AAIB Bulletin No: 3/2005 **Ref: EW/G2004/11/10** **Category: 1.1**

INCIDENT

Aircraft Type and Registration:	Cessna 550 Citation, G-FCDB
No & Type of Engines:	2 Pratt & Whitney Canada PW530A turbofans
Year of Manufacture:	2001
Date & Time (UTC):	25 November 2004 at 0700 hrs
Location:	Teesside Airport, Darlington, Co Durham
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	None.
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	7,500 hours (of which 4,000 were on type) Last 90 days - 102 hours Last 28 days - 32 hours
Information Source:	Air Accident Report Form submitted by the pilot, flight data recorder and reports from the airport operator and aircraft engineering facility

History of the flight

The aircraft taxied with a crew of two and one passenger for a flight to Copenhagen. The crew was instructed by ATC to taxi via taxiway Alpha for Runway 23 and was subsequently cleared for takeoff prior to reaching holding point Alpha One. The commander, who was the handling pilot, reported that he carried out a rolling takeoff after following the taxiway centreline onto the runway. Take-off power was set and all engine indications were seen to be normal. As the aircraft was accelerating through an estimated airspeed of 70 kt, the commander felt a bump, then felt the aircraft yaw to the right. The co-pilot later reported that he had seen a hare or rabbit run towards the aircraft from the right hand side and associated the bump with this animal, though he did not have time to call this to the commander at the time.

The commander instinctively applied opposite rudder to correct the yaw, which had an immediate effect. The maximum heading deviation achieved, though initially thought by the commander to be much higher, was later reported as 10°; the co-pilot assessed the deviation as 30° to 40°. The commander initially thought that the bump and yaw may have been due to a tyre failure, though he had only previously experienced this in the simulator. Using rudder but no braking, the commander was able to bring the aircraft back onto the runway heading by the time the aircraft had reached the end of the concrete dispersal area (Figure 1), but the aircraft was now on the edge of the marked runway. The aircraft then partly left the paved surface and crossed a grass area between the dispersal concrete and the disused section of Runway 01/19. After crossing Runway 01/19, the aircraft was still at the main runway edge and the commander was aware that the right wheel had entered the soft grass which was causing the aircraft to yaw to the right. As it did so the nose wheel also left the paved surface and the commander, attempting to regain the runway as soon as possible, applied differential braking and increased power on the right engine. He was aware that the nose wheel was on the grass and was tracking down the edge of the runway surface for a time before the aircraft finally re-entered the runway. The commander then taxied the aircraft back to the apron and shut down.

The commander was unable to account for the bump or sudden yaw and was unsure if it could have been caused by hitting an animal. He was confident that it was not due to an inadvertent brake application by himself, and the co-pilot's feet were not on the rudder pedals at the time. He further commented that the lead in area to the runway was poorly lit and that there were no runway centreline lights.

Aerodrome Information

The main runway at Teesside Airport is orientated 23/05 and is 2,291 metres (7,515 feet) in length, 46 metres (150 feet) wide and has a magnetic heading of 232º. The main runway is crossed by Runway 01/19, though only that part to the south of the main runway is useable. The airport was originally a military base, and is equipped with two concrete dispersal areas at each runway end to the north side. The runway edge is marked across the dispersal areas by an unbroken white line which extends to each threshold.

The runway is equipped with high intensity bi-directional edge lights at 60 metre spacing with a low intensity omni-directional component. The edge lights are set 2.5 metres outside of the runway edge marking. There are high intensity runway centre line lights at 30 metre spacing. Taxiway Alpha is marked by a yellow line as it joins the runway and is equipped with green centreline lights, supplemented by green reflectors. As the taxiway crosses the edge of the dispersal area, the taxiway edge is marked by blue reflectors. The white runway edge line is supplemented by red reflectors one

metre outside the line for that part of it which crosses the dispersal area. Apart from the white runway edge line, there are no ground markings on the Runway 23 dispersal area. The associated dispersal area for Runway 05 is marked by white crosses to indicate that it is not to be used for take off. Figure 2 shows the view along Runway 23 from a point adjacent to taxiway Alpha as it enters the runway.

The United Kingdom AIP entry for Teesside airport includes the following statement:

> *At both ends of Runway 05/23, its width is twice that of the associated edge lights due to extra pavement at the northwest side. Pilots should ensure that they are correctly lined up, especially if take-off is at night, when the runway is contaminated or in low visibility. The yellow taxiway centre-line marking supplemented with green reflective studs must be followed until alignment with the runway centre-line lights is achieved.*

Meteorological information

At 0620 hrs Teesside Airport reported a surface wind from 200º(M) at 8 kt, a visibility of 6,000 metres and a temperature and dew point of 8ºC. Sunrise was at 0752 hrs.

