircraft suddenly turned towards the left and the pilot attempted to regain the centreline using rudder. The aircraft did not respond and it departed the left side of Runway 29, striking another aircraft, G-CDLK, parked with its right wing close to the runway. This contact caused G-CCEM to slew further to the left in the direction of another parked aircraft, G-MESH. The pilot cut the master switch and applied full braking, but was unable to avoid a collision with the second aircraft.

In the pilot's opinion, his attempt to apply right rudder to regain the centreline resulted in both pedals being operated, with no consequent rudder deflection being achieved.

ACCIDENT

Aircraft Type and Registration:	Beech 76 Duchess, G-GCCL
No & Type of Engines:	2 Lycoming LO-360-A1G6D piston engines
Year of Manufacture:	1980 (Serial no: ME-322)
Date & Time (UTC):	9 November 2014 at 1340 hrs
Location:	Cambridge Airport
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose cone and front section of nose gear doors
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	28 years
Commander's Flying Experience:	3,255 hours (of which 20 were on type) Last 90 days - 141 hours Last 28 days - 44 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further inquiries by the AAIB

Synopsis

After selecting the landing gear lever to DOWN, the nose landing gear failed to extend. After several further attempts, an approach to Cambridge Airport was made with the nose landing gear retracted. The aircraft touched down and the nose was held up for as long as possible before it descended and contacted the runway surface.

Neither flight crew sustained any injuries. The reason for the failure of the gear to extend could not be established at the time of this report. Previous events have identified reasons why the nose gear may not extend and that this aircraft type requires accurate rigging and vigilant maintenance of the nose landing gear.

History of the flight

The aircraft was engaged on a training flight which initially consisted of assessing the aircraft handling characteristics, including the effects of lowering the landing gear. After selecting the landing gear lever to the DOWN position, the main landing gear extended successfully. However, the nose landing gear transit light remained on and the green light indicating that it was down and locked did not illuminate. The flight crew then performed a visual check which confirmed that the nose gear was still retracted.

The landing gear lever was cycled but the nose landing gear still did not extend. The emergency gear deployment system was also operated with the same result. Further attempts to lower the nose landing gear were made by manoeuvring to increase the normal acceleration but to no avail.

The flight crew elected to divert to Cambridge Airport due to the length of the runway, wind direction and fire service capability. The aircraft was placed in a hold at 4,000 ft to burn fuel, during which the crew briefed for the landing, secured loose items and tightened their harnesses.

Prior to the approach, the aircraft was flown past the tower for a visual confirmation of the main landing gear position. A long approach to Runway 23 was flown with full flap and the engine power reduced to gauge the aircraft's glide performance. Once the crew considered that landing was assured, the engines were shut down and the propellers feathered, with the left propeller stopping almost horizontal. The student pilot briefly operated the starter for the right engine to align it horizontally to prevent any possible propeller damage from the runway. The magnetos, alternator and battery were then selected OFF.

The aircraft touched down on its main wheels and the nose was held up for as long as possible but eventually it contacted the runway and the aircraft came to a halt. After confirming the aircraft was secure, both crew exited the aircraft without injury.

Previous events

In May 1989, the aircraft manufacturer issued 'Safety Communique 76-91' indicating that there had been previous events of this aircraft type being unable to extend the nose landing gear. The document provided possible reasons why and a number of maintenance actions. In addition, 'Service Instructions (SI) No 1209' was issued in May 1983 and 'Mandatory Service Bulletin (SB) No 2310' in October 1989. These highlighted modifications to reduce the possibility of any binding of the nose gear doors or linkages and lubrication intervals of the hinges as:

> *'each 60 days thereafter, if operating under more severe conditions, lubricate the hinges more frequently.'*

The aircraft operator confirmed the embodiment of SI 1209 and SB 2310 and that the last lubrication was on 27 October 2014. Retraction and rigging checks were performed during the last annual check on 4 August 2014. They added that:

> *'doors are checked at all inspections for freedom of movement and lubricated (with WD40 as recommended by Beech) with extra attention given to greasing pin and fork on U/C. Doors are disconnected/reconnected at annual inspections and 150 hour inspections and retraction checks are carried out to check landing gear and door operating mechanism. In addition to 6 weekly lubrication, extra lubrication is carried out if the aircraft has stood for long periods.'*

Aircraft examination

The aircraft was jacked after the event and the operator reported that the nose landing gear appeared to be resting on the closed doors. After some manual assistance, the doors opened and the gear extended. Subsequently, the aircraft was recovered to a hangar but, as it had not been examined further, the reason why the nose landing gear did not extend could not be reported. The operator has been made aware of the previous possible causes and confirmed they will assess the aircraft damage accordingly.

ACCIDENT

Aircraft Type and Registration:	Cessna T210L, N2257S	
No & Type of Engines:	1 TS10-520 SER TCM piston engine	
Year of Manufacture:	1976 (Serial no: 21061201)	
Date & Time (UTC):	20 December 2014 at 1330 hrs	
Location:	Providenciales Airport, Turks and Caicos Islands	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to propeller and lower fuselage	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	54 years	
Commander's Flying Experience:	5,893 hours (of which 20 were on type) Last 90 days - 37 hours Last 28 days - 10 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

It was intended to fly the aircraft on a delivery flight from Fort Lauderdale, Florida to Sao Paulo, Brasil. The first leg of the route was from Fort Lauderdale to Providenciales, where the aircraft was to be refuelled.

After a normal approach to Providenciales, the aircraft landed with the landing gears retracted, sliding on its belly for an estimated 100 ft. The pilot reported that he omitted to extend the gear before touchdown. It is uncertain whether the audio warning, which should sound if the throttle is retarded to a low level without all three gears being down and locked, was serviceable.

ACCIDENT

Aircraft Type and Registration:	Maule MX-7-180C, N1052U
No & Type of Engines:	1 Lycoming 0-360-C1F piston engine
Year of Manufacture:	1998 (Serial no: 28007C)
Date & Time (UTC):	4 February 2015 at 1525 hrs
Location:	Strathaven Airfield, South Lanarkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to right landing gear, windscreen, fuselage, wings and struts, propeller, engine, cowling and empennage
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	189 hours (of which 21 were on type) Last 90 days - 23 hours Last 28 days - 23 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft was landing at Strathaven Airfield. The final approach seemed satisfactory to the pilot but when he glanced at the airspeed indicator, he saw that he was below his target speed. However, when he tried to increase power, the engine stopped and the aircraft stalled, hitting some trees before coming to rest in a field. The pilot considers that either carburettor ice or water in the fuel may have been responsible for the engine stoppage.

History of the flight

The aircraft had turned from right base leg onto finals for Runway 27, having flown from Perth without incident. The pilot adjusted the propeller rpm to 2,500 and set 10 lb manifold pressure. He commenced the final descent from 800 ft, selecting three stages of flap and states that the approach was "fine" as the aircraft cleared a tall tree in its path. He then glanced at the airspeed indicator and saw that it was reading 55mph (against a target 60-70 mph) and decreasing, whilst the aircraft was sinking. The pilot applied full power but the engine "coughed" and then stopped.

He lowered the nose slightly and tried to turn the aircraft left to force land in a field but it stalled, struck trees beneath him and came to rest in the field. The pilot was uninjured but the aircraft suffered substantial damage.

The pilot considers that the behaviour of the engine was consistent with either carburettor ice or water in the fuel. He reported that he normally applies carburettor heat upon entering the circuit and, whilst he could not definitely recall whether he did on this occasion, he saw no reason to believe that he had omitted such an habitual action. The weather conditions were such that the aircraft was flying in the '*Moderate icing risk at cruise power and serious icing risk at descent power'* portion of the carburettor icing chart published by the Civil Aviation Authority (Figure 1). The carburettor float chamber had not been checked for the presence of water at the time of preparation of this Bulletin.

