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SERIOUS INCIDENT

Aircraft Type and Registration:	Beech B200 Super King Air, G-SYGA
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-42 turboprop engines
Year of Manufacture:	1982 (Serial no: BB-1044)
Date & Time (UTC):	15 September 2012 at 0500 hrs
Location:	Glasgow Airport
Type of Flight:	Commercial Air Transport (Non-Revenue)
Persons on Board:	Crew - 2 Passengers - 3
Injuries:	Crew - None Passengers - None
Nature of Damage:	No damage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	2,700 hours (of which 2,000 were on type) Last 90 days - 45 hours Last 28 days - 21 hours
Information Source:	AAIB Field Investigation

Synopsis

On approach to Glasgow Airport, the crew inadvertently activated the go-around mode as they approached a cleared altitude. The distraction of this, coupled with their lack of experience on this type of B200, caused a short breakdown in crew situational awareness and the aircraft descended below the cleared altitude.

History of the flight

The aircraft was on a medical flight from Wick Airport to Glasgow Airport. This was the second sector the crew had flown that day; the first sector was the positioning flight from Glasgow to Wick. The aircraft had a crew of two pilots and there were three passengers in the cabin, a pregnant woman, a paramedic and a medical escort. On the positioning flight to Wick, the commander was the handling pilot and the co-pilot performed non-handling pilot duties. On the initial approach into Glasgow, the co-pilot was flying the aircraft from the right seat with the autopilot engaged in IAS (indicated airspeed) and HDG (heading) modes and with ALT SEL (altitude select) and APP (approach) modes armed.

The aircraft was vectored onto an ILS approach to Runway 23 at Glasgow and, at 18 nm from touchdown, cleared to intercept the localiser and to descend to 3,500 ft. In order to reduce speed, the co-pilot selected VS (vertical speed) mode (to maintain the current rate of decent) and reduced power.

Having established the aircraft on the ILS localiser, and as it approached the cleared altitude, to further reduce speed the co-pilot reduced power again, which caused the gear warning horn[1] to activate. The co-pilot attempted to cancel the warning horn with the GEAR HORN SILENCE button, which he thought was located on the left power lever, but accidentally pressed the GO-AROUND button instead. This caused a fly-up indication to be displayed on the flight director on the left instrument display, the autopilot to disengage and all the previously engaged flight director modes to disengage.

The commander immediately noticed that all the autopilot and flight director modes had disengaged, and informed the co-pilot that he intended to re-engage them. The co-pilot looked across at the annunciator panel, located above the left hand primary flight instruments, and observed that some of the modes had disengaged. The commander pressed the WARN HORN SILENCE button and directed his attention to the centre console to re-engage the autopilot modes (HDG, APP and ALT SEL). He looked back at the centre console when his initial attempt to re-engage ALT SEL was unsuccessful. When he looked back at the flight instruments he saw that the aircraft had descended below 3,000 ft and that the altimeter indication was decreasing rapidly. He immediately instructed the co-pilot to climb the aircraft back to 3,500 ft. The co-pilot applied full power, rotated the aircraft into a climb attitude and manually flew the aircraft back to 3,500 ft.

The co-pilot heard the commander state that the modes had disengaged and looked across the cockpit at the mode annunciator lights but, due to the angle of his view, he was not able to read them with sufficient clarity to determine which modes were active. He was distracted from his instrument scan by the persistent gear warning horn, by looking across the cockpit to the annunciator panel and by the subsequent activity of the commander. Initially he was unaware that the autopilot had disengaged. When the commander alerted him to the height loss, he took immediate action to climb the aircraft to the cleared altitude.

The ATCO observed the height loss and alerted the pilots. The GPWS system generated the aural warning "TERRAIN TERRAIN PULL UP" but this occurred after the crew had started to recover the aircraft to the cleared altitude. The ATC minimum safe altitude warning (MSAW) system alert was also activated but the ATCO had already observed the height loss and alerted the crew. At 11 nm from touchdown, the ATCO instructed the crew to descend to 3,000 ft and cleared them to fly the ILS. This, and the subsequent landing proceeded without further incident. The incident took place at night and in IMC.

Recorded information

The aircraft's position was recorded by the Glasgow radar head which also recorded the aircraft's Mode S altitude to within ± 50 ft. This altitude was corrected to the Glasgow QNH of 1012 hPa. The recorded track shows the approach to Glasgow Airport which crossed over the high ground to the north-east of the airport (see Figure 1).

As the aircraft descended through 3,500 ft, the rate of descent increased to approximately 3,000 ft per minute which was maintained for around 16 seconds. The aircraft descended to 2,273 ft before climbing back to 3,500 ft over 40 seconds and then continuing its approach to Glasgow Airport. The minimum terrain clearance during this manoeuvre was 1,484 ft.

Footnote

[1] The landing gear warning horn sounds when the landing gear is not in the down and locked position with the flaps in the UP or APPROACH positions and either or both power levers are retarded below approximately 85% N_1. The horn can be cancelled with a WARN HORN SILENCE button located on the main panel beside the landing gear control switch handle, just forward of the commander's right knee.

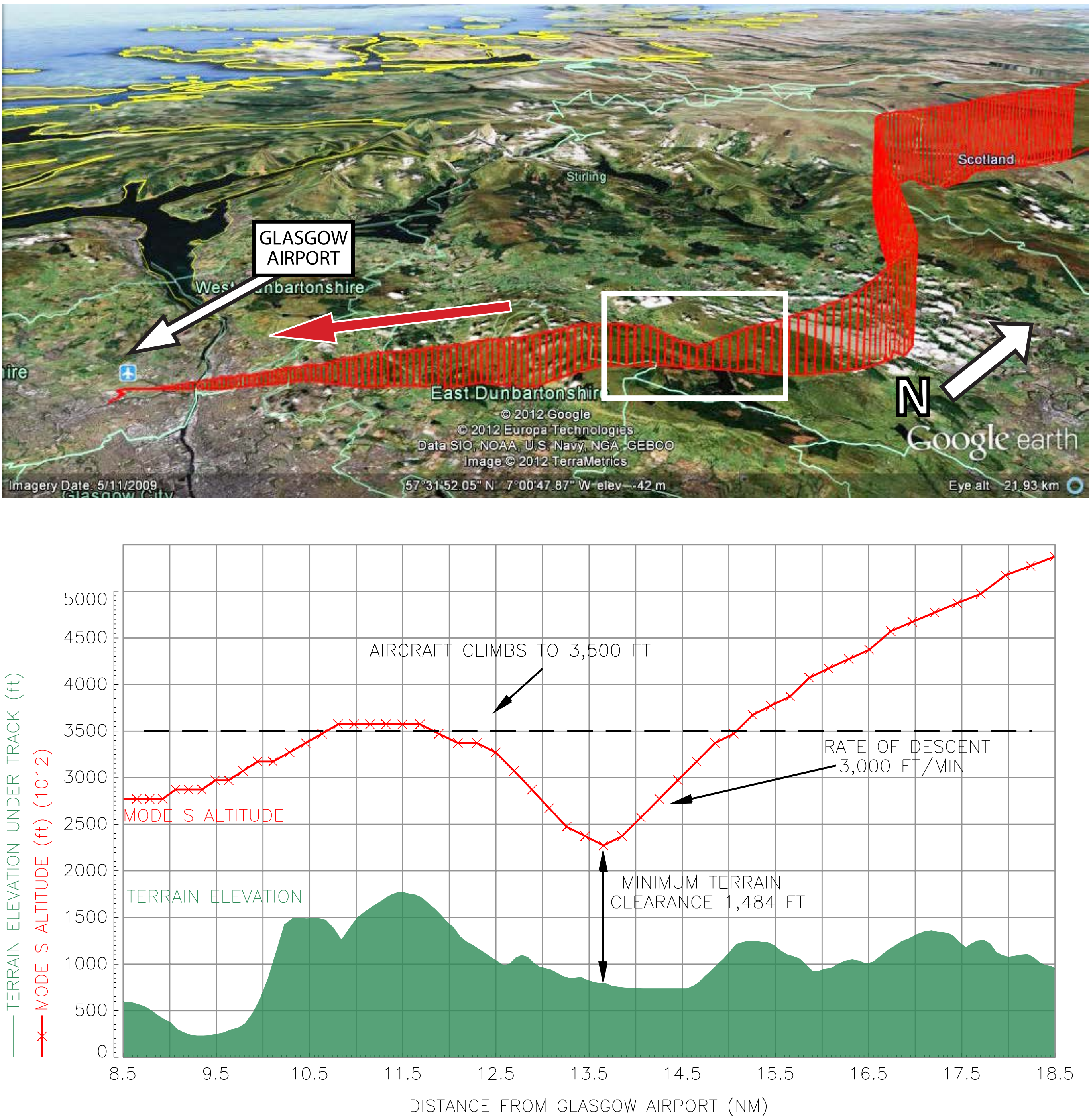


Figure 1

G-SYGA radar track and terrain under track

Beech B200 King Air cockpit differences

The pilots usually flew aircraft equipped with Pro Line 21 instrumentation. The operator leased G-SYGA when these aircraft were not available. There are several difference between the two types; only those relating to this incident are highlighted below.

Pro Line 21

The B200 cockpit with which the pilots were more familiar featured a Pro Line 21 electronic flight information system (EFIS). The autopilot and flight director mode selector panel is positioned above the centre instrument panel, just below the coaming, and is placed centrally between the two pilots. Autopilot modes are annunciated in the top section of each pilot's primary flight display.

The GEAR HORN SILENCE button is positioned on the left side of the left power lever just underneath the GO-AROUND button, which is located in a recess on the left side of the left power lever knob.

The co-pilot's main instrument display for a Pro Line 21 B200 is shown in Figure 2 and the associated power levers are shown in Figure 4.

G-SYGA

The cockpit of G-SYGA consists of conventional electromechanical flight instruments for both pilots. The left attitude indicator incorporates a flight director whereas the right attitude indicator has no flight director. The autopilot and flight director mode selector panel is located on the centre console to the right of the commander's right knee. The autopilot and flight director mode annunciators comprise a panel of rectangular lights positioned above the left attitude indicator. There are no mode annunciators on the co-pilot's side of the cockpit.

The WARN HORN SILENCE button is located on the lower main instrument panel just in front of the commander's left knee. The GO-AROUND button is located in a position similar to that of Pro Line 21-equipped aircraft but the button protrudes from the power lever knob rather than being recessed in it.

The co-pilot's main instrument display in G-SYGA is shown in Figure 3 and the power levers are shown in Figure 5.

Figure 2

Pro Line 21 - Right primary flight instrument display

Figure 3

G-SYGA - Right primary flight instrument display

Figure 4

Pro Line 21 – Power levers

Figure 5

G-SYGA – Power levers.

Co-pilot training

The co-pilot had joined the operator recently. He completed his type rating training in the USA using a simulator equipped to Pro Line 21 standard and on his return to the UK undertook line training at Aberdeen on Pro Line 21-equipped aircraft. After completing this training he flew a further five sectors, again on Pro Line 21 aircraft. A few days before the incident, before flying G-SYGA, he received a ground briefing on the aircraft from another pilot who was not an instructor. The co-pilot told the company he was content to fly an aircraft equipped with mechanical instrumentation.

Published guidance

EASA requirements

EASA publish a list of class or type ratings that details when differences training is required should a pilot extends his or her privileges to another variant of aircraft within one class or type rating. EASA do not require differences training should pilots move between different variants of B200 aircraft.

Where differences training is required, Part FCL.710 states that if a variant has not been flown for a period of two years following differences training then further differences training or a proficiency check shall be required.

LASORS

LASORS (Licensing, Administration, Standardisation, Operating Requirements and Safety), published by the CAA, provided the following guidance for pilots converting from EFIS to mechanical instruments for the first time.

'Converting from EFIS to Mechanical Instruments for the first time

Pilots trained in using Integrated EFIS displays but not trained on mechanical flight instruments, are likely to have established a scan pattern quite different from the techniques required by a conventional, mechanical instrument layout. These pilots are strongly advised to obtain differences training on conventional instruments, including selective radial scan techniques, before flying an aircraft with conventional mechanical instrumentation. EFIS can provide very precise information, which requires little interpretation, *as opposed to conventional instrument displays, which require considerable interpretation and different scan techniques. A key element in this type of training, on whatever system, is ensuring the pilot fully understands what information is available, what is being displayed and how to interpret the display correctly.'*

CAP 804

Two days after the incident, LASORS was superseded by CAP 804 entitled '*Flight Crew Licensing: Mandatory Requirements, Policy and Guidance*'. Part H, Subpart 1 of this document sets out the requirements for class and type ratings included in EASA licences, and contains '*Acceptable Means of Compliance and Guidance Material (AMC and GM)*'. The GM details guidance on differences training which includes, amongst other material, guidance on differences training for pilots converting to aircraft equipped with EFIS. The document did not contain any guidance on the differences training for pilots converting from EFIS equipped aircraft to those fitted with conventional mechanical instrumentation such as G-SYGA.

Analysis

On the day of the incident, the co-pilot was operating G-SYGA for the first time and, on the flight from Wick to Glasgow, flew as PF for the first time in this type of B200. The flight proceeded uneventfully until approaching 3,500 ft, when the co-pilot attempted to cancel the gear warning horn that followed a power reduction. He tried to locate the button in the position relevant to a Pro Line 21 aircraft but, as the button was in a different place, this resulted in inadvertent selection of the GO-AROUND button instead. This disengaged the autopilot and all the previously engaged autopilot and flight director modes, but produced no associated indications on the co-pilot's instrument panel.