Flight data recorder

The indicated airspeed (IAS) readout commenced at 34·3 kt, which was achieved just as the aircraft stabilised on runway heading. Eight seconds later there was a heading deviation of 2° to the right for about two seconds before a larger deviation to the left, to about 7° left of the runway heading. The heading then deviated right once again, about 3° right of the runway heading, before once again deviating left of the runway heading by a maximum of 15°; this was the point at which the aircraft re-entered the runway. The recorded engine RPMs initially reached a maximum of 79·1%, which was reached just as the first heading deviation to the right occurred and about one second before the point at which the maximum recorded IAS of 72·5 kt. During the second deviation to the right, the RPM for the number 2 engine was seen to increase from idle to a maximum of 81·7%, and then reduce as the aircraft re-entered the runway. Accelerations were consistent with passage across an unprepared surface and there were no indication of an 'initiating event'.

Examination of site

An examination of the site was conducted by the airport operator. The results of the examination are shown diagrammatically at Figure 1. The diagram also shows the centreline of Taxiway Alpha entering the runway, and a notional point A indicating the start of take-off roll for an aircraft following this yellow line.

Tyre marks were seen entering the grassed area at point B, which measured 140 metres from point A. The point where the tyre marks entered the grass was 26·2 metres from the runway centreline, and continued for 23·3 meters, approximately parallel with the runway, until the track entered the crossing runway at point C. A further tyre mark started on the crossing runway at point D, 28 metres from point C, and continued for a further 37·2 metres to the edge of the disused runway at point E. As the tyre mark crossed the disused runway, it was deviating to the right slightly. As the tyre mark entered the grass at point E, a further tyre mark is seen entering the grass, but closer to the runway. Both tracks then deviate to the left and the tyre track closer to the runway re-enters it 10 metres further along. The main tyre track then parallels the runway edge before deviating to the right once again at which point the second track re-appears. Both tracks then show a gradual turn to the left and re-enter the runway at F, a distance of 134 metres from point E where the tracks entered the grass for the second time.

An extensive search for the reported hare or rabbit was conducted immediately after the incident but no remains were found.

Aircraft examination

The aircraft was examined by the company's engineering personnel the day after the incident. No fault was found which could account for the yaw described by the crew. The aircraft was subsequently returned to service and has experienced no reoccurrence at the time of writing.

Analysis

Although both crew members reported a significant yaw which resulted in the aircraft leaving the paved surface, this was not evident from the recorded data. The commander recalled that the yaw event was corrected and the aircraft returned to a track parallel to the runway by or about the time that it encountered the first grass area. For a 10° heading change to develop, as reported by the commander, and cause the aircraft to reach the grass at point B, it would have had to commence almost as soon as the aircraft had begun its take-off roll. In this case the aircraft would have been bought under control long before the edge of the runway was encountered.

If the assumption is made that the aircraft followed the taxiway lead-in line, it would have been lined up at about point A, a distance of 140 metres from the beginning of the grass area and, since IAS first registers as the aircraft aligns with the runway, the airspeed at this point can be assumed to be 34·3 kt. Using recorded IAS data it is possible to determine the approximate distances of significant flight events from point A. The maximum airspeed was recorded 9 seconds, or approximately 237 metres after point A, which is about the time the aircraft enters the grass for the second time. The slight yaw to the right takes place when the aircraft has travelled between 167 and 237 metres

from point A; this coincides with the crossing of the disused runway. The first deviation to the left is calculated to occur after 273 metres, which matches closely the observed ground marks.

The possibility that the initial set of tyre marks between B and C were not made by the aircraft involved in this incident was considered, together with the possibility that a higher, though momentary, deviation to the right had occurred which had not been recorded on the data recorder which sampled heading at a rate of once per second. However, considering that there was no heading deviation until about 167 metres from point A, the yaw rate and amount that would have been necessary to cause the aircraft to leave the paved surface at point E would have been beyond the capabilities of the aircraft without it sustaining major damage and is not supported by lateral acceleration data which has a higher sampling rate.

The available flight data and ground witness marks indicate that the aircraft was lined up for takeoff on the runway edge line instead of the runway centre-line. The commander's report that the runway did not have centre-line lighting, when if fact it does, also supports this conclusion. The investigation therefore looked at how the crew may have made this error and what may have caused both pilots to interpret the subsequent events in the way they did.

