

SERIOUS INCIDENT

Aircraft Type and Registration:	Cessna 550 Citation II, G-JBIZ
No & Type of Engines:	2 Pratt & Whitney Canada JT15D-4 turbofan engines
Year of Manufacture:	1979
Date & Time (UTC):	14 March 2008 at 1433 hrs
Location:	On approach to Edinburgh Airport
Type of Flight:	Commercial Air Transport (Passenger)
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:	32 years
Commander's Flying Experience:	5,450 hours (of which 750 were on type) Last 90 days - 200 hours Last 28 days - 52 hours
Information Source:	AAIB Field Investigation

Synopsis

The flight crew experienced control difficulties during the descent, the reasons for which were not evident but are now suspected to be due to interaction with the autopilot. The subsequent approach and landing were conducted at speeds considerably higher than normal. Crew Resource Management issues were considered to be a contributory factor.

History of the flight

The aircraft was operating a public transport positioning flight from Palma de Majorca to Edinburgh with the commander as the handling pilot and the co-pilot operating the radios.

Prior to engine start at Palma a 'DOOR NOT LOCKED'

caption illuminated, which the crew were unable to extinguish. After satisfying themselves that all doors were secure and that dispatch with this defect was allowed in the Minimum Equipment List, they continued with the preparations for departure. After engine start, the 'AIR DUCT O'HEAT' caption illuminated. The crew reportedly consulted with maintenance personnel by telephone for advice and the caption was cleared by actioning the relevant checklist. During the taxi for takeoff the 'FDR FAIL' caption illuminated, but as the aircraft had already dispatched, the commander elected to continue.

During the climb after departure from Palma the 'AIR DUCT O'HEAT' caption again illuminated intermittently,

but after passing 30,000 ft, it remained extinguished for the rest of the flight.

Evidence from the Cockpit Voice Recorder (CVR) was available from shortly before the top of descent. This evidence was used to assist in developing the remainder of the history of the flight. At the start of the recording the crew were discussing a 'FLT/HR EQUIP COOL' circuit breaker (CB), which had tripped. The commander made one attempt to reset it, despite the co-pilot's insistence that he should not, but it immediately tripped again and no further reset attempts were made. It was evident from the discussion on the CVR recording that the crew were very concerned about the state of the aircraft due to the number of perceived defects that had occurred since the start of the flight and that they wanted to land as soon as possible.

G-JBIZ was cleared by ATC to descend to FL 340 from its cruising altitude of FL 400. As the descent commenced with the autopilot engaged, the crew continued to voice their concerns about the state of the aircraft. Their comments to each other reinforced a joint perception that there was a significant underlying fault with the aircraft.

The crew then discussed what action would be appropriate if the 'AIR DUCT O'HEAT' caption reappeared, and mention was made of the checklist procedure. The descent checklist was commenced, during which a problem was encountered with the air conditioning system temperature control. The crew attempted both manual and automatic control of the air conditioning system in an attempt to resolve a problem with the supply of conditioned air to defog the windscreen and to the foot warmers. After reselecting the system to manual, the commander commented "JUST DREAD LOOKING BACK AND SEEING THAT THING BLACK DON'T YOU", apparently referring to the cabin rear bulkhead. They

then completed the descent checklist. Two minutes later the commander stated "THERE'S OBVIOUSLY SOME HEATING ISSUES GOING ON THE CIRCUIT BREAKER FOR FLIGHT...FLIGHT RECORDER EQUIPMENT COOLING IN THE BACK YOU KNOW".

Over the next 11 minutes the crew switched the air conditioning system between manual and automatic to try and resolve the problem. Soon after this the commander suggested to the co-pilot that it would be worth inspecting the rear equipment bay after landing to see if there was any sign of heat generation, although he did not believe that there would be a problem.