The commander saw on the mode annunciation panel that the modes had disengaged. During his attempt to re-engage the modes using the panel on the centre console his attention was drawn away from the main flight instruments, diminishing his ability to monitor the flight path.

The co-pilot was unfamiliar with the instrument presentation on this aircraft which may have diminished the effectiveness of his instrument scan and increased his workload. Actions associated with the inadvertent autopilot disengagement distracted both pilots from the primary flight instruments and caused a breakdown in situational awareness, such that the aircraft descended below its cleared altitude unnoticed by the crew.

The co-pilot had received no formal differences training on B200 aircraft with mechanical flight instruments as recommended in LASORS. A formal programme of differences training would have addressed his inexperience on this type of B200 and this could have prevented the incident occurring.

Safety actions

As a result of this incident, the operator has introduced procedures to ensure that pilots who have not flown a mechanically instrumented aircraft within 90 days receive an expanded differences briefing from a training captain before flying the aircraft.

The CAA has amended Section 4, Part H of CAP 804 to include guidance on differences training for pilots converting from EFIS to mechanical instruments.

Conclusions

The incident followed a loss of situational awareness by the crew, caused by a combination of distraction and an unfamiliar cockpit layout.

SERIOUS INCIDENT

Aircraft Type and Registration:	Boeing 737-35B, LY-SKA
No & Type of Engines:	2 CFM56-3B2 turbofan engines
Year of Manufacture:	1988 (Serial No: 23972/1537)
Date & Time (UTC):	21 September 2012 at 1211 hrs
Location:	Birmingham International Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 137
Injuries:	Crew - None Passengers - None
Nature of Damage:	Nosewheels and tyres damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	45 years
Commander's Flying Experience:	7,520 hours (of which 4,500 were on type) Last 90 days - 150 hours Last 28 days - 62 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft left the paved surface of the taxiway and came to rest on grass beside it, having turned to vacate the runway at approximately 20 kt ground speed. The commander was attempting to vacate the runway expeditiously to avoid causing the following aircraft to go around.

History of the flight

The aircraft was on a scheduled flight from Nice Airport, France, to Birmingham International Airport on behalf of a UK operator. The commander was the pilot flying.

During the arrival brief the commander selected Autobrake 2 and planned to vacate Runway 33 at Taxiway Bravo. Figure 1 shows the layout of Birmingham International Airport. After an uneventful approach the aircraft landed in the touchdown zone, at the correct IAS; IDLE reverse thrust was then selected. The runway was wet and the wind was from 010° at 6 kt.

During the landing roll the commander judged the aircraft would not decelerate sufficiently to vacate at Taxiway Bravo without excessive braking, so he disconnected the Autobrake using the brake pedals just before Taxiway Bravo. He then cancelled thrust reverse, released the brakes and let the aircraft roll to the end of the runway to vacate at Taxiway Alpha.

As the aircraft rolled towards Taxiway Alpha, ATC informed a following aircraft "EXPECT LATE LANDING CLEARANCE PREVIOUS LANDER HAS GONE ALL THE WAY TO THE END." The commander stated he did not want

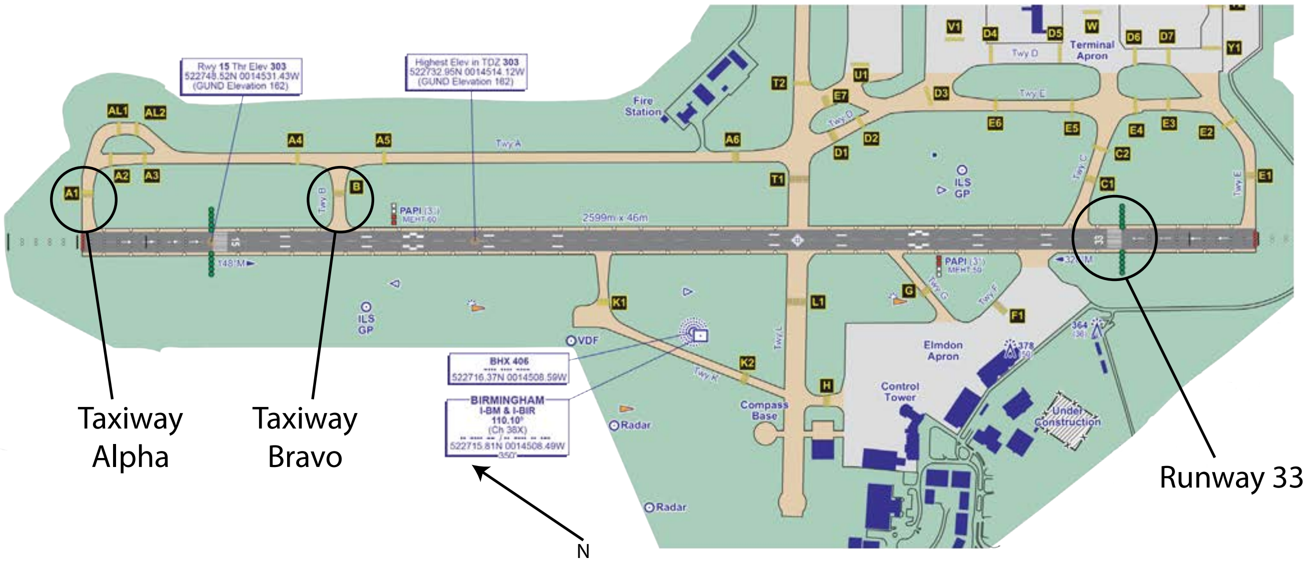


Figure 1

Birmingham International Airport Layout

to delay vacating the runway and cause the following aircraft to go around. He added that as the aircraft approached Taxiway Alpha he started to turn the aircraft at "about 12 kt". Initially the aircraft responded as expected but as the turn progressed the aircraft became "uncontrollable" and started to skid towards the left edge of the taxiway. The commander applied the brake pedals fully but the aircraft departed the taxiway onto adjacent grass and stopped. As ATC saw LY-SKA turn off the runway the following aircraft was cleared to land. Shortly thereafter the crew of LY-SKA informed ATC that they had stopped on the grass; the following aircraft was then instructed to go around.

After the aircraft stopped, the pilots started the APU and shut down the engines. They then established that there were no injuries. The passengers and crew eventually disembarked by the right rear door using steps provided by the airport operator and were transferred to the terminal by buses.

No other aircraft landing on Runway 33 in the wet that day reported any difficulties taxiing from the runway.

Examination of the aircraft

An examination by the engineering organisation that usually conducted turn-round checks for the operator revealed cuts in the tyre tread which probably occurred when travelling over the grass. The nosewheels and tyres were replaced.

There were no hydraulic leaks and the brake system components were undamaged. The brake wear pins were all found to be within limits. A built-in test of the anti-skid system revealed no faults and the main gear oleo extensions, checked following a report that the aircraft had adopted a 'right wing low' stance prior to departure, were found to be the same on each side.

Runway friction measurements

Chapter 10 of Annex 14 to the International Civil Aviation Organisation (ICAO) - *'Aerodrome Standards'*, outlines the requirement for airfield operators to undertake regular assessments of runway surface friction characteristics and to ensure that friction is maintained at an acceptable level. Civil Aviation

Publication 683 - '*The Assessment of Runway Surface Friction Characteristics*', published by the CAA, describes how runway friction assessments should be conducted using the three types of equipment currently accepted for use in the UK, and states target values for surface friction levels that should prompt maintenance or NOTAM action following an assessment, together with a Minimum Friction Level (MFL).

Birmingham International Airport (BIA) used a Grip Tester Mark II, which is equipped with a measuring wheel and an automatic watering system that delivers a 0.25 mm layer of water beneath the wheel. The Design Objective Level friction value using this equipment is 0.80 or greater, the Maintenance Planning Level is 0.63, and the MFL is 0.55.

BIA conducted a surface friction assessment following the incident. The results indicated that the overall friction level for the entire runway paved surface was 0.80, although the central portion was slightly less. There was no point on the runway where the friction level fell below the Maintenance Planning Level value for more than 100 m. The results showed there was no material change from the previous assessment, which was conducted in June 2012.

BIA also conducted a friction assessment of the taxiway surfaces[1] at each end of the runway. The start point for each Grip Tester run was the western edge of the runway, with the end point the 'Alpha One' or 'Echo One' stop-bar, giving a run length of 130 and 160 m respectively. As this was less than the minimum of 500 m required by the Grip Tester software, a non-standard method was employed to record the results. A small area of the surface was found to be under the MFL value on Alpha One. However, the average value for the surveyed area was in excess of 0.70.

Figure 2 shows the approximate track of LY-SKA's wheels and the area of reduced friction. The nose and right main gear traversed a maximum distance of approximately 5 m in this area.

Taxiway Echo results generally indicated slightly higher friction values, with no part falling below the MFL value.

Commander's comments

The commander commented that he was reluctant to cause the following aircraft to go-around because, on a previous occasion that he had been slow to vacate a runway, he had been admonished by the pilot of an aircraft that was instructed to go-around as a result.

Operations Manual

The operator's operations manual stated:

> '*Taxi Speed*
>
> *When approaching a turn, speed should be slowed to an appropriate speed for conditions. On a dry surface, use approximately* **10 knots** *for turns greater than those typically required for high speed runway turnoffs* [Rapid exit taxiways[2]].'

Recorded information

The aircraft was fitted with a Flight Data Recorder (FDR) and a two-hour CVR which both captured the landing event. The FDR recorded 18 parameters which did not include any thrust reverser, braking, steering or ground speed parameters.

Footnote

[1] This assessment was conducted to assist the AAIB; there are currently no requirements, procedures or standards for the assessment of friction on taxiways.

Footnote

[2] Annex 14 'Aerodrome Standards' states: '*The intersection angle of a rapid exit taxiway with the runway shall not be greater than 45°. nor less than 25° and preferably shall be 30°.*'

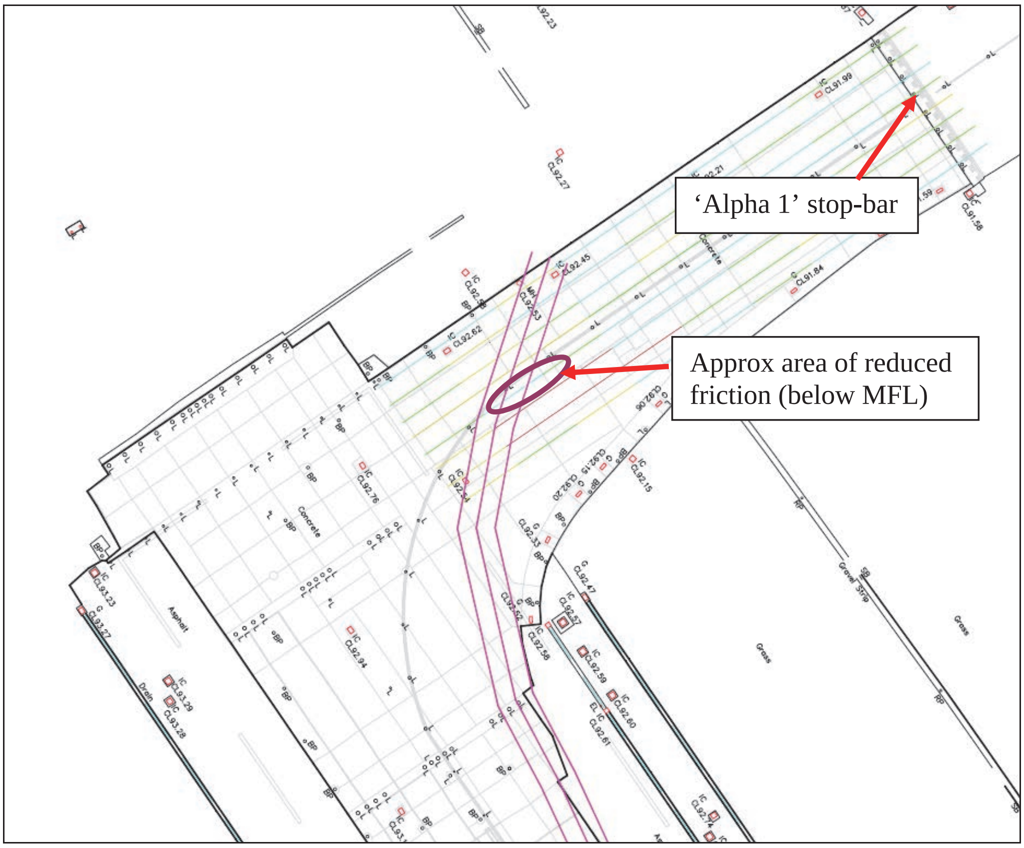


Figure 2

Northern end of Runway 33 showing approximate track of LY-SKA's wheels and area of friction below MFL

Closed-circuit television provided by the airport operator showed that the aircraft touched down within the Runway 33 touchdown zone. At the same time the FDR recorded an airspeed of 137 kt, which in the prevailing conditions indicates a groundspeed of 132 kt. The groundspeed for the remainder of the landing was calculated using longitudinal acceleration because airspeed becomes inaccurate at low speed.