The initial heading deviation to the right was probably caused by the drag of the right main wheel as it encountered the grass. This would have been exacerbated if the wheel had contacted a drain cover and the edge of the disused runway, which would also account for the bump felt by both pilots. By this stage it would have been obvious to both pilots that they were not on the runway centreline, which would not have agreed with their "mental model". As there would have been some sensation of a yaw to the right, it is likely that both pilots remembered the yaw as more severe than it was in an unconscious attempt to make sense of what had happened. Both pilots report that the commander instinctively applied rudder to correct the swing, but instead of correcting track to parallel the runway as they believed, this was actually yawing the aircraft back towards the runway, as is evident from the flight data and ground marks. Once beyond this point, the crew's recollection matches the other available evidence.

Measures had been taken by the airport operator to reduce the likelihood of a crew lining up on the edge line. These included the requirement stated in the UK AIP that crews follow the taxiway marking and lights until established on the centre-line lights, the provision of blue taxiway edge reflectors when approaching the runway and the red reflectors placed about one metre outside the edge line as it crosses the dispersal area. However, unlike Runway 05, there were no ground markings to indicate that the dispersal area was not part of the runway. The view had been taken that the position of the PAPI lights was such as to alert a crew of an incorrect line up. However, this visual cue may not be available in poor visibilities when the error may be likely to occur. Nor did

this prevent the crew of the aircraft involved in this incident from lining up incorrectly. The flight deck of this aircraft is also much lower than larger types and this may have reduced the effectiveness of the visual alert provided by the PAPI lights.

Safety action by the airport operator

The ground markings at Teesside Airport are the subject of a current refurbishment programme. In the light of this incident and as part of that process, the airport operator has scheduled a review of the ground markings for Runway 23 which will take place early in 2005. Additionally, an upgrade to the airfield ground lighting system is scheduled for mid-2005.

