

**Serious Incident**

<b>Aircraft Type and Registration:</b>	Beech 400A, N709EL
<b>No &amp; Type of Engines:</b>	2 Pratt & Whitney Canada JT15D turbofan engines
<b>Year of Manufacture:</b>	1992 (Serial no: RK-52)
<b>Date &amp; Time (UTC):</b>	7 October 2022 at 1100 hrs
<b>Location:</b>	Newquay Airport, Cornwall
<b>Type of Flight:</b>	Private
<b>Persons on Board:</b>	Crew – 2                      Passengers – 1
<b>Injuries:</b>	Crew – None                      Passengers – None
<b>Nature of Damage:</b>	Damage to mainwheel tyres
<b>Commander's Licence:</b>	Airline Transport Pilot's Licence
<b>Commander's Age:</b>	40 years
<b>Commander's Flying Experience:</b>	5,263 hours (of which 2,692 were on type) Last 90 days – 150 hours (of which 30 on type) Last 28 days – 47 hours (of which 4 on type)
<b>Information Source:</b>	AAIB Field Investigation

**Synopsis**

Immediately after touchdown the flight crew noticed the deceleration was greater than normal. Reverse thrust and speed brakes were applied, and as the aircraft slowed below about 50 kt the aircraft started to drift towards the right side of the runway. A combination of weathercocking into the wind and applying left pedal brought the aircraft back to the runway centreline where it came to rest angled about 45° to the left of the centreline, with the mainwheel tyres deflated and the brakes seized.

The rapid deceleration on touchdown was caused by either the tyres having already deflated due to the fuse plugs having melted, or the brakes being seized, or a combination of both. This was the result of the brakes having been heated during the takeoff run because the parking brake had been left on with partial pressure applied.

The lack of a light or caption to indicate that the parking brake is on, or an aural or visual warning that the parking brake is on when takeoff power is applied, may have contributed to the incident, as may have the lack of a 'release parking brake' item in the 'Before Takeoff' checklist. One Safety Recommendation is made to the aircraft manufacturer regarding the 'Before Takeoff' checklist.

## History of the flight

During the takeoff roll from East Midlands Airport the commander reported that the acceleration seemed normal through 80 kt, but then there was a hesitation in acceleration at about 95 kt. He felt there might be extra drag on the nosewheel, but the aircraft rotated and climbed normally after liftoff.

The crew completed the after-takeoff checks and there were no indications of abnormalities. The commander thought the reduced acceleration at about 95 kt might have been caused by possible loss of nosewheel tyre pressure, because the tyre had been replaced prior to flight. Another possibility considered was a gust of wind during takeoff as the wind was 22 kt gusting 33 kt. He discussed these theories with the co-pilot.

Prior to the descent, the commander was scanning the flight deck and noticed that the parking brake handle on the lower left side of the instrument panel was not fully pushed in. He pushed it in, which required some force but no more than he sometimes experienced when disengaging the parking brake on the ground after it has been applied after a landing. He then realised that the reduced acceleration was probably caused by the parking brake remaining on, with partial brake pressure locked in the system, causing the brakes on the main wheels to remain applied during the takeoff. He considered the possibility that the brakes had then become heated during the takeoff roll due to the friction in the brake pack as the wheels attempted to rotate against the brakes. The heat generated may then have caused the thermal relief plugs in the wheel hub to melt and release main wheel tyre pressure.

He did not recall setting the parking brake at the holding point prior to takeoff, but he assumed he probably did. He could not recall if he subsequently pushed the parking brake handle partially in to release or not at all. He reported that a normal amount of break-away thrust was required to leave the holding point and the initial acceleration felt normal, so the brakes could only have been applied with partial brake pressure. The parking brake operates by locking in the pressure applied by the toe brakes, so applying a small amount of toe brake pressure will provide a small amount of parking brake pressure. The commander reported that there was a slight uphill gradient at the holding point and without brake pressure applied idle thrust alone would overcome the gradient and cause the aircraft to move forwards, so he thought it likely that he had only needed to apply a small amount of brake pressure to prevent the aircraft rolling forward.