FDR data confirmed deceleration after touchdown at around the Autobrake 2 deceleration target of 0.155g. Approximately 25 seconds after touchdown, the deceleration profile suggested a pedal braking override of Autobrake, followed by release of the brake pedals for 18 seconds as the aircraft coasted towards Taxiway Alpha. Figure 3 shows that at a calculated groundspeed of 36 kt, further deceleration, from pedal braking, was applied just prior to the turn. When the rate of turn was at a maximum, the calculated aircraft groundspeed was 21 ± 3 kt which reduced to 14 ± 3 kt as the nosewheel left the taxiway onto the grass.

The Air Traffic Service Unit (ATSU) at Birmingham stated that as LY-SKA touched down, the next aircraft to land was 4.5 nm from touchdown at an altitude of 1,900 ft. As LY-SKA began to vacate the runway, the next aircraft was 2.5 nm from touchdown at 1,100 ft and was instructed to go around when at 600 ft and ⅔ nm from touchdown.

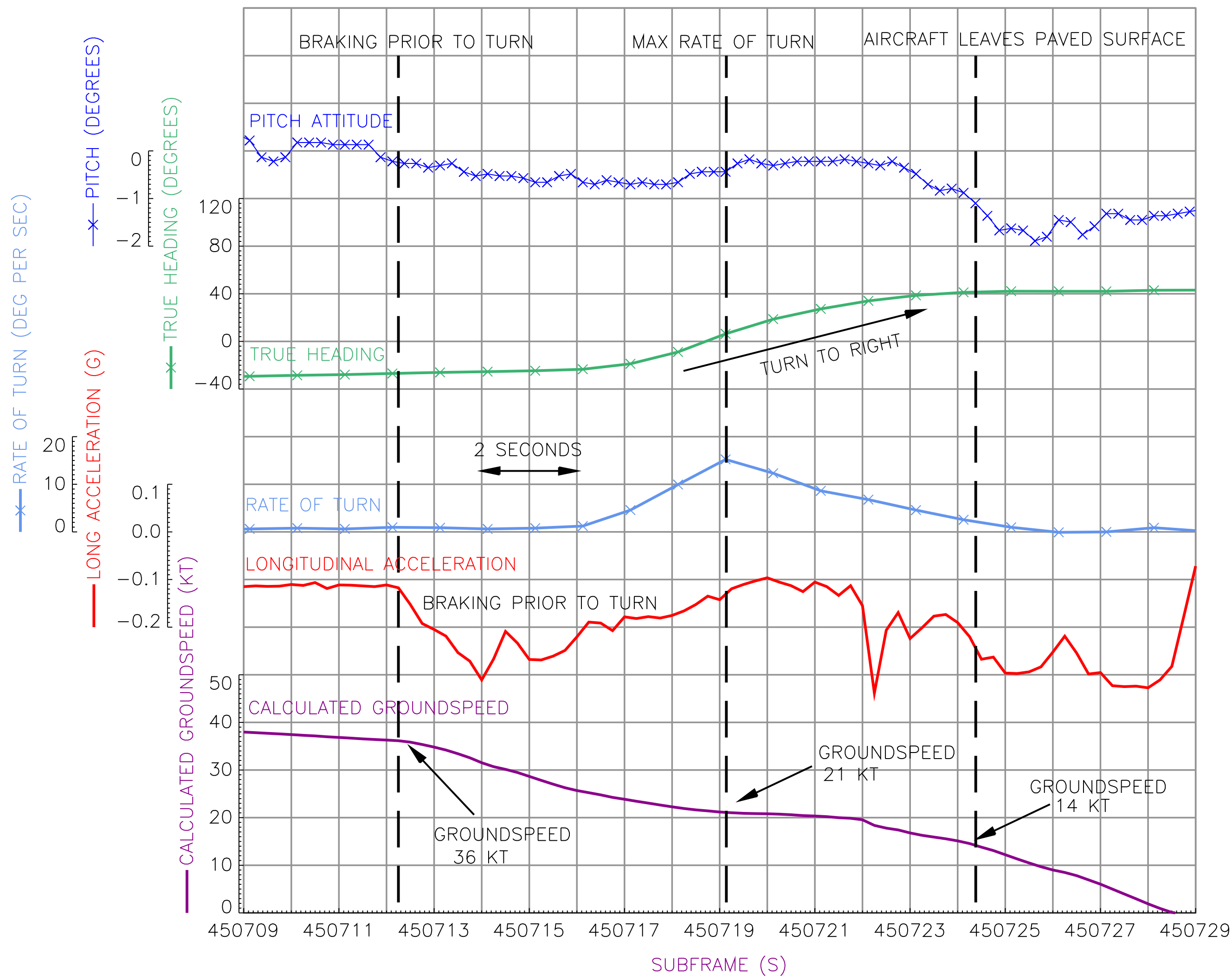


Figure 3

LY-SKA FDR parameters

Analysis

The operator's operations manual stated that a ground speed of approximately 10 kt should be used for making a turn from runway on to a non high-speed taxiway in the dry, such as Taxiway A at BIA. As the runway and taxiway were wet a lower speed would have been appropriate. The aircraft commenced the turn from the runway above 20 kt. It is unlikely the area of reduced friction on Taxiway Alpha had a significant effect on the outcome because the nose and right main gear encountered it for a maximum distance of approximately 5 m.

The commander stated that he did not want to cause the following aircraft to go-around by occupying the runway for too long. However, the commander would not have known how far behind the following aircraft was or how much time remained to vacate the runway without affecting its approach. In the event, the following aircraft was instructed to go-around because LY-SKA had not completed the turn successfully.

Conclusion

The aircraft departed the paved surface of the taxiway because it turned to vacate the runway at a speed inappropriate for the conditions.

SERIOUS INCIDENT

Aircraft Type and Registration:	Fan Jet Falcon 20E, G-FRAI
No & Type of Engines:	2 General Electric Co CF700-2D-2 turbofan engines
Year of Manufacture:	1972 (Serial no: 270)
Date & Time (UTC):	9 August 2012 at 0915 hrs
Location:	Runway 23, Durham Tees Valley Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Foreign object damage to engines
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	39 years
Commander's Flying Experience:	3,066 hours (of which 1,005 were on type) Last 90 days - 78 hours Last 28 days - 27 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft overran the runway when takeoff was abandoned due to a potential birdstrike. The crew stated that V_1 had not been called when the decision to stop the takeoff was made but analysis of available recorded data indicated that the aircraft was approximately nine knots above V_1 when actions were taken to reject the takeoff. No aircraft faults were found to have contributed to the incident although the surface friction characteristics of the runway stopway adversely affected the deceleration rate achieved during the final stages of the rejected takeoff. The lack of a CVR or FDR severely limited the ability of the investigation to determine the exact sequence of events during the incident. Two Safety Recommendations are made.

History of the flight

The crew, comprising a commander and co-pilot, reported for duty at 0745 hrs at their company offices at Durham Tees Valley Airport, together with an electronic warfare officer[1] who was to fly with them that day. On reporting, they were informed that they had been tasked that morning to simulate electronic threats for RAF aircraft training over the North Sea. The crew carried out the necessary pre-flight planning and walked out to the aircraft at about 0845 hrs. They completed the aircraft pre-flight preparation, which went without incident, and taxied for takeoff at 0903 hrs, with the commander acting as handling pilot. The electronic

Footnote

[1] The electronic warfare officer operates equipment carried by the aircraft but, as he is not intrinsic to the operation of the aircraft itself, is not technically considered part of the crew.

warfare operator occupied a seat halfway down the aircraft cabin, situated behind a mission equipment console.

The aircraft was taxied for a full length takeoff from Runway 23, during which the crew received takeoff clearance for a visual departure. They configured the aircraft for a flap zero departure and carried out the pre-takeoff checks, which included a brake and anti-skid check. All checks were normal.

After lining up approximately 40 m from the start of Runway 23 the pilots carried out a power assurance check in accordance with standard procedure, setting an EPR of 1.55 prior to releasing brakes for takeoff. As the aircraft accelerated down the runway the co-pilot carried out the standard acceleration checks[2]. These revealed an indicated longitudinal acceleration reading of 0.27 g against the pre-determined figure of 0.25 g, and a time to 100 kt of 19 seconds, against the calculated time of 21 seconds. Takeoff was continued with the standard calls being made between the two pilots. These included calls on passing 80 kt and 100 kt, with the commander expecting the next call to be on passing the calculated V_1 of 141 kt. Before this call had been made, the commander became aware of a large bird standing close to the runway centreline about 250 m ahead of the aircraft. The bird was seen to take off and fly along the runway, away from the aircraft, before turning round and flying back down the runway towards the aircraft. The bird passed down the left side of the aircraft, sufficiently close that the commander considered a birdstrike inevitable. He was concerned that this might result in damage to the control surfaces or an engine and so he decided to abort the takeoff. The commander stated he called "bird, aborting", retarding the thrust levers whilst applying full brakes and then deploying the airbrakes. The commander said that he called that he was aborting the takeoff at the same time as the co-pilot called V_1.

The crew felt the aircraft decelerate and the co-pilot informed ATC that the takeoff had been aborted. The slope of the runway meant that the end of the runway was not initially visible to the crew. When the end of the runway came into sight a few seconds later the commander considered the aircraft was not slowing at a sufficient rate to stop in the distance remaining. While maintaining maximum force on his own brake pedals he told the co-pilot to apply the brakes as well to ensure full braking pressure was being applied. The co-pilot did so, but with no discernable effect on the aircraft's deceleration.

There were no failure or warning indications apparent to the crew at any point during the aircraft acceleration and deceleration phases and they maintained maximum pressure on the brake pedals as the aircraft continued to slow. Despite this the commander realised the aircraft was not going to stop in the distance remaining and steered to the right of the centreline to avoid the ILS and lighting arrays beyond the end of the runway.

The aircraft departed the end of the runway, crossed the 119 m stopway, the remaining 60 m of the runway strip and continued onto the grass Runway End Safety Area (RESA). The wheels of the undercarriage sank into the soft ground, quickly bringing the aircraft to a halt. The crew shut down the engines and made the aircraft safe before vacating the aircraft through the left cargo door, this being the normal door used for entry and exit. The airfield emergency services were quickly in attendance, followed by emergency vehicles from the local authority. There was no fire, although fire crews reported that when

Footnote

[2] Three seconds after brake release the indicated longitudinal acceleration is checked to ensure it equals or exceeds the pre-determined value. The time for the aircraft to accelerate to 100 kt is then also checked to ensure it is equal to, or less, than the pre-determined value.

they arrived there had been smoke or steam coming from mud which had become caked between each pair of main wheels. The mud was removed from the brake units to assist with brake cooling.

Incident site

The aircraft came to rest within the RESA, on a soft grass surface 54 m beyond the end of the Runway 23 strip (Figure 1). The aircraft's tyre marks were discernible on the concrete-surfaced section of the runway and on the stopway and strip, both of which had an asphalt surface covered by scattered loose gravel. Inspection of these tyre marks showed no evidence of mainwheel skidding or locking.

The aircraft sank above the mainwheel axles into the soft grass surface and slewed to the right, onto a heading of 244º M, due to softer ground beneath the right main landing gear. A small quantity of fuel leaked from the right wing fuel tank vent, due to the resting attitude of the aircraft. Mud and stones were ingested into both engines. The right inboard brake unit had seized and was removed to allow the aircraft to be recovered.

The remains of a single carrion crow, weighing approximately 1 lb, were recovered from the runway at a point approximately 1,400 m (4,600 ft) from the start of the aircraft's takeoff roll. The crow was largely intact and showed no evidence of having been ingested by either of the aircraft's engines. No witness mark from a bird impact was visible on the aircraft, although it may have struck the landing gear with any impact marks having been subsequently obscured by mud.

Figure 1

Incident site

Weather

The weather at the time of the incident was good with dry conditions and a light wind of 2 kt from the SSW. The temperature was 18° C and the QNH was 1026 hPa. The temperature at the time the crew carried out their performance calculations had been 12° C and this figure was used in their calculations.

Pre-flight performance calculations

Takeoff performance for the flight was determined as part of the pre-flight preparations by the crew using the relevant aircraft manuals. Section 5, sub-section 10, page 1a of the aircraft flight manual describes the take-off field length as the greatest of:

'• *115% of all engines operating distance up to 35 ft*

- *The total distance considering an engine failure recognition at V_1 appropriate to a dry runway*
- *The total distance considering an engine failure recognition at V_1 appropriate to a wet runway'*

Section 5, sub-section 1, page 2 of the aircraft flight manual defines V_1 as the critical engine failure speed (dry or wet) for which, if an engine failure occurs:

- *'The distance to continue the takeoff to a height of 35 feet for "dry V_1", or not less than 15 feet for "wet V_1" will not exceed the usable takeoff distance, or,*
- *The distance to bring the aeroplane to a full stop will not exceed the accelerate-stop distance available.*
- *The speed V_1 corresponds to the time a failure is detected.'*

It further states that V_1 must not be greater than the rotation speed, V_R.

Takeoff performance

The aircraft had underwing stores fitted to three of its four pylons and a fuel load of 8,400 lb, giving a takeoff mass of 29,171 lb.

The maximum takeoff weight for the aircraft under the prevailing conditions (but with a temperature of 12° C) was 29,800 lb, restricted by an obstacle in the second segment climb. The dry V_1 speed was 141 kt and the field length limit allowed takeoff at the aircraft's maximum certified takeoff mass of 30,000 lb.