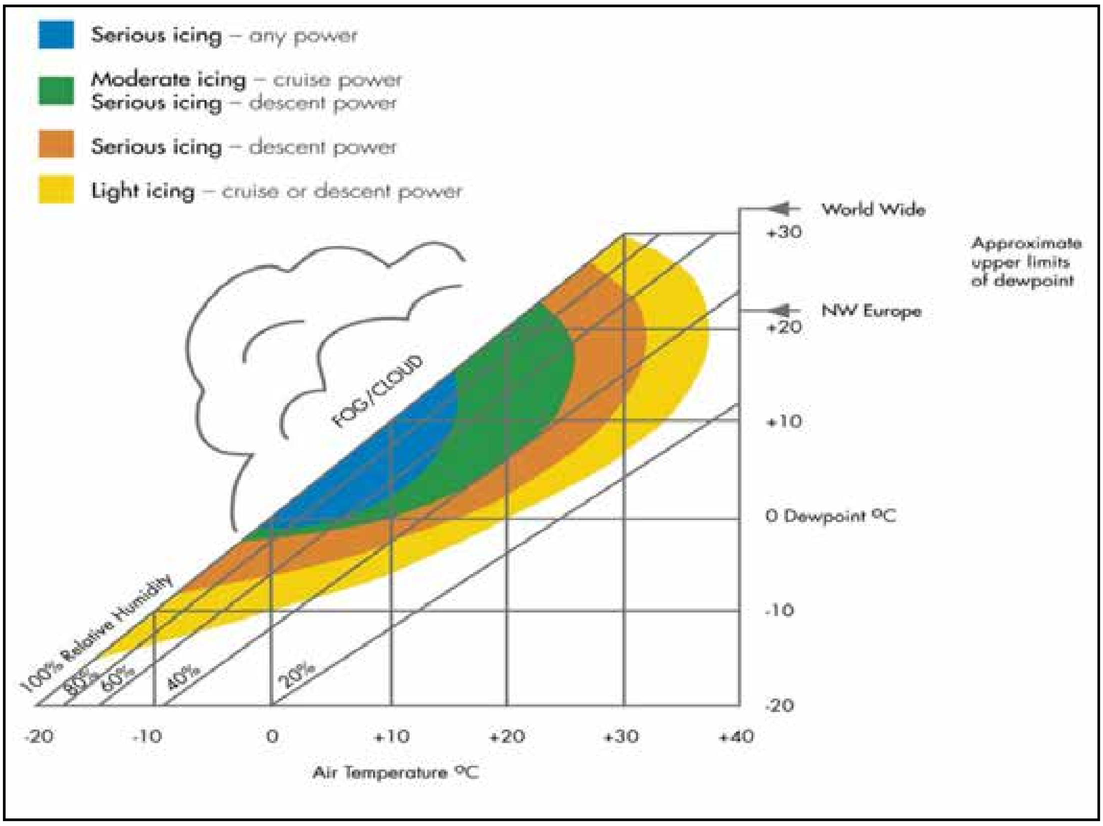


Figure 1

ACCIDENT

Aircraft Type and Registration:	Piper PA-46-350P Malibu, N71WZ
No & Type of Engines:	1 Lycoming TI0-540 SER piston engine
Year of Manufacture:	2000
Date & Time (UTC):	24 January 2015 at 1206 hrs
Location:	Bournemouth Airport, Dorset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nosewheel, propeller and windscreen damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	680 hours (of which 472 were on type) Last 90 days - 5 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was landing on Runway 26 at Bournemouth Airport. The weather was fine, with a surface wind from 310° at 11 kt. The aircraft touched down on the runway centreline but immediately deviated to the left. It ran off the paved surface onto the adjacent wet grass before the pilot was able to regain directional control through rudder pedal application and use of the right side wheel brakes. The pilot steered the aircraft back towards the runway, but as it crossed back onto the paved surface the nose landing gear encountered a slightly recessed drain and collapsed. The pilot noted that, as the aircraft was being recovered, the left wheel brake appeared to be binding. This, combined with the aircraft's behaviour at touchdown, led him to believe that the aircraft had touched down with undemanded partial left brake pressure applied.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MT-03, G-JBRE	
No & Type of Engines:	1 Rotax 912 ULS piston engine	
Year of Manufacture:	2007 (Serial no: RSUK/MT-03/016)	
Date & Time (UTC):	1 November 2014 at 1513 hrs	
Location:	Shoreham Airport, West Sussex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Rotor blades, propeller blade tips, tailplane, rudder cables and rods.	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	57 years	
Commander's Flying Experience:	149 hours (of which 92 were on type) Last 90 days - 29 hours Last 28 days - 9 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

During the initial part of an attempted takeoff from Runway 20 at Shoreham Airport, the gyroplane rotors came into contact with the propeller causing damage to the rotor blades, the tips of the propeller blades and the tailplane. The pilot rejected the takeoff and steered the gyroplane into the grass at the side of the runway. The control inputs and forward speed were inappropriate for the rotor speed, resulting in retreating blade stall. The pilot did not have much experience of busy airfields and believes this was a factor.

History of the flight