The approach to Edinburgh was under the control of Scottish ATC, who provided radar vectors for Runway 24. At 38 nm from touchdown, G-JBIZ was cleared by ATC to descend from FL 80 to an altitude of 6,000 ft. Prior to descending the co-pilot said "...ALT SEL 6,000" after which the commander commented that they were below the clouds and that the descent should commence. Clearance was then given to descend to 4,000 ft and the commander recalled making an autopilot selection, but was surprised when the aircraft failed to respond, saying "WHERE'S MY AUTOPILOT?". He glanced down at the autopilot control panel and saw that the autopilot and yaw damper engaged lights were off. There had been no visual or aural annunciations that the autopilot had disengaged. He recalled reselecting the autopilot and yaw dampers, but the lights remained off.

The commander reported that he pressed the autopilot disconnect button on the left side of the yoke. He then attempted to disconnect the autopilot using the TCS¹

Footnote

¹ Touch Control Steering - pressing the TCS button allows the pilot to interrupt the autopilot and make manual control inputs without cancelling any autopilot selected modes. Releasing the button re-engages the autopilot.

switch and the electric pitch trim, reportedly without success. He recalled that the controls felt “unresponsive and very stiff” and he directed the co-pilot to feel his controls. The co-pilot then said “IS THAT OFF?”, to which there was no response from the commander.

The commander then took over the radio and informed Edinburgh Radar “WE’VE GOT SERIOUS FLYING CONTROL PROBLEMS SIR AND WE NEED TO GET IN AS SOON AS”, requesting radar vectors for the runway. He directed the co-pilot to assist him on the controls. The descent continued below 4,000 ft with the commander overpowering the control resistance, with the co-pilot’s assistance. There was no discussion between the crew about the possible cause of the control problem. The tone of both pilots’ voices recorded on the CVR suggested that at this stage, they were extremely concerned about their safety and the controllability of the aircraft. The commander attempted to reassure the co-pilot and asked ATC to ensure the emergency services were present for the landing.

At 220 kt the aircraft reportedly initiated a full left rudder then full right rudder sequence. As the airspeed reduced to 210 kt, the aircraft began pitching up and down. The uncommanded control inputs became more severe and more frequent with decreasing airspeed and so the commander accelerated back to 220 kt, the minimum speed at which he felt control could be maintained.

ATC cleared the aircraft to descend to 3,000 ft and the radar controller stated “GOLF INDIA ZULU I’M BRINGING YOU IN FOR RUNWAY 30 THERE’S AN AIRCRAFT ITS NOT ON THE THRESHOLD ITS JUST ON THE ORP².” The commander accepted this runway, which allowed for an almost

straight-in approach. At seven miles from Runway 30 the commander transmitted to ATC “JUST NEED TO GET ON THE GROUND AS SOON AS POSSIBLE WE’RE DESCENDING AT EH THOUSAND FEET PER MINUTE WITH ALMOST FULL FULL NOSE FORWARD”. The controller made it clear that if the crew were uncertain of retaining control he would vector the aircraft out over the sea rather than over the city of Edinburgh, but the commander reassured the controller “NO WE’RE ER WE’RE OK SIR”.

Some 30 seconds later, with considerable concern, the commander transmitted “WE ARE LITERALLY ALMOST OUT OF CONTROL HERE BUT STANDBY” and “GOT SERIOUS FLUTTER GOING ON”. Given the control difficulties, the commander elected not to lower the flaps and landing gear. At just under four miles to touchdown, he informed ATC “...AND EH THIS IS A MAYDAY NOW GOLF INDIA ZULU WE’RE GOING TO HAVE TO TOUCHDOWN AT 200 KNOTS WITH THE GEAR UP.” During the final few miles of the approach the commander handed over control of the throttles to the co-pilot and instructed him to maintain 200 kt. The commander flew a shallow, high-speed approach to Runway 30 with the aircraft in a clean configuration.