Using the actual temperature at takeoff of 18° C, the maximum takeoff mass for the aircraft remained limited by the obstacle in the second segment climb with the dry V_1 speed remaining at 141 kt. The field length limit still allowed takeoff at the aircraft's maximum certified takeoff mass of 30,000 lb. Under these conditions the scheduled takeoff distance required was 2,194 m (7,197 ft) with a maximum brake energy speed (V_{MBE}) of 156 kt.

Airfield information

Durham Tees Valley Airport has a single runway, denoted 05/23. It is 2,291 m long and 45 m wide classifying it as a Code 4 runway under CAP 168[3]. The runway is predominantly asphalt except for a concrete section at either end.

The longitudinal profile of Runway 23 complies with CAP 168 requirements. CAP 168 Chapter 3,

Footnote

[3] CAA document: CAP 168 Licensing of Aerodromes.

Section 3.4.1 states that where slope changes cannot be avoided they should be such that for aircraft with the wingspan of the Falcon 20E:

> *'there will be an unobstructed line of sight from any point 2 m above the runway to all other points 2 m above the runway within a distance of at least half the length of the runway'.*

Records held by the CAA do not identify a variation from this requirement at Durham Tees Valley Airport although it has not been possible to determine whether this has ever been properly confirmed through an appropriate survey.

The following distances for Runway 23 are declared in the UK AIP:

Takeoff Run Available (TORA)	2,291 m (equivalent to 7,516 ft)
Accelerate Stop Distance Available (ASDA)	2,410 m (equivalent to 7,906 ft)
Takeoff Distance Available (TODA)	2,500 m (equivalent to 8,202 ft)

CAP 168 provides the following definitions and additional information:

> '<u>TORA</u> - *The distance from the point on the surface of the aerodrome at which the aeroplane can commence its take-off run to the nearest point in the direction of take-off at which the surface of the aerodrome is incapable of bearing the weight of the aeroplane under normal operating conditions.*
>
> <u>ASDA</u> - *The distance from the point on the surface of the aerodrome at which the aeroplane can commence its take-off run to the nearest point in the direction of take-off at which the aeroplane cannot roll over the surface of the aerodrome and be brought to rest in an emergency without the risk of accident.*
>
> <u>Stopway</u> - *A defined rectangular area beyond the end of the TORA, suitably prepared and designated as an area in which an aircraft can be safely brought to a stop in the event of an abandoned takeoff.'* (The stopway's length is equivalent to the difference between ASDA and TORA and equates to 119 m for Runway 23). *'It should have sufficient load-bearing qualities to support the aeroplanes it is intended to serve without causing them structural damage. The surface of a paved stopway should have friction characteristics not substantially less than those of the associated runway and above the Minimum Friction Level stated in CAP 683*[4]*. It should be kept free from debris and loose material which could damage aeroplanes. A stopway may be an economical substitute for what would otherwise have to be provided as paved runway to meet the take-off field length requirements of some aeroplanes.*
>
> <u>Runway Strip</u> - *An area of specified dimensions enclosing a runway intended to reduce the risk of damage to an aircraft running off the runway and to protect aircraft flying over it when taking-off or landing. A runway strip is an area enclosing a runway and any associated stopway. Its purpose*

Footnote

[4] CAA Document – CAP 683 The Assessment of Runway Surface Friction Characteristics.

is to reduce the risk of damage to an aeroplane running off the runway by providing a graded area which meets specified longitudinal and transverse slopes, and bearing strength requirements. It protects aeroplanes during take-off by providing an area which is clear of obstacles except permitted aids to air navigation. A runway strip should extend beyond each end of a runway and of any associated stopway for a distance of at least 60 m for a Code 4 runway.' (The runway strip at the end of Runway 23 at Durham Tees Valley is 60 m). *'The total area within the runway strip should be capable of supporting unrestricted access for emergency service vehicles.*

RESA - An area symmetrical about the extended runway centreline and adjacent to the end of the runway strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway. The surface of the RESA does not need to be prepared to the same standard as other associated runway areas but should enhance the deceleration of aeroplanes in the event of an overrun whilst not causing it damage or hindering the movement of rescue and fire fighting vehicles.' Runway 23 had a RESA of 106 m which exceeds the minimum required length for a Code 4 runway of 90 m. Wherever practical and reasonable CAP 168 recommends a RESA of at least 240 m.

An annotated diagram showing how the above definitions relate to the end of Runway 23 at Durham Tees Valley Airport is shown in Fig 2 below.

Figure 2

The end of Runway 23 at Durham Tees Valley Airport

Runway friction

A runway surface friction assessment conducted in May 2012 found that its friction characteristics exceeded the requirements as defined in CAP 683. The results indicated that the friction characteristics would have remained above the minimum required levels at the time of the incident. Limitations in existing continuous friction measuring equipment makes the measurement of friction characteristics at runway ends and stopways impractical and figures for these areas of Runway 23 were not available. The CAA, with others, is currently undertaking research into friction measurement capability in order to address this problem.

Bird control measures

During daylight hours bird control patrols were conducted continuously on the airfield with bird activity and control measures employed being recorded in a log. A runway inspection was carried out a least once every thirty minutes. Where bird or animal remains are found on airfield they are removed.

The bird control log listed a number of birds having to be dispersed from the airfield on the morning of the incident. A bird inspection of Runway 23 took place at 0845 hrs with two crows being sighted at 0850 hrs on the northern side of the runway in the area of the Runway 05 threshold. The log indicates the birds were moved from the area of the runway by the patrol.

CAP 772 provides information on birdstrike risk management at airfields. Chapter 6, section 4.4.2 includes the following information on carrion crows:

> *'Carrion crows are involved in very few birdstrikes. Although continuously and almost universally present on aerodromes, they occur in small numbers and, being resident, apparently establish routines that help them avoid aircraft. However, their habit of feeding on carrion on runways and the occurrence of nomadic flocks create a potential birdstrike risk, which cannot be ignored.'*

The aircraft

G-FRAI was built in 1972 and acquired by the operator in 1990 for conversion into a special-missions aircraft, which involved the addition of four under-wing pylons for external stores and an electronic warfare officer's (EWO) workstation in the cabin. In 1995 the aircraft's maximum certified takeoff mass was increased from 28,660 lb to 30,000 lb by a UK CAA-approved Supplementary Type Certificate (STC).

The operator upgraded the aircraft's avionics system to incorporate the Collins ProLine IV system in 2004, and certain parameters from this system were recorded on the EWO's Situational Awareness Display System (SADS). Each pilot had an airspeed indicator which had a vertically-moving digital strip.

The aircraft was not equipped with thrust reversers or a drag chute.

Description of the braking system

The aircraft has twin-wheel main landing gears (Figure 3) and each mainwheel is equipped with a three-rotor disk brake assembly. The brake rotors are keyed such that they rotate with the mainwheels and are coated with a friction lining on both faces. The fixed section of the brake assembly consists of a housing plate accommodating ten brake pistons in addition to

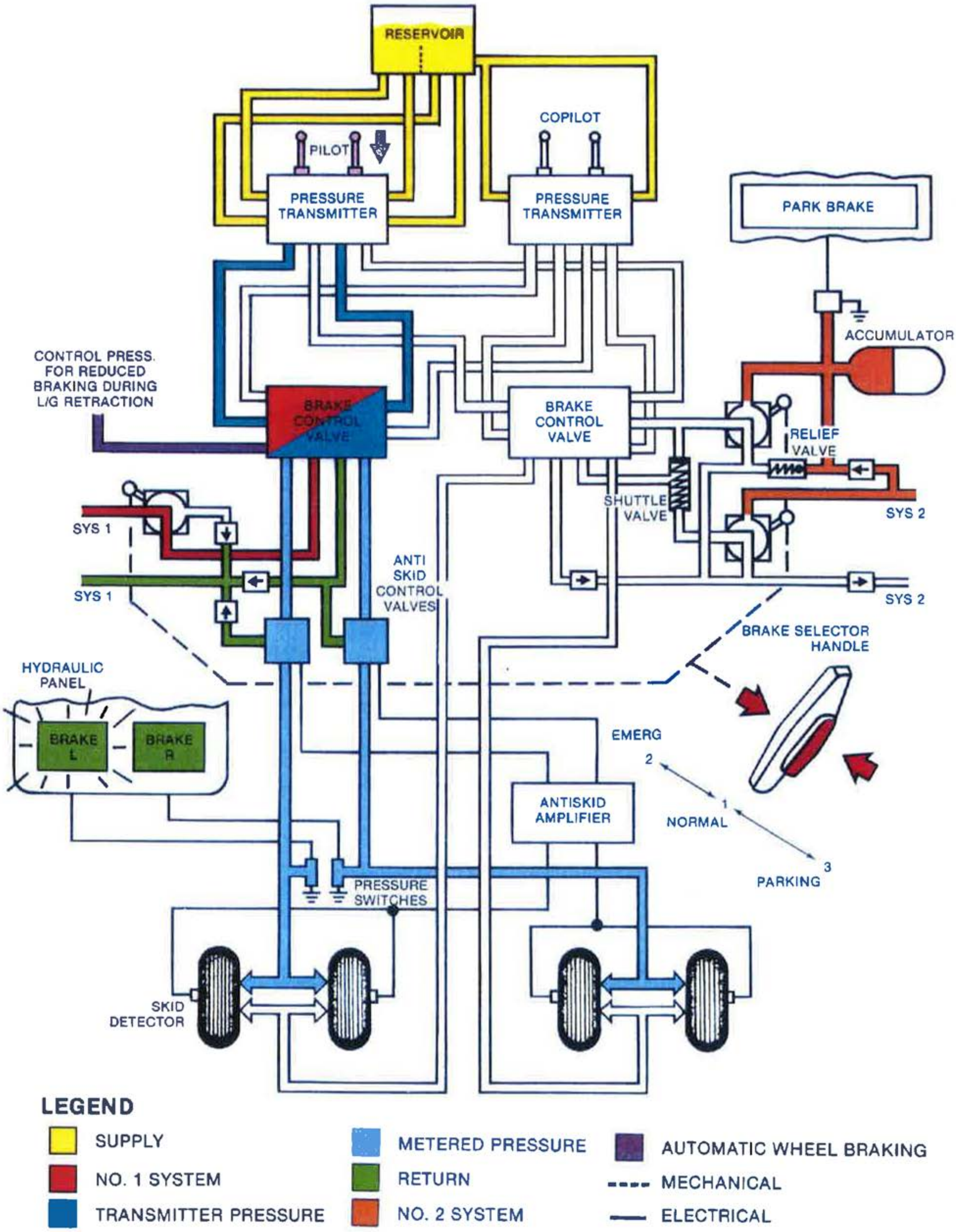


Figure 3

Falcon 20E braking system operation in the normal mode a thrust plate, a pressure plate and two stator disks, all of which are lined with friction pads. When hydraulic pressure is applied to the brakes, the pistons contact the thrust plate and compress the rotor and stator disks against the pressure plate to provide braking action. The housing plate is drilled with two independent hydraulic passageway systems, each supplying five brake pistons, enabling brake pressure to be independently supplied by either the number 1 hydraulic system for normal brake operation, or by the number 2 hydraulic system for emergency braking. Selection of the braking mode is controlled by a three-position mode selector handle mounted in the centre of the instrument panel glareshield.

In the normal braking mode, when the rudder pedals are pushed forwards, transmitters connected to the rudder pedals actuate a brake control valve that increases the pressure in the brake pistons up to a maximum nominal value of 1,175 psi. An anti-skid system modulates the maximum braking pressure to just below the skid threshold point by means of wheel-speed tacho-generators mounted in each mainwheel axle, two anti-skid control valves and a system control box mounted in the rear fuselage.

During certification flight testing of the three-rotor disk brakes, the manufacturer demonstrated rejected takeoffs (RTOs) from a maximum kinetic energy of 43.2 MJ. Analysis conducted by the manufacturer showed that during these RTOs approximately 84% of the aircraft's kinetic energy, 36.2 MJ, was absorbed by the brake units, with the remaining 16% being mainly accounted for by aerodynamic drag and rolling resistance.

Aircraft records

The aircraft technical log recorded that a daily inspection had been carried out at 1715 hrs on the day preceding the incident, following the last flight that day. The engineer who performed this inspection confirmed that the brake wear indicators were checked using the correct special tool and that the brake wear was within AMM limits.

Aircraft examination

The aircraft was recovered to the operator's hangar for detailed examination. Apart from foreign object damage to both engines, the aircraft was otherwise undamaged. None of the mainwheel thermal fuse plugs had melted and all the aircraft's tyres remained inflated. The aircraft was raised on jacks to allow the hydraulic pressure at each brake unit to be measured using pressure gauges which, for the purpose of the test, required the seized right inboard brake assembly to be replaced with a new unit. In the normal braking mode, full deflection of the pilot's brake pedals resulted in brake pressures of between 1,080 and 1,140 psi being recorded, with minor variations between individual brake units. The acceptable range of maximum brake pressure is specified in the aircraft maintenance manual (AMM) and has a lower limit of 1,073 psi and an upper limit of 1,233 psi. Full deflection of the co-pilot's brake pedals resulted in brake pressures between 1,160 and 1,200 psi and it was therefore demonstrated that full deflection of either set of brake pedals resulted in the required level of maximum brake pressure.