The pilot positioned his gyroplane on asphalt Runway 20 at Shoreham Airport with another gyroplane waiting to depart ahead of him and a number of aircraft sequenced to depart after him. The pilot pre-rotated the blades to the normal speed of 200 rpm to ensure he would not delay the following departures once he received his clearance. Pre-rotation reduces the risk of retreating blade stall to the main rotors as the airspeed increases during takeoff. After a short while without receiving takeoff clearance, he released the pre-rotation button to reduce wear to the drive mechanism. He stated that he subsequently re-engaged pre-rotation and, as he did so, he received takeoff clearance. He reported glancing at the rotor rpm indicator and, believing at the time that it read 200 rpm, he advanced the throttle, pulled back on the stick and started adjusting the rotor trim. Very shortly afterwards he felt a lateral jolt and then vibration. Misdiagnosing this as a problem with a wheel, he decided to vacate the runway to reduce damage to the runway and the wheel. He shut down and vacated the aircraft on to the grass to the left of the runway.

The damage to the lower surfaces of the rotor, along with the blade tip damage to the propeller, indicates that the combination of control inputs, low rotor speed and building airspeed resulted in the rotor blades contacting the engine propeller. The pilot believes his inexperience using a busy airfield was a factor.

ACCIDENT

Aircraft Type and Registration:	Skyranger J2.2(3), G-CBXS
No & Type of Engines:	1 Jabiru 2200 piston engine
Year of Manufacture:	2002 (Serial no: BMAA/HB/248)
Date & Time (UTC):	25 January 2015 at 1400 hrs
Location:	Ince Airfield, Merseyside
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose leg, nosewheel and spat, engine cowlings and propeller, engine possibly shock-loaded
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	175 hours (of which 18 were on type) Last 90 days - 13 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft made an approach to Runway 18 at Ince Airfield, Merseyside, with the wind direction and strength reported to be south-westerly at 11 kt. The pilot reported that the approach was normal until touchdown, when a gust of wind lifted the starboard wing, causing the aircraft to become airborne again with insufficient airspeed. The aircraft then landed heavily on its nosewheel, causing the nose leg to bend backwards and the propeller to strike the ground. The pilot, who was uninjured, vacated the aircraft normally.

Miscellaneous

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

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

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

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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

Published September 2011.

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

Published November 2011.

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

Published February 2014.

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

Published June 2014.

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

Published September 2014.

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

http://www.aaib.gov.uk

GLOSSARY OF ABBREVIATIONS

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

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