Approximately 2 nm from the runway, the commander called “GEAR DOWN GEAR DOWN” to the co-pilot, who actioned the command. ATC cleared the aircraft to land, passing the surface wind of 250°/11 kt. A number of Enhanced Ground Proximity Warning System (EGPWS) aural warnings were recorded by the CVR as the approach continued. The co-pilot selected idle thrust and deployed the speed brakes just prior to touchdown, which occurred at around 193 kt, close to the threshold of Runway 30. Both pilots applied maximum wheel braking, bringing the aircraft to a stop around 50 metres from the end of the runway. The commander called for an evacuation, but the evacuation checklist was not carried out. The

Footnote

² Operational Readiness Platform, an area of hard standing immediately adjacent to the runway, often found at ex-military airfields. At Edinburgh the Runway 30 ORP forms part of a parking area known as ‘Block 33’.

crew shut down the aircraft and exited expeditiously via the cabin door.

The Airport Fire and Rescue Services (AFRS) were in immediate attendance. A thermal imaging camera did not reveal any evidence of a fire on the aircraft. The pilots inspected the rear equipment bay under the supervision of the AFRS and although they were unable to determine any obvious damage, they reported that there was a strong smell of electrical burning.

Aircraft examination

General

Examination of the aircraft at Edinburgh by the AAIB did not reveal any evidence of fire or overheat damage. Two CBs in the cockpit had tripped; the first, located on the left CB panel, was labelled 'FLT/HR EQUIP COOL'. The second, on the right CB panel, was apparently labelled 'PHONE AC SWITCH'.

The first of these CBs protected the circuits for two avionics cooling fans located in the aircraft's nose compartment, a cooling fan behind the instrument panel, the defog fan and the Hobbs meter. The second CB was in fact the 'AC SWITCH' CB, and should have been labelled as such. However, the CB directly above it had a panel fastener above it, in the location where the 'PHONE' legend for the CB would be expected to have been located. The legend was therefore put below it, with the effect that the 'AC SWITCH' CB below was apparently labelled 'PHONE AC SWITCH'.

The 'AC SWITCH' protected, amongst other circuits, the autopilot engaged and yaw damper engaged switch-lights, located on the autopilot control panel, below the thrust lever quadrant. It also protected the audio disconnect warning horn for the autopilot and the flashing autopilot disconnect warning light below the glare shield. Consequently, none

of these operated when the autopilot was functioned on the ground. Once the CB was reset, the autopilot and yaw damper engaged switch lights illuminated when each system was selected on and the autopilot disengage visual and aural annunciations operated normally.

Autopilot

The basic autopilot functions operated correctly when tested. With the exception of the right 'go-around' switch on the thrust levers, the various methods of disconnecting the autopilot also functioned correctly.

The autopilot pitch channel operated normally when tested. The autopilot uses elevator to recover from short-term pitch perturbations. If full elevator travel is reached, the autopilot will then begin to trim the aircraft nose-up or nose-down, using the full range of available pitch trim. According to the aircraft manufacturer, overpowering autopilot pitch inputs with the aircraft in trim would require a force of only 15 lbs +/-5 lbs. The control forces for an out-of-trim condition would be considerably higher.

When the autopilot computer was tested at the manufacturer's UK service and repair base, no faults were found. However, on reinstallation in the aircraft, intermittent uncommanded roll inputs occurred when the 'TEST EACH FLT' button on the autopilot control panel was operated on the ground. When this computer was installed in another Citation 2 aircraft, similar uncommanded roll inputs occurred during ground testing.

A loan autopilot computer was installed on G-JBIZ and two proving flights were flown. The aircraft behaved normally on both flights and the air duct overheat warning did not reappear.

Flight controls

The flight controls and pitch trim system operated

normally when tested. No faults were found within the rudder and yaw damper systems that could have caused uncommanded rudder movements. The aircraft manufacturer estimated that a force of 55 lbs +/-6 lbs would be required to overpower autopilot rudder inputs.

'FDR FAIL' caption

The FDR system is designed such that it will only operate if the door sensors indicate that the doors are locked. Examination of the microswitch on the nose baggage compartment right door revealed that its striker plate was sufficiently out of alignment that a door locked indication was not provided, even when the door was physically locked. As a consequence, the FDR did not record any data for the incident flight. After readjusting the striker plate, the 'DOOR NOT LOCKED' and 'FDR FAIL' captions extinguished when all doors were closed.