All four brake units were removed for disassembly and, despite having absorbed considerable heat during the rejected takeoff, the brake rotors still retained an average thickness of 0.4 mm of friction lining material[5]. The cause of the seized right inboard brake assembly was traced to small areas of brake lining material that had melted, fusing the rotors and stators together as it subsequently cooled; the reason why this brake unit

Footnote

5 A new brake pack was measured which had a brake rotor friction lining thickness of 1.7 mm.

had become marginally hotter than the other brake units could not be determined.

The anti-skid system was checked for correct operation by performing the test procedure set out in the AMM and additionally by carrying out an approved *'Local Maintenance Instruction'* procedure using a test box to perform more detailed testing of the anti-skid control electronics. Both tests demonstrated that the anti-skid system was serviceable.

Samples of hydraulic fluid from both hydraulic systems were taken and analysed by a specialist laboratory and the results did not reveal any abnormalities that would cause a significant reduction in the aircraft's braking action. A pitot/static system calibration and leak check was carried out in accordance with the AMM and all measurements were within the required tolerances.

Recorded data

The aircraft was being operated under the UK Air Navigation Order 2009 but had a UK CAA exemption from the requirement to be equipped with an FDR and a CVR, and had neither fitted. However, the SADS, a Windows XP based tablet, recorded data gathered from the Collins ProLine avionics via a dedicated interface unit. This recorded UTC, radio altitude, pressure altitude, IAS, temperature, ground speed, track, heading, drift, pitch, latitude, longitude and magnetic variation. However, the SADS was designed to give the operator situational awareness and, as the sampling rate used by the system to gather data is not sufficiently consistent, the system is inadequate for detailed incident analysis.

Data point timing

The SADS gathers data samples from avionics busses at a nominal rate of one per second but, as the tablet uses an operating system that is not designed for real-time applications, this rate can vary. Testing by the interface unit manufacturer, using a computer system representative of, but not identical to, the SADS tablet, indicates that the majority of samples are likely to be requested within approximately 50 ms of the nominal one second sample period but occasionally a larger gap between samples was observed.

Parameters are time-stamped but, with limitations of the time stamp resolution and refresh rate, a parameter value could have sampled anywhere within a 1.2 second period. This results in recorded data with insufficient fidelity for detailed analysis.

It is unlikely that successive samples will have been requested by the tablet at intervals of significantly less than 1 second, but the actual time between requests for samples with a time-stamp of one second apart could theoretically have been up to 2.2 seconds apart.

During the RTO, at the time of peak speed and another point shortly after this, two time-stamps and their associated parameters were not recorded. With a missing time-stamp, samples that are stamped as 2 seconds apart could theoretically be between 0.8 and 3.2 seconds apart.

GPS data

The recorded position, track and groundspeed are GPS based. These GPS based parameters were unreliable at low speeds at the start of the takeoff run and towards the end of the RTO and so were not used for further analysis. However, when the GPS parameters appeared more stable, the recorded values of IAS were consistent with those of groundspeed.

The average GPS position of the stationary aircraft on the runway was taken as the start point of the takeoff roll. This was approximately 40 m (131 ft) from the start of the runway. Integrating the IAS over time from this start point provided a calculated distance travelled that correlated well with the actual distance travelled.

Event data

Figure 4 shows the pertinent recorded parameters and acceleration calculated from the recorded IAS.

Calculations indicate that on passing 141 KIAS the aircraft had travelled approximately 1,171 m (3,842 ft).

The data shows continued consistent acceleration between 140 KIAS and 150 KIAS. The peak recorded airspeed was 151.9 KIAS, three seconds after 140.6 KIAS was recorded. Even taking into account the time-stamp issues discussed above, it is unlikely that the time between these values was less than 2.8 seconds.

From 140 KIAS to 100 KIAS, assuming accurate time-stamps, the average deceleration was -0.42 g. The aircraft left the end of the runway at approximately 75 KIAS. Once on the stopway and then the runway strip, deceleration reduced significantly and the aircraft continued until it ran onto the grass. The aircraft departed the stopway with a speed of approximately 60 KIAS and entered the grass with a speed of approximately 50 KIAS. The data indicates the grassed area provided significant retardation, bringing the aircraft to a stop.

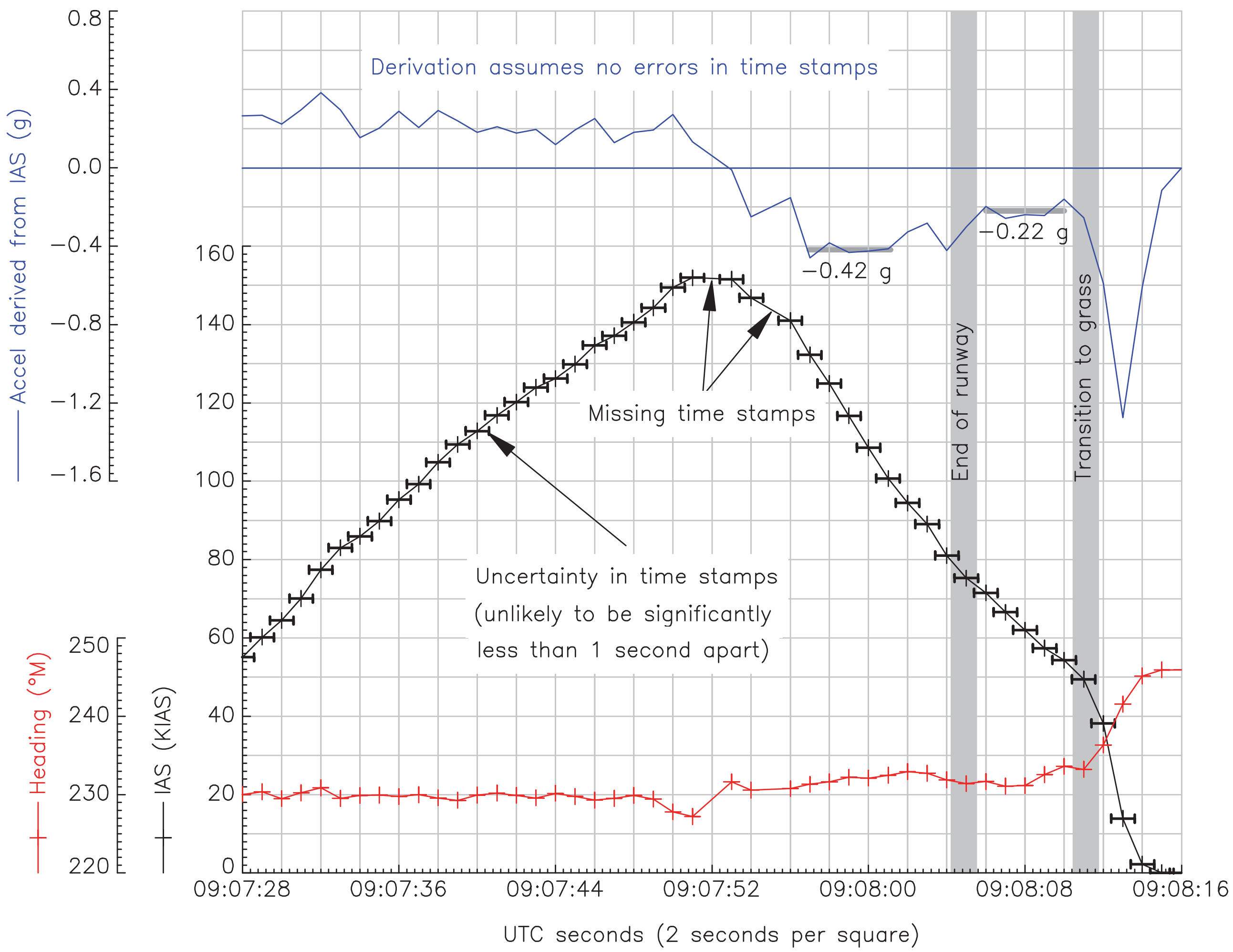


Figure 4

Pertinent recorded data and calculated acceleration

FDR and CVR exemption

Under the requirements of the UK Air Navigation Order 2009, this type of aircraft should be fitted with an FDR and CVR. However, the operator has a UK CAA exemption from this requirement for its Dassault Falcon 20 fleet. The application for the exemption was made due to perceived difficulties and cost in retrofitting the recorder systems required when weighed up against the expected remaining life of this particular fleet. The UK CAA granted this exemption on an annual basis since the fleet was acquired by this operator. The exemption renewal granted in 2009 followed correspondence between the CAA and the AAIB as to the acceptability of its continuation.

A significant part of the cost of retrofitting an FDR system is associated with providing additional wiring and interfacing to the existing aircraft systems to capture the required parameters. This investigation has highlighted that, since the original exemptions were granted, this operator's aircraft have been retrofitted with a modern avionics suite with provisions for interfacing to an FDR. This would significantly reduce the cost of interfacing to the majority of the required parameters should an FDR system be retrofitted.

Discussions with the appropriate maintenance organisation did not identify any significant obstacles to retrofitting a modern CVR.

Crew information

The commander had carried out three RTOs prior to this incident. The first was when flying fast jets in the military and he had carried out a high speed RTO from about 150 kt due to a hydraulic failure. He had also had to stop from about 120 kt when flying a Falcon as a co-pilot for the operator due to birds on the runway (at a different airfield). Finally, two months before this incident, he had rejected a takeoff due to an instrument failure at about 60 kt. All of these RTOs had been conducted without incident.

The commander had received training in RTOs during both his initial training with the operator as a co-pilot, and again when training as a commander. This had been conducted in a simulator and had considered a number of different scenarios.

The co-pilot was an experienced pilot with the operator. He stated that, when acting as the non-handling pilot, he would switch his scan during takeoff between the flight and the engine instruments. As V_1 approached he would switch his scan to the flight instruments and would call 'V_1' when the appropriate speed was indicated on the digital scale, as he stated that he did during the incident takeoff.

Operator's Operations Manual – Rejected takeoffs

Part B, Section 2.2.5.1 of the operations manual considers rejected takeoffs and states:

> *'Either pilot shall call STOP for any problem affecting aeroplane safety up to 100 KIAS. If runway length is limiting, either pilot shall only call stop between 100 KIAS and V_1 if there is a control restriction or two or more indications of engine failure. If runway length is not limiting, the Commander shall brief which emergencies shall trigger a STOP call between 100 KIAS and V_1.'*

Whilst it has not been possible, without the benefit of a CVR, to determine exactly which emergencies the commander briefed he would stop for, he believes his decision to reject the takeoff under the circumstances was correct. He considered an impact with the bird was inevitable and that, due to its size, damage to a control surface might have resulted.

Brake system and anti-skid system malfunction checklist

A review of the checklist revealed a discrepancy in the font and layout used to identify the '*brake failure on landing*' section of the checklist which had the potential to make the appropriate checks hard to identify. It was also apparent that the checklist only considered a brake failure on landing, and not during other phases of ground operation. Finally, the brake failure checklist was not a memory item, as might be expected, and also included references to the drag chute which is no longer carried on the aircraft.

Aircraft manufacturer's performance data

The aircraft was originally certified by the manufacturer with a MTOW of 28,660 lb. In order to issue the STC to increase the MTOW to 30,000 lb, only limited flight testing was required (which did not include formal takeoff performance tests) as the increase in MTOW was not greater than 5%.

In support of this investigation, the manufacturer extrapolated their original data to the takeoff weight of G-FRAI during the incident in order to generate a performance model that could be used to analyse the event.