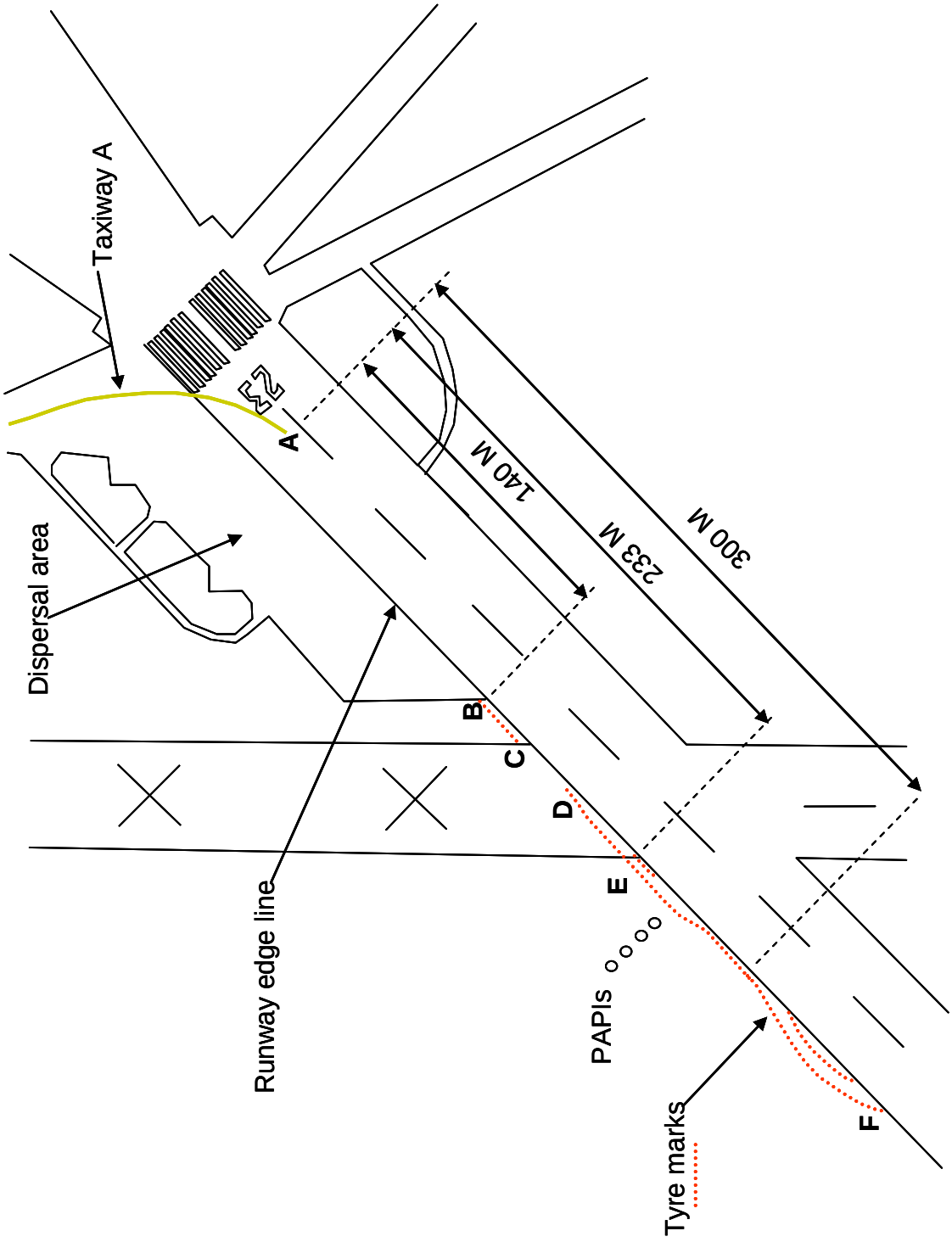
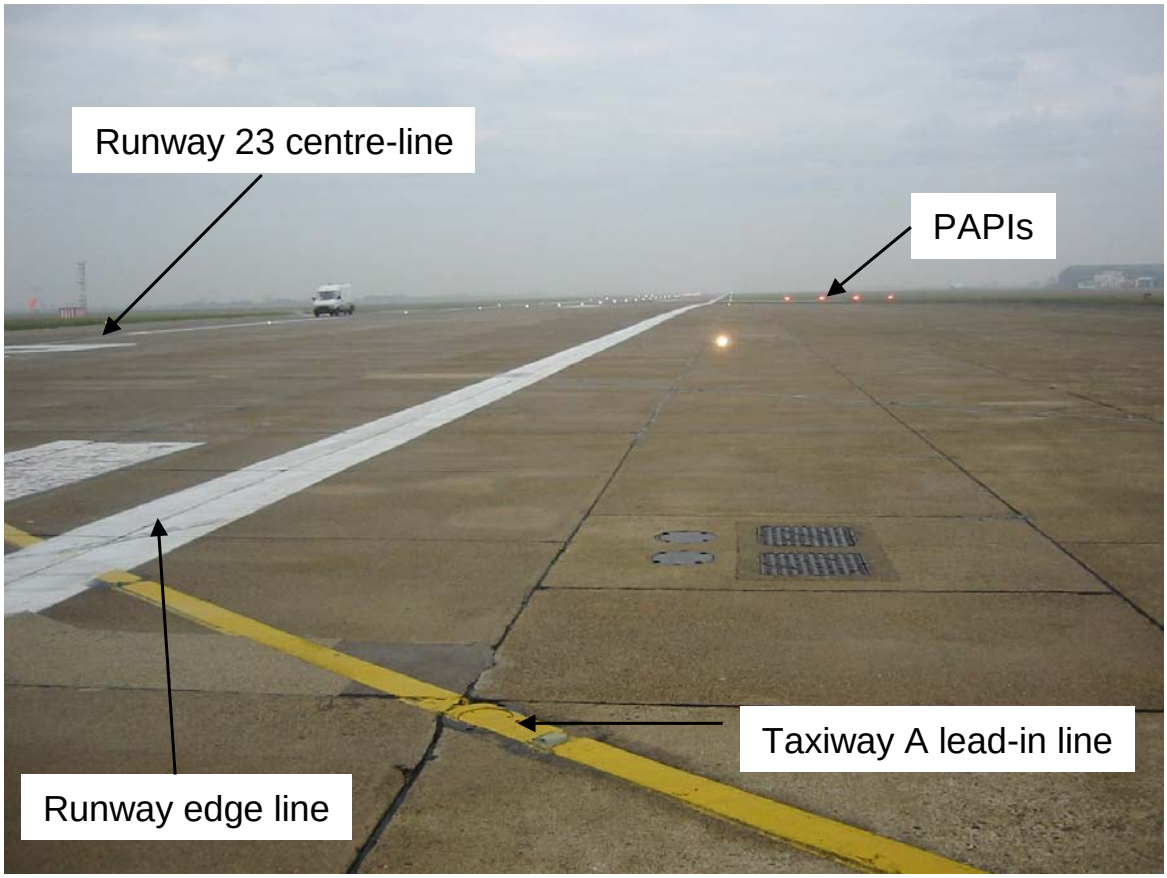

Taxiway A
Dispersal area
Runway edge line
PAPIs
Tyre marks
A
B
C
D
E
F
140 M
233 M
300 M

Figure 1



Runway 23 threshold area

Figure 2