'FLT/HR EQUIP COOL' CB

This CB was reset and although it did not trip again during extensive system functional checks, it was replaced as a precaution. The Hobbs meter was found to be inoperable and was disconnected. The defog fan switch was found to be cracked internally and was also replaced.

Recorded information

Recorded data from the flight were available from the CVR (presented in the History of the flight), the EGPWS and radar.

The EGPWS is a system which provides pilots with alerts and warnings aimed at preventing the aircraft from colliding with terrain. The unit fitted to G-JBIZ was removed from the aircraft and the contents of its memory were downloaded by the manufacturer. When an EGPWS warning is generated, a number of aircraft

parameters are logged from 20 seconds prior to the warning until 10 seconds after. Three EGPWS warnings were recorded on the incident flight. The data show that the landing gear was recorded as locked down at an airspeed of 207 kt, just under 2 nm from the runway threshold. The final data point recorded placed the aircraft around 200 metres from the runway threshold at a radio altitude of 26 ft and an airspeed of 193 kt.

Flight crew information

The commander held a valid ATPL and a Class 1 medical certificate. He had completed his last Operator Proficiency Check (OPC) in October 2007. The check was carried out in G-JBIZ and the duration of the flight was 50 minutes.

The co-pilot, aged 33, held a valid CPL(A) and a Class 1 medical certificate. His total flying experience was 647 hours, of which 430 hours were on type.

Both crew members' previous rest period was approximately 17 hours.

CRM training

At the time of this incident the requirements for the operation of commercial aircraft (previously contained in JAR-OPS, now EU-OPS) included a requirement for pilots and cabin crew to undertake Crew Resource Management (CRM) training. This training is intended to teach crews behaviour that will allow them to make the optimum use of the resources available to them. It provides a structured approach for dealing with situations (and abnormal situations in particular), placing emphasis on the importance of communication between crew members.

The requirements state that pilots must receive an initial CRM course within one year of commencing work

for an operator. Both pilots involved in this incident had worked for the operator concerned for less than 12 months and had not yet received from them their initial CRM training course. The commander may have received initial CRM training at a different operator, but no evidence to confirm this was available.

In January 2009, the European Aviation Safety Agency (EASA) released a Notice of Proposed Amendment (NPA) covering the rules for Air Operators. This NPA included the requirement for pilots of multi-crew aircraft to have completed initial CRM training before commencing unsupervised line flying.

Both pilots had attended a CRM recurrency training course at a large third party training provider. The commander completed this training in March 2007. The training provider, in accordance with the guidance provided in CAA publication CAP 737, spread the recurrency training over a three-year cycle. The recurrent training syllabus is designed as a refresher and covers topics in less depth than the initial CRM course.

The training provider reported that the crew had received training in the use of the 'DODAR' system as a decision-making aid. The acronym DODAR stands for 'Diagnose, Options, Decide, Assign and Review'. A crew is expected to apply this structured approach to decision making when faced with abnormal situations. It is intended to assist crews in assessing the situation, making best use of the available information and in considering the possible outcomes before deciding on a course of action.

Airport information

Edinburgh Airport (EGPH) has two runways. Runway 06/24 is 2,557 metres long by 46 metres wide, of grooved asphalt construction, and is ILS-equipped. Runway 12/30 is 1,798 metres long by 46 metres wide and asphalt-surfaced. It is not equipped with an ILS.

Analysis

General

No evidence of overheat damage was found on examining the aircraft and the air duct overheat warning could not be reproduced during subsequent testing. The 'FDR FAIL' message was attributable to a misaligned striker plate on the right door of the nose baggage compartment; this also accounts for the fact that the FDR did not record any data for this flight.

Once reset, the 'FLT/HR EQUIP COOL' and 'AC SWITCH' CBs did not trip again during subsequent testing. The reason for them initially tripping could not be established with any certainty.