The following assumptions were made:

- *The UK performance model used for AFM data expansion (reference: DTM 918), extrapolated above the certified MTOW of 28,660 lb,*
- *Transition times used for the UK certification as shown below, where T is the time the failure was detected:*

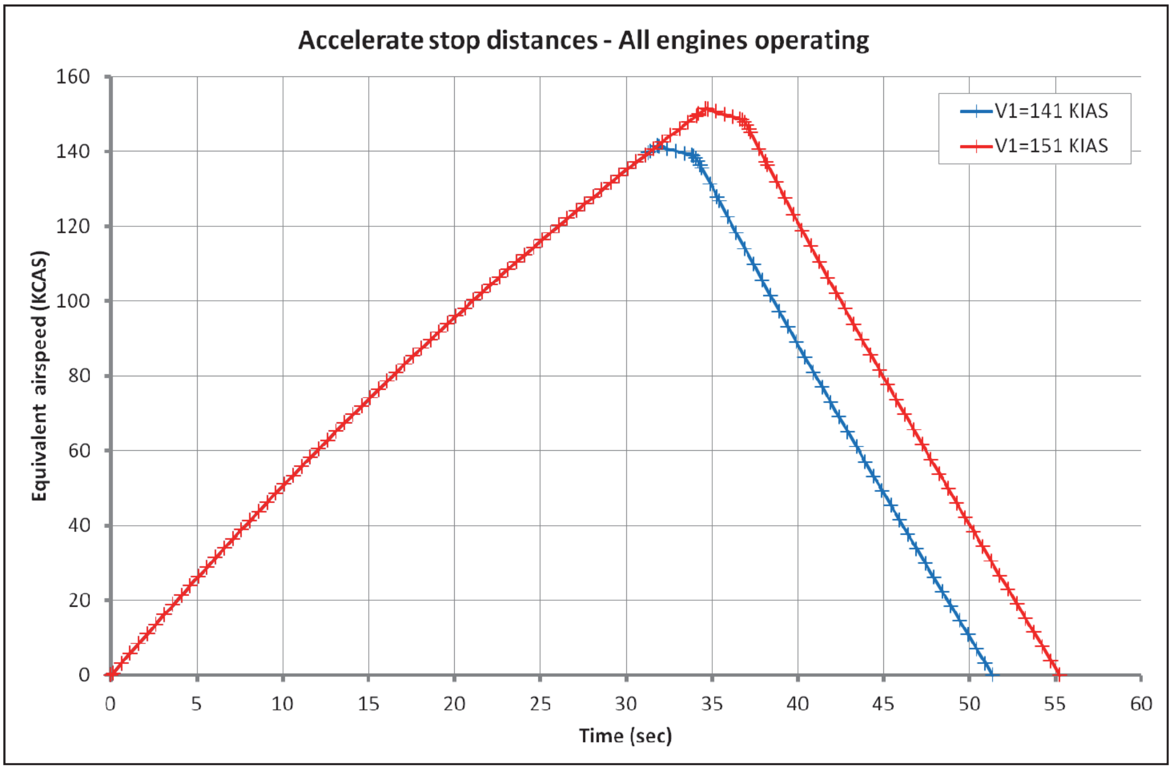
  T + 0.5 seconds: throttles set to IDLE position-35
  T + 2.5 seconds: pilot commands airbrakes extension and initiates braking
  T + 3 seconds: full braking action achieved
  T + 4 seconds: airbrakes fully extended
- *Full brake application according to the AFM procedure,*
- *TOW = 29,171 lb,*
- *Field Pressure Altitude = 0 ft,*
- *OAT = ISA+3°C,*
- *No wind / No runway slope,*
- *Dry runway,*
- *Take-off configuration: flaps 0°,*
- *Drag index = 47 (i.e. +24 dm^2 additional drag),*
- *EPR = 1.55 (as set by the pilot),*
- *Airspeed correction (DIAS= CAS-IAS) during ground roll computed for aircraft fitted with Rosemount pitot/static probes (DFS 2016 modification): DIAS = -1.2 kt.*
- *Both engines[6] remained running throughout*
- *Runway friction remained constant throughout*

Figure 5 shows the manufacturer's modelled speed profiles for V_1 speeds of 141 KIAS and 151 KIAS.

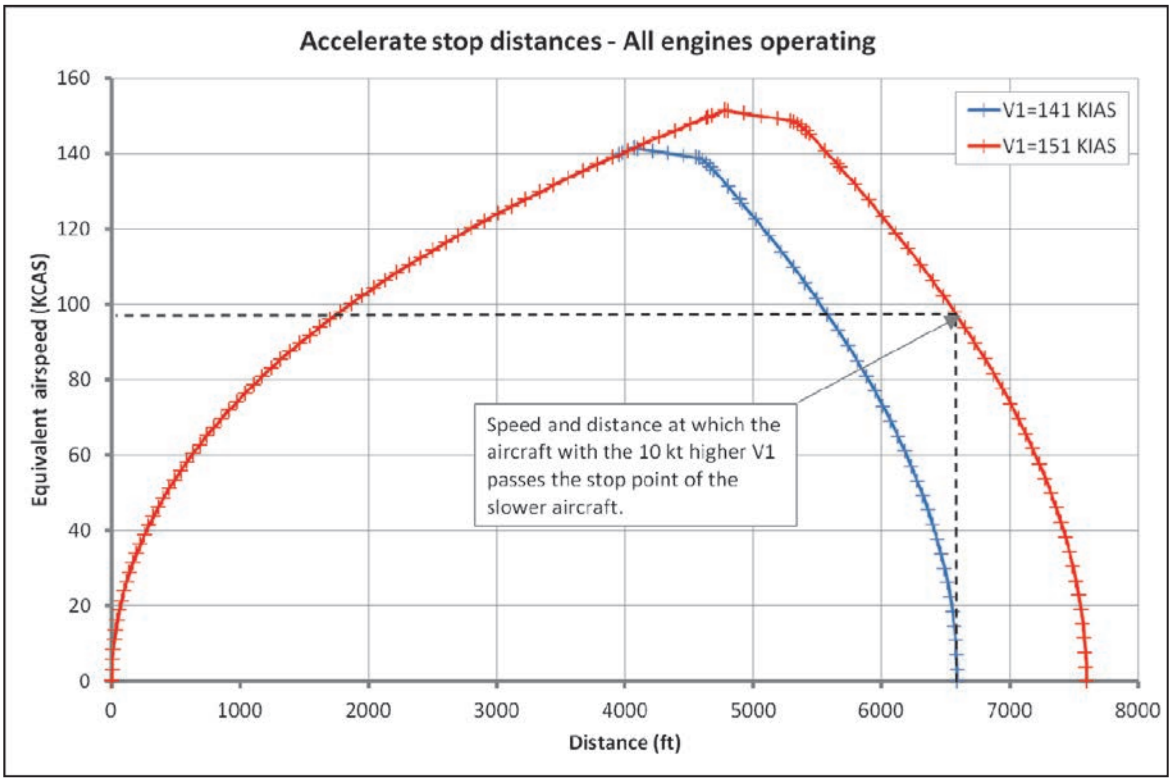
Figure 5 (b) illustrates that with a V_1 of 151 KIAS an aircraft would only decelerate to a speed of about

Footnote

[6] The aircraft manufacturer confirmed that, due to low residual thrust, the difference in stopping distance between both engines selected to idle versus one engine selected to idle and the other inoperative, is negligible.



(a)



(b)

Figure 5

Modelled profiles for (a) speed over time and (b) speed over distance travelled for the V_1 = 141 KIAS and V_1 = 151 KIAS scenarios

100 KIAS in the same distance it would take an aircraft with a V_1 of 141 KIAS to stop. The graph also shows the difference between the calculated accelerate stop distances for the two different V_1 speeds of just over 1,000 ft.

The calculated stopping distance from a V_1 of 141 KIAS was 2,635 ft (803 m) and the accelerate stop distance was 6,592 ft (2,009 m). With a V_1 of 151 KIAS the stopping distance increases to 2,944 ft (897 m) and the accelerate stop distance to 7,597 ft (2,316 m).

Assuming a start point of 120 ft from the start of the runway this would result in the aircraft entering the stopway at approximately 42 KIAS.

Modelling for a V_1 of both 141 KIAS and 151 KIAS yielded a peak RTO airspeed reached of less than 2 KIAS above the respective V_1 speeds. Taking the highest recorded speed of 151.9 KIAS as the peak during a modelled RTO, the associated V_1 would have been 150.2 KIAS. Assuming fully functioning systems and fully compliant crew actions, the accelerate-stop distance would have been 7,513 ft (2,290 m) plus the line-up distance. This indicates that over running the runway onto the stopway was inevitable. The calculated deceleration, after full braking is achieved in this scenario, reduces from an initial peak of -0.466 g to -0.398 g at slow speed, averaging -0.437 g. From 140 KIAS to 100 KIAS the average modelled deceleration is -0.45 g. The energy absorbed by the brakes during such deceleration would not have exceeded the maximum demonstrated braking energy.

AAIB calculations based on the manufacturer's performance model

The modelled decelerations were used to assess how changing the stopway and strip surface to perform as well as the runway would have affected the event profile. With the recorded stopway entry speed but runway levels of friction, the aircraft would have left the stopway at approximately 44 KIAS and entered the grass at approximately 6 KIAS.

Joint Industry/FAA Pilot Guide to Takeoff Safety - 2004

Whilst accurate statistics aren't available, the guide estimates that approximately one in 3,000 takeoff attempts ends with a rejected takeoff. This, it argues, will mean a short haul pilot might expect an RTO every three years, whilst a pilot flying long haul might expect one every thirty years.

Available data indicates that 94% of RTOs are initiated at speeds of 100 kt or less, 4% between 100-120 kt and 2% above 120 kt. RTOs in this latter high speed group account for the majority of overrun incidents. In 55% of the 97 accidents and incidents studied in producing the guide, the RTO was initiated above V_1. 7% of the cases involved birdstrikes.

Further analysis determined that 52% of the 97 accidents and incidents would have been avoided had the takeoff been continued. It conceded however that the decision to stop would have been based on a number of factors, not all of which can easily be analysed after the event.

The guide highlights possible ambiguity in the interpretation of the meaning of V_1. The FAA definition quoted differs from that used by the CAA in that it represents the speed at which the first *action* in rejecting the takeoff must be taken, rather than the point at which the *decision* to reject has been taken. It also allows a time between the failure of an engine and the first pilot action as the longer of the flight test demonstrated time or one second, at least double that allowed by the CAA. However, the latest definition of V_1 now used by the FAA and EASA for the certification of Part 25, Transport Category Aircraft, is the same.

Of note is the following statement:

> *'At heavy weights near V_1, the airplane is typically travelling at 200 to 300 feet per second, and accelerating at 3 to 6 knots per second. This means that a delay of only a second or two in initiating the RTO will require several hundred feet of additional runway to successfully complete the stop. If the takeoff was at a Field Limit Weight, and there is no excess runway available, the airplane will reach the end of the runway at a significant speed.'*

This is further demonstrated in Figure 6, based on a graph in the guide, but using the G-FRAI incident conditions and data provided by the aircraft manufacturer:

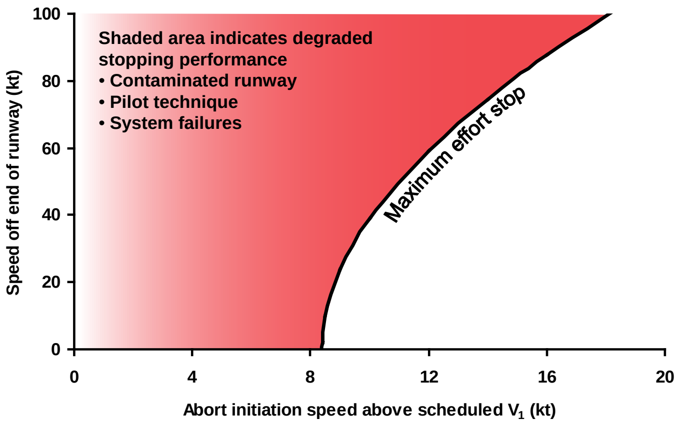


Figure 6

Effect of initiating RTO above V_1

Analysis

Airspeed indications

There were no identifiable problems with the pitot-static system and, as the aircraft had not rotated it is considered that any possible position errors could be discounted. Thus it is considered that the airspeed indications were correct during the takeoff.

Achieved braking

Inspection of the aircraft's braking system did not reveal any defect that could account for a lack of braking action and the recorded data shows that, following the decision to reject the takeoff and once sustained full braking was applied, the aircraft decelerated from 140 KIAS to 100 KIAS over a five-second period, which equates to a longitudinal deceleration of -0.42 g. This figure is very close to the performance data supplied by the aircraft manufacturer that showed that the aircraft should achieve a longitudinal deceleration of -0.45 g on a dry runway at the incident takeoff weight. The small difference between these two decelerations could be as a result of the data timing issues previously discussed. Given the quality of the recorded data and the limitations of modelling, the data indicates that the braking system was fully operational for at least the high speed portion of the deceleration.

The change in the aircraft's kinetic energy during the incident, based on the reduction in speed between the peak of 150.7 KCAS and the speed of approximately 49 KCAS (approximately 50 KIAS) at which it departed the runway strip, was 35.6 MJ. This figure is 82% of the maximum kinetic energy absorption demonstrated during certification flight testing.

Crew actions

The manufacturer's performance figures indicate that with fully operational systems, applying the correct actions in the appropriate transition times yields a peak speed of less than 2 KIAS above the V_1 speed. In the absence of any known system failures and assuming the correct crew actions and timing, the performance modelling indicates that the decision to reject the takeoff was made at a speed such that the equivalent V_1 was 150.2 KIAS.

The modelled accelerate-stop distance using a V_1 of 150.2 KIAS is only 3 ft shorter than the Runway 23 TORA. When the extra line-up distance is added, even when matching the CAA certification transition times for an RTO, the aircraft would have left the runway onto the stopway. Under the same circumstances but with a V_1 of 141 KIAS the aircraft would have stopped 319 ft before the end of the runway.

The pilots were candid in their description of what they could recall but despite this, without the benefit of either a CVR or FDR, it has not been possible to determine the exact sequence of events. The data and performance modelling, however, indicate that the takeoff was rejected above V_1, by up to 9 kt, and that the actions taken after the decision to reject the takeoff to some degree did not exactly mirror certification conditions.

The commander believed the bird represented a significant threat to the aircraft. He was confident in his ability to stop the aircraft on the runway as he did not believe the aircraft had reached V_1 at the time he decided to abort the takeoff. Equally, he stated he would not have attempted to abandon the takeoff had he known the aircraft was above V_1.

The co-pilot believed he had called V_1 at the correct speed. A call of 'V_1' should coincide exactly with the relevant speed being indicated on his airspeed indicator. Due to the high rate of acceleration, any delay to the call will result in a significant increase in aircraft speed above V_1. Similarly, any delay in carrying out the actions required following a decision to reject would result in a similar effect.

Safety action taken

The operator has been proactive in seeking to address issues raised by this incident. In particular it is seeking to clarify the RTO decision process and is reviewing the relevant information contained in its operations manual and the training given to pilots. This includes section 2.2.5.1 where it differentiates between takeoffs where runway length is limiting and those where it is not.

The operator is also reviewing the brake system and anti-skid system malfunction checklist and references in its documentation to the drag chute which is no longer carried.

As a result of this incident and other events, including the publication of draft rules for aerodrome by the European Aviation Safety Agency (EASA), the CAA is reviewing its policy and requirements on stopways.

Stopway friction characteristics

The recorded data indicates significantly less retardation, about -0.22 g, whilst the aircraft was on the stopway and runway strip. This is approximately half that of when the aircraft was on runway and is considered to have been as a consequence of the reduced friction afforded by the change in surface material or contamination by loose debris.

Had the friction levels been the same as that of the runway, it is estimated that the aircraft would have entered the grass area at 6 KIAS rather than the 50 KIAS recorded. The current inability to measure the friction levels accurately of such areas is of concern as it may result in friction levels below those required in CAP 683. The airport has advised that it is reviewing this issue, However, as it is evident from the incident data that the stopway friction is significantly below that of the runway the following recommendation is made:

Safety Recommendation 2013-004

It is recommended that Durham Tees Valley Airport takes action to ensure that, in accordance with the requirements of *CAP 683 – The Assessment of Runway Surface Friction Characteristics*, the surface of the Runway 23 stopway has friction characteristics not substantially less than those of the associated runway.

FDR and CVR exemption

The lack of flight recorders has been a significant handicap to the investigation, even with the availability of the unprotected SADS data.

The investigation has highlighted that the work required to retrofit flight recorders to this fleet has reduced due to other extensive retrofit programmes that have been undertaken since the original exemption was granted. Many of the required parameters are available on a data bus provisioned for that purpose. Others would probably still necessitate the installation of sensors.

Safety Recommendation 2013-005

It is recommended that the Civil Aviation Authority cease to grant Cobham Leasing Limited exemptions from the Air Navigation Order flight recorder requirements for their Falcon 20 fleet.

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	Britten-Norman BN2B-20 Islander, G-SICA
No & Type of Engines:	2 Lycoming IO-540-K1B5 piston engines
Year of Manufacture:	2006 (Serial no: 2304)
Date & Time (UTC):	16 January 2013 at 1007 hrs
Location:	Lerwick/Tingwall Airport
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:	47 years
Commander's Flying Experience:	5,259 hours (of which 1,348 were on type) Last 90 days - 46 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

At the beginning of the takeoff roll, on an untreated runway surface contaminated with ice, the aircraft started an uncontrollable drift to the left. The takeoff was abandoned and the aircraft slid off the runway at slow speed without suffering any damage. The Airport Authority and aircraft operator have amended their procedures for operations on runway surfaces contaminated by snow or ice.

History of the flight

The aircraft was departing from Runway 20 at Lerwick/Tingwall Airport, with the commander PF. The wind was variable at a speed of less than 5 kt and the air temperature was 0ºC. The runway was contaminated with ice but the commander had taken off and landed on it within the previous hour.

As the takeoff roll began, the aircraft started to veer to the left. The commander was unable to correct this drift, using differential braking and nosewheel steering, so he closed the throttles and abandoned the takeoff. At a speed estimated to be between 10-20 kt, the aircraft slid about two metres off the paved surface and came to a stop. It was undamaged but a frangible runway edge light had been damaged. The pilot considered that the condition of the runway was responsible for his inability to control the drift but could only surmise that a gust of wind had initiated it. The airport AFISO thought it possible that the ice on the runway may have started to thaw in the sunlight and "glazed" the surface.

The Airport Authority stated that the operator of the aircraft had recently requested that they stop treating icy or compressed snow contaminated runways with sand,because of the risk of sand ingestion into turbine engines. Following this incident, the Airport Authority has reversed this decision on the proviso that the runway will be swept if turbine-powered aircraft operations are to take place. The operator also amended its operating procedures to preclude operations on untreated runways contaminated with ice or packed snow.

BULLETIN CORRECTION

The following correction was published in the July 2013 Bulletin

AAIB Bulletin No 6/2013, page 35 refers

The report in AAIB Bulletin 6/2013 stated in the first sentence in the **Synopsis**:

At the beginning of the takeoff roll, on an untreated runway surface contaminated with ice, the aircraft started an uncontrollable drift to the **left**.

This should have read:

> At the beginning of the takeoff roll, on an untreated runway surface contaminated with ice, the aircraft started an uncontrollable drift to the **right**.

Also, in the first sentence of the second paragraph in the **History of the flight**, it stated:

As the takeoff roll began, the aircraft started to veer to the **left**.

This should have read:

> As the takeoff roll began, the aircraft started to veer to the **right**.

ACCIDENT

Aircraft Type and Registration:	Extra EA 300/L, G-ZXCL
No & Type of Engines:	1 Lycoming AEIO-540-L1B5 piston engine
Year of Manufacture:	2006 (Serial no: 1223)
Date & Time (UTC):	7 February 2013 at 1615 hrs
Location:	Northampton (Sywell) Aerodrome
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to canopy and underside of right tailplane
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	48 years
Commander's Flying Experience:	6,219 hours (of which 13 were on type) Last 90 days - 13 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was taking off for a singleton aerobatic training sortie. The first part of the takeoff was uneventful but, at a height of about 50 ft and at a speed of 80 kt, the cockpit canopy suddenly opened. The canopy is a large transparency incorporating the windscreen, hinged on the right and it broke upon contact with the right wing, leaving the frame attached but fully open.

The pilot immediately aborted the takeoff, cut power and landed back on the runway where he shut the aircraft down and vacated it. He concluded that, although he believed that he had performed his pre-flight checks thoroughly, he must have omitted to lock the canopy properly.

ACCIDENT

Aircraft Type and Registration:	Pioneer 300 Pioneer, G-EKIM
No & Type of Engines:	1 Jabiru Aircraft Pty 3300A piston engine
Year of Manufacture:	2007 (Serial no: PFA 330-14491)
Date & Time (UTC):	4 March 2013 at 1655 hrs
Location:	Chiltern Park, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nosewheel and retraction system, engine, propeller and cowling
Commander's Licence:	Private Pilot's Licence
Commander's Age:	66 years
Commander's Flying Experience:	404 hours (of which 234 were on type) Last 90 days - 8 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft arrived at Chiltern Park from the south-west, expecting to land on grass Runway 22L/04R. However, the pilot saw that that runway was being used to lay out a hot air balloon prior to flight, so he selected Runway 33 instead and made a descending right turn towards the threshold. He stated that he crossed the threshold "possibly a bit too fast" at a height of 100 ft and the first touchdown caused the aircraft to bounce slightly. On the third touchdown the nosewheel hit a bump and collapsed, causing the propeller and engine cowling to strike the ground as the aircraft came to a halt.

Whilst remarking that the runway surface was somewhat uneven, the pilot acknowledged that the accident was caused by too much speed prior to touchdown coupled with his failure to go around as the bouncing commenced.

ACCIDENT

Aircraft Type and Registration:	Piper PA-22-150 Caribbean, G-ARHN
No & Type of Engines:	1 Lycoming O-320-B2B piston engine
Year of Manufacture:	1960 (Serial no: 22-7514)
Date & Time (UTC):	15 September 2012 at 1400 hrs
Location:	South of Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Substantial
Pilot's Licence:	1) National Private Pilot's Licence 2) Private Pilot's Licence
Pilot's Age:	1) 44 years 2) 60 years
Pilot's Flying Experience:	1) 88 hours (of which 8 were on type) Last 90 days - 0 hours Last 28 days - 0 hours 2) 940 hours (of which 341 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB enquiries

Synopsis

During a go-around, the aircraft made an undemanded turn to the left, the speed remained low and the aircraft did not gain height despite full power being selected. The aircraft stalled shortly before entering some treetops. The investigation found misinterpretations of Air Navigation Order's 90-day currency and pilot-in-command requirements.

History of the flight

The aircraft had two pilots on board. Pilot 1 occupied the left seat, but had not flown within the previous 90 days of the accident and had not flown the accident aircraft since August 2010. Pilot 2 occupied the right seat and was acting as a 'check' pilot who was supervising Pilot 1 in accordance with the policy of the group that operated the aircraft. Group policy stated that:

> *'If a member undergoing check has exceeded the 90 day, 3 take off and landing limit, then the check pilot has to be P1.'*

The pilots refuelled the aircraft to full tanks prior to the flight. During the pre-flight inspection, the pilots noticed some sediment in the fuel sample from the left tank. However, after further samples were taken the fuel appeared to be free of any sediment. A clear fuel sample was also taken from the lower fuel strainer. The aircraft took off from Runway 26 at Popham Airfield, departed the circuit area and the pilots conducted approximately 35-45 minutes of upper air work in the local area before returning to the airfield to practise circuits. At Popham Airfield, touch-and-go landings are not permitted on Runway 26 so, after each full stop landing, pilots are required to taxi the aircraft to the takeoff point for any subsequent circuit. After rejoining the circuit, the pilots flew a number of circuits including a landing demonstrated by Pilot 2.

Shortly before the final approach, which was flown by Pilot 1, the pilots noticed that the fuel in the right tank had reduced to ¼ capacity so Pilot 1 selected the left tank. In the latter stages of the approach, Pilot 1 assessed that the aircraft was too high and decided to go-around so he applied full power. Almost immediately, the aircraft started to turn to the left. He checked that he had applied full power and that the carburettor heat control was in the off position. The aircraft turned through approximately 90° and struck the tops of trees to the south of the airfield. Pilot 2 reported that the engine was at full power but the airspeed was low and, just before the impact, the aircraft appeared to stall and the right wing dropped. A witness, who was standing on the airfield, described the left turn as being gentle at approximately 10° of left bank and the aircraft appeared to be slow and failed to gain height before it struck the treetops. He also stated that the engine appeared to be producing power and that the engine sound did not change until the impact. The aircraft fell to the base of the trees, both pilots were injured and the aircraft suffered substantial damage.

Aircraft fuel system

The aircraft was fitted with two 15 imperial gallon fuel tanks, one in each of the two wing roots. There is no fuel pump and the fuel is gravity fed to the engine. The fuel feed to the engine is via a fuel cock located on the left wall of the cockpit. The Flight Manual for the aircraft states that the aircraft must not take off with the right fuel tank selected if it is less than ⅓ full but does not specify any other fuel asymmetry limitations.

Status of Pilot 1

Pilot 1 believed that Pilot 2 was the pilot-in-command (PIC) of the aircraft for the flight in accordance with the group policy.

Status of Pilot 2

The investigation obtained evidence indicating that Pilot 2 performed the role of PIC until Pilot 1 had carried out three takeoffs and three landings to satisfy the 90-day currency requirement in accordance with the group policy. Some time after the flight, Pilot 2 stated that he had become aware that the group policy was "an incorrect interpretation of the ANO" and that, with the exception of the landing he demonstrated, he was neither handling pilot nor PIC during the flight.

CAP 393 Air Navigation Order (ANO)

Section 1, Part 33 of the ANO defines pilot-in-command as follows:

> *'Pilot in command' means a person who for the time being is in charge of the piloting of an aircraft without being under the direction of any other pilot in the aircraft'*

Schedule 7 to the ANO, Part A Flight Crew Licences, Section 1 United Kingdom Licences, Sub Section 1

(Private Pilot's Licence (Aeroplanes)) para (2), sub-para (g)(i) states that:

> *'The holder may not fly as pilot in command of such an aeroplane carrying passengers unless within the preceding 90 days the holder has made at least three take-offs and three landings as the sole manipulator of the controls of an aeroplane of the same type or class;….'*

The CAA provided the following clarification of these rules:

> *'The aircraft was certificated for single pilot operation and therefore the only person who can be a member of the flight crew in addition to the handling pilot is a flying instructor who is instructing or supervising the handling pilot. A person who is not a flying instructor and not the handling pilot would be a passenger.*
>
> *A pilot wishing to regain his/her 90-day currency to be entitled to carry passengers must complete at least three take-offs and three landings as the sole manipulator of the controls. These manoeuvres must be flown either solo or under the supervision of a flying instructor as a passenger cannot be carried until the currency is regained.*
>
> *The rationale behind this rule is that a flying instructor has been trained to fly an aircraft from either seat and to know when to intervene if the pilot under instruction or supervision appears to be struggling to handle the aircraft safely. An instructor is also aware that he or she remains pilot in command during an instructional flight.'*

Analysis

The engine appeared to be producing full power during the go-around but the aircraft appears to have been flying unusually slowly as it entered the undemanded turn to the left. At the time of the accident, the aircraft left fuel tank was nearly full and the right tank was at ¼ tank capacity. Although there are no fuel asymmetry limitations in the Flight Manual, the investigation could not discount the contribution of the fuel asymmetry to the uncommanded left turn at low speed during the go-around. The possibility that contaminated fuel from the left tank could have caused the engine to lose power during the go-around was considered. However, as the engine appears to have been producing power until the moment of impact, it is considered unlikely that the engine suffered any significant power loss. It is probable that the slow speed of the aircraft put it in a high drag configuration that prevented it from climbing.

Pilot 1 had not flown at least three take-offs and three landings in the 90 days before the accident flight. The group's policy stated that:

> *'If a member undergoing check has exceeded the 90-day, 3 take off and landing limit, then the check pilot has to be P1'*

so he believed that Pilot 2 was PIC of the aircraft.