Once the 'FLT/HR EQUIP COOL' CB had tripped, there would have been insufficient airflow from the windscreen defog vents due to the defog fan becoming inoperative. The cooling fan behind the instrument panel would also have ceased to operate. This may have influenced the cooling airflows in the cockpit/windscreen areas and may explain the pilots' concerns about the air conditioning system during the early part of the descent. It is possible that the cooling flow issue caused the temperature in the region of the right hand CB panel to increase. It is understood that older CBs of the type used in this aircraft can be sensitive to local temperature. The possibility that an elevated temperature in this area had caused the 'AC SWITCH' CB to trip therefore could not be ruled out.

Once the 'AC SWITCH' CB had tripped, there would have been no visual or aural warnings available to the crew to indicate whether the autopilot and yaw damper were engaged or disengaged.

The crew reports of the aircraft's behaviour indicated that there were difficulties in pitch and yaw control. Although the autopilot computer intermittent defect could not be explained, it only manifested itself in the roll axis and therefore did not appear to be associated with the control problems reported by the crew. No defects were found that could account for the reported uncommanded rudder inputs.

Crew reaction to event

Perceived overheat condition

It was apparent from the CVR recording that the crew were very concerned about the serviceability of the aircraft prior to the incident.

The recording shows that the crew believed that there was a potential overheat condition in the rear equipment bay. This theory was based on the evidence of the air duct overheat warnings that they had received before departure and during the climb. The tripping of the 'FLT/HR EQUIP COOL' CB, which the commander took to be related to the flight recorders, located in the rear of the aircraft, served to reinforce this hypothesis. This was reflected in his comment to the co-pilot "JUST DREAD LOOKING BACK AND SEEING THAT THING BLACK". It was evident from the crew's discussions on the CVR recording that they wished to land the aircraft as soon as possible.

Control difficulties

The event that led to the incident started with the autopilot apparently not responding to input commands.

The situation would undoubtedly have been extremely confusing to the crew, as all of the autopilot visual and aural annunciations were inoperative. There would therefore not have been any unambiguous way of determining whether or not the autopilot was engaged. The commander may have unknowingly disengaged and re-engaged the autopilot during the initial stages of the event and it is possible that the subsequent flight control difficulties were caused by the crew and the autopilot working against each other, possibly with the aircraft out of trim, which would have significantly increased the pitch control forces.

According to the aircraft manufacturer, 15 lbs +/-5 lbs of force is required to overcome autopilot pitch inputs. If the aircraft was out of trim, the increased pitch control forces would have helped to reinforce the crew's belief that there was a serious control problem. No defects were found with the autopilot system that could otherwise account for the handling problems reported by the crew.

CRM issues

The crew were already highly concerned about the state of the aircraft when the incident occurred. When the control problems appeared, they were already under some degree of stress and this had a detrimental effect on their ability to deal with the situation. They did not make any combined effort to diagnose the problem and the commander responded to the situation by overpowering the controls, with the co-pilot's assistance. The fact that the commander was considering performing a gear-up landing on Runway 30 at 200 kt, suggests that he believed that the aircraft was in serious danger.

Had the crew applied the principles of CRM, and the 'DODAR' method in particular, it may have helped them better to deal with the situation. Even if it did not enable them to diagnose the cause of the control difficulties,

it would have provided structure to their response and would have slowed the decision-making process, giving them the opportunity to arrive at a less risky solution than landing at 193 kt.

Conclusions

The crew were already concerned about the possibility of an overheat condition in the rear of the aircraft when they encountered control difficulties, the reason for which was not obvious. The situation would have been confusing, given the lack of autopilot visual and aural annunciations. Subsequent examination of the aircraft did not highlight any defects which could explain the reported control problems.

The crew did not make any joint attempt to diagnose the problem and did not apply the principles of CRM, which could have allowed them to arrive at a less risky solution. It is likely that, had they received more comprehensive CRM training, they would have been better placed to manage their response to the incident.

Given that the EASA has already issued an NPA for a requirement for pilots of multi-crew aircraft to have completed initial CRM training before commencing unsupervised line flying, no AAIB Safety Recommendation is considered necessary.