The ANO defines the pilot in command as a person who for the time being is in charge of the piloting of an aircraft without being under the direction of any other pilot in the aircraft. Pilot 1 was not within the 90-day requirement; he therefore should not fly as PIC of an aircraft carrying passengers. Pilot 2 was not a flying instructor and therefore should not be PIC whilst another pilot regains 90-day currency nor was he qualified to give direction to Pilot 1.

Conclusions

The most likely cause of the accident is that the handling pilot allowed the speed to reduce during the go-around. This, possibly combined with the asymmetric fuel loading, made control of the angle of bank difficult causing the aircraft to turn to the left prior to stalling as it entered the treetops.

In a single pilot aircraft, the handling pilot is the PIC unless he/she is being supervised or instructed by a flying instructor.

In order for a pilot to regain 90-day currency to be entitled to carry passengers, he/she must carry out at least three take-offs and three landings as the sole manipulator of the controls either flying solo or under the supervision of a flying instructor.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28-140 Cherokee, G-AVGI
No & Type of Engines:	1 Lycoming O-320-E2A piston engine
Year of Manufacture:	1967 (Serial no: 28-22822)
Date & Time (UTC):	15 February 2013 at 1345 hrs
Location:	On takeoff from Runway 27, Liverpool John Lennon Airport
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Student
Commander's Age:	30 years
Commander's Flying Experience:	32 hours (of which none were on type) Last 90 days - 32 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The student pilot was preparing to take off on his first solo flight. The first attempt was abandoned because he felt that the engine power reduced during the takeoff roll. On the second attempt, the aircraft became airborne but the engine lost all power at about 300 ft. The aircraft force-landed within the airfield perimeter and its nose landing gear collapsed.

History of the flight

The student pilot was about to embark on his first solo flight, following a dual lesson after which his instructor considered that he was ready for a solo circuit. The instructor listened out on the radio in the flying school as his student performed power checks on the general aviation apron and heard him being given clearance to taxi, line up and take off on Runway 27. As the aircraft commenced its takeoff roll the instructor went outside to watch. There appeared to be some delay, so he went back inside to listen to the radio transmissions, where he learned that the student had been unhappy with the initial takeoff roll and had aborted the takeoff. Permission to backtrack and try again was granted but the instructor remained unaware of the reason for the abort: the student subsequently told him that he had felt that the engine lost some degree of power but, on the second attempt, the engine seemed normal and he thought he must have been mistaken.

The student ran the engine up to 2,000 rpm 'on the brakes' before rolling for the second takeoff. The aircraft got airborne but, at a height of about 300 ft, the engine lost power. The student reacted in accordance with his training, broadcast a MAYDAY and lowered the nose to maintain flying speed, electing to land on the grass within the airfield boundary rather than risk ditching in the River Mersey. Having used rudder to turn right to avoid the approach light gantries, the aircraft came to rest some 50 metres from the threshold of Runway 09 but the nose landing gear had collapsed. The student disembarked from the aircraft normally, having shut down the fuel and electrics. He was uninjured.

The instructor commented that he had high regard for his student's flying skills, particularly his handling of the 'engine failure after takeoff' drill. His only regret was that, had he known the reason for aborting the first takeoff, he would have instructed the student to abandon the sortie. He states that his organisation has reiterated to all pilots flying with them that they must cancel their flight and return should any problems be experienced prior to takeoff. At the time of preparing this Bulletin, no reason for the engine failure has been established.

ACCIDENT

Aircraft Type and Registration:	Airborne Edge XT912-B/Streak III-B, G-XTEE
No & Type of Engines:	1 Rotax 912 piston engine
Year of Manufacture:	2004 (Serial no: XT912-026)
Date & Time (UTC):	17 March 2013 at 1225 hrs
Location:	Private airstrip near Shrewsbury, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to wing and propeller
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	236 hours (of which 121 were on type) Last 90 days - 9 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft was one of two flex-wing microlights scheduled for a flight test from a 420 m long private airstrip, about 7 nm south of Shrewsbury. The weather was clear and calm, with a light surface wind from 230°, which was directly along the airstrip. The ground was described as wet, under about 3 inches of frozen snow.

After the two test flights had been completed satisfactorily, the owner of G-XTEE decided to fly the aircraft himself, encouraged by the fact that the two earlier flights had been successful. However, he abandoned the first takeoff after the aircraft failed to gain sufficient speed. He made another attempt to take off, during which the aircraft reached about 40 mph. He was unable to raise the nose clear of the ground and the aircraft entered a skid to the right, which he tried to correct. However, he lost directional control and the aircraft slewed to the left and tipped over.

The pilot, who was uninjured, later considered that the ground conditions had proved unsuitable for takeoff and that his best course of action would have been to forgo a second takeoff attempt.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-KYLE
No & Type of Engines:	1 Jabiru Aircraft PTY 2200A piston engine
Year of Manufacture:	2005 (Serial no: 0053-T600N-113)
Date & Time (UTC):	15 February 2013 at 1625 hrs
Location:	Near Killinchy, Co Down
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - None
Nature of Damage:	Damage to fuselage and right wing
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	75 hours (of which 45 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot and additional inquiries by the AAIB

Synopsis

After about 1¼ hours of flight and whilst the aircraft was climbing, the propeller suddenly detached. The aircraft was damaged as it overran the field selected for the forced landing. The propeller flange mounting screws had failed in fatigue in a manner apparently similar to three previous events investigated by the AAIB and had achieved only about half their operating life of 500 hours.

History of the flight

The aircraft was returning to its base at Newtownards after a local flight of about 1¼ hours. As the pilot climbed through 1,600 ft towards 2,000 ft the propeller detached. He initiated an engine failure drill and circled as he selected a field for a forced landing. The touchdown was gentle but the aircraft "ran out of field" and struck a hedge at the far end, bringing down a power cable before coming to a halt in the next field. The pilot, who had sustained a cut knee, and his passenger evacuated the aircraft quickly because of the threat of fire. They called the airfield from a nearby cottage to alert them to the situation.

History of propeller failures on Thruster aircraft

There have been several cases of propeller detachment on Thruster aircraft fitted with the same engine and propeller combination. The AAIB has reported on four, including G-KYLE: G-EVEY (Bulletin 4/2010), G-CBWJ (Bulletin 3/2011), G-CCUZ (Bulletin 8/2011). All appeared to be very similar failures, in that the flange mounting screws had mostly failed in High Cycle fatigue (HCF). A loss of clamping torque in-service was initially suspected after earlier failures and the engine manufacturer had issued Service Bulletin (SB) JSB 022-1 in July 2008, emphasising the use of the correct installation procedures, including use of a locking agent.

In April 2011, following the three occurrences mentioned above, the airframe manufacturer issued an SB (TAS/SB 014) which required replacement of the screws before 500 operating hours. This was further mandated by the issue, in May 2011, of a CAA Mandatory Permit Directive 2011-004E.

G-KYLE was in compliance with SB 014, having had the screws replaced in November 2009 and having flown 253 hours since then. Photographs of the failed screws suggest that the failure mechanism also involves fatigue and is very similar, if not identical to the previous events. The British Microlight Aircraft Association and the aircraft manufacturer have been made aware of the circumstances of this accident.

ACCIDENT

Aircraft Type and Registration:	Zenair CH 601UL Zodiac, G-CBAP
No & Type of Engines:	1 Rotax 912-S piston engine
Year of Manufacture:	2001 (Serial no: PFA 162A-13656)
Date & Time (UTC):	17 February 2013 at 1435 hours
Location:	Near Cumnock, East Ayrshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	65 years
Commander's Flying Experience:	304 (of which 174 were on type) Last 90 days - 6 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilot had been airborne for about 10 minutes when the canopy suddenly detached from the aircraft. He made a forced landing, but the ground was rougher than expected and the aircraft was badly damaged as a result; the pilot was uninjured. The reason for the canopy detachment was not immediately evident.

History of the flight

The pilot had flown from his home airstrip at Benston Farm, near Cumnock, to Bute. After a short stay he prepared his aircraft for the return journey. The checklist included a check of the canopy locks. The subsequent takeoff was uneventful, but about 10 minutes into the flight the pilot experienced what appeared to be an explosion, but he quickly realised that the canopy had detached.

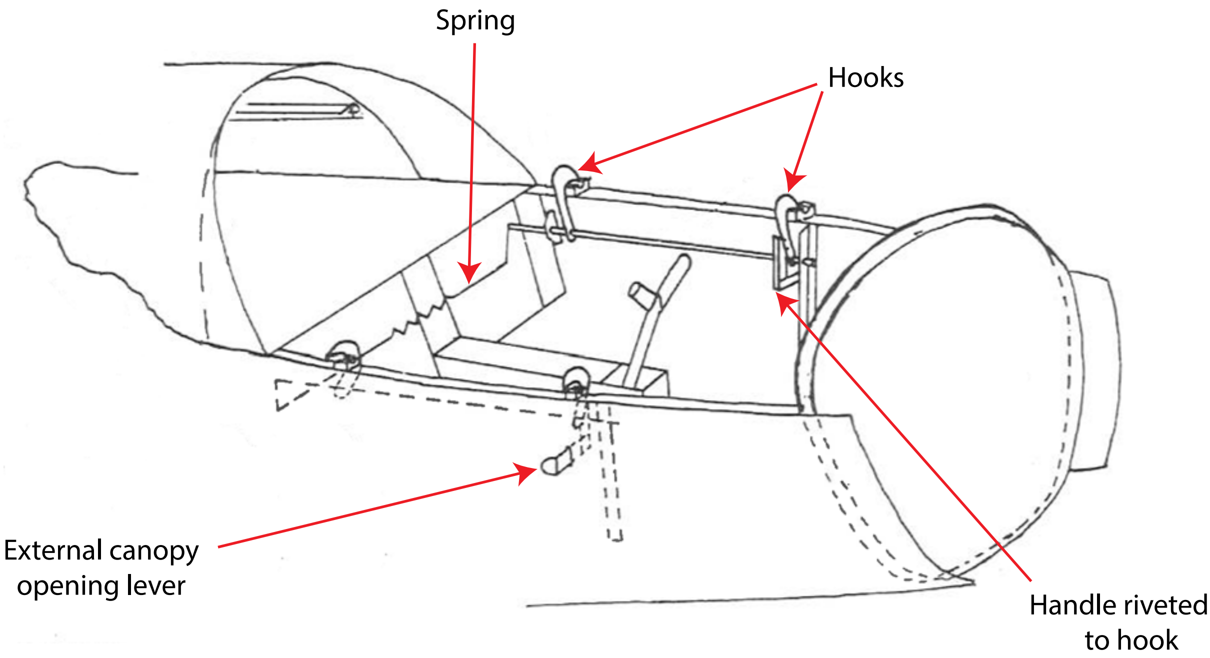
When the canopy detached the pilot lost his headset, cap, spectacles, one of his charts and one of the two GPS navigation displays he carried. From the other display he could see he was about 5 miles from Kilmarnock. The fields below were quite saturated so he continued en route to remain clear of buildings, descended to about 500 ft and reduced speed to 60 kt. Whilst he could see the waypoints on the GPS display, he could not read the distances without his spectacles.

By the time he reached his next waypoint at Cumnock, his eyes were becoming sore and he could not see the ground very clearly. This, and the fact that he felt that the rudder "didn't feel right", prompted him to make a forced landing in a field. As he touched down he realised that the field was rougher than he had thought and the aircraft slid to a halt on its nose, having collapsed the nose landing gear. In addition to the damage caused during the landing, the canopy had struck and damaged the rudder and right elevator when it departed. Although very shaken, the pilot was uninjured.

Neither the canopy nor the pilot's personal equipment had been recovered at the time of writing this bulletin.

Canopy latching mechanism

On this model of the CH601 Zodiac the one-piece canopy is hinged sideways, as opposed to later models which are hinged from the front. Longitudinal tubes on the sides of the canopy frame are secured by two hooks on each cockpit sill (Figure 1). The hooks are spring-biased towards the locked position by a light duty helical spring stretched across the rear of the cockpit. Handles attached to the left and right rear hooks allowed one side or the other of the canopy to be unlocked and opened; the hooks on the other side then acted as hinges. Note that, although Figure 1 is taken from the builder's manual for G-CBAP, the unlatch handles were attached to the rear hooks and not the front as depicted and only the left handle could be operated externally. In addition, and also not shown, two sliding bolts were attached to the left and right cockpit sidewalls which engaged into holes in the front hooks to keep them in the closed position. Opening the canopy from the inside thus required two operations: firstly, disengaging the bolt and then operating the release handle.



Sketch from builder's manual showing principle of the canopy locking mechanism.
Description of how G-CBAP differed from this is in the text

Figure 1

Canopy latching mechanism

Discussion

The pilot subsequently stated that he was aware of the left rear canopy hook unlatching first, moments before the canopy detached. Examination showed the right side of the canopy had torn away, leaving the longitudinal tube retained by the hooks on that side. On the right side, the longitudinal tube was missing (presumably still attached to the canopy), even though both hooks on that side were closed and the front hook locked by the pin.

The Light Aircraft Association is investigating the various possibilities for this scenario including a foreign object becoming trapped by a rear hook or wear causing an apparently locked mechanism to fail to retain the canopy.

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

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

Published February 2010.

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

Published May 2010.

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

Published May 2010.

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

Published September 2010.

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

Published September 2010.

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

Published November 2010.

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

Published November 2010.

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

Published December 2010.

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

Published September 2011.

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

Published November 2011.

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

http://www.aaib.gov.uk