The flight crew briefed for the possibility of loss of tyre pressure on landing. The landing gear was lowered early to allow for additional cooling of the brakes, although he realised that this would have no effect if the fuse plugs had already melted. The aircraft's Quick Reference Handbook (QRH) did not provide any guidance for this situation. At their destination of Newquay Airport the landing distance available was 8,000 ft which was within the calculated distance required of 3,300 ft, and the weather was suitable. They planned to touch down close to the runway threshold to maximise the runway available.

The ILS approach to Runway 30 at Newquay was normal, and the aircraft touched down close to the runway threshold. The wind at the time of the landing was from 240° at 21 kt. Immediately, the commander noticed the deceleration was greater than normal. Reverse thrust and speed brakes were applied, and as the aircraft slowed below about 50 kt the aircraft started to drift towards the right (downwind) side of the runway. A combination of weathercocking into the wind and applying left pedal brought the aircraft back to the runway centreline where it came to rest angled about 45° left of the centreline.

The flight crew shut down the engines and advised ATC they were evacuating on the runway. The crew and passenger then exited via the cabin door. The mainwheel tyres were found fully deflated and there was smoke emanating from them, but there was no fire. The airport fire service was on the scene shortly thereafter.

### **Recorded information**

The aircraft was fitted with a Cockpit Voice Recorder (CVR) which was downloaded at the AAIB. The audio quality of the two flight crew channels was poor, rendering most of the speech unintelligible. Tests on the CVR did not reveal any faults so it indicated an issue with the aircraft's system. The operator re-installed the CVR and carried out the normal maintenance procedure checks which did not reveal any issues. However, the maintenance procedure does not require listening to a sample recording. The AAIB suggested this to the operator, but the aircraft was in the process of being sold so this was left to the new owners.

### **Aircraft information**

The Beech 400A (later models were renamed the Hawker 400) is a light business jet with an MTOW of 7,303 kg (Figure 1). It has capacity for seven to nine passengers.



**Figure 1**

Incident aircraft Beech 400A after it came to rest off the runway centreline

The parking brake handle is located on the lower left side of the instrument panel (Figure 2). The parking brake is set by pulling the handle fully out and depressing the toe brakes. The hydraulic brake pressure applied by the toe brakes is then locked in the system when the toe brakes are released. Accordingly, the pressure applied when the parking brake is set is not a fixed value but varies depending on the instantaneous pressure applied at the toe brakes when the parking brake handle is pulled. Pilots can therefore set an intermediate (partial) pressure between zero and the maximum achievable brake pressure. The parking brake is released by pushing the handle in, which releases the brake pressure.



**Figure 2**

Parking brake handle location

The Pilot's Operating Manual<sup>1</sup> states that the parking brake is set by pulling out the handle and 'depressing the toe brakes two or three times'. It also states that: 'The parking brake should not be set if the brakes are very hot. This increases brake cool-down time due to decreased airflow. This may result in sufficient heat transfer from the brakes to cause the parking brake hydraulic pressure to rise excessively, or to melt the thermal relief plugs in the wheel.' The aircraft manufacturer clarified that the above description is applicable when the engines are not running, and the hydraulics are depowered. When the engines are running and the hydraulics are powered, pulling the parking brake handle out with toe brakes depressed will be sufficient. There is no guidance in the Pilot's Operating Manual on how hard the toe brakes should be pressed or what the brake pressure level should be. There is no indication of applied brake pressure in the flight deck.

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**Footnote**

<sup>1</sup> Beechjet 400A Pilot's Operating Manual P/N 128-590001-149A14. Revised 4 September 2002

There is no light or caption in the flight deck to warn the flight crew that the parking brake is applied, and there is no aural or visual warning if the pilot applies takeoff power when the parking brake is applied. There is, however, a pitch trim aural warning system which sounds when takeoff power is applied and the pitch trim is not set in the takeoff trim zone.

### Aircraft examination

Both mainwheel tyres were intact but had partially separated from their wheel rims (Figure 3). The fuse plugs on both mainwheels were found to have melted, and both brake units had seized.



**Figure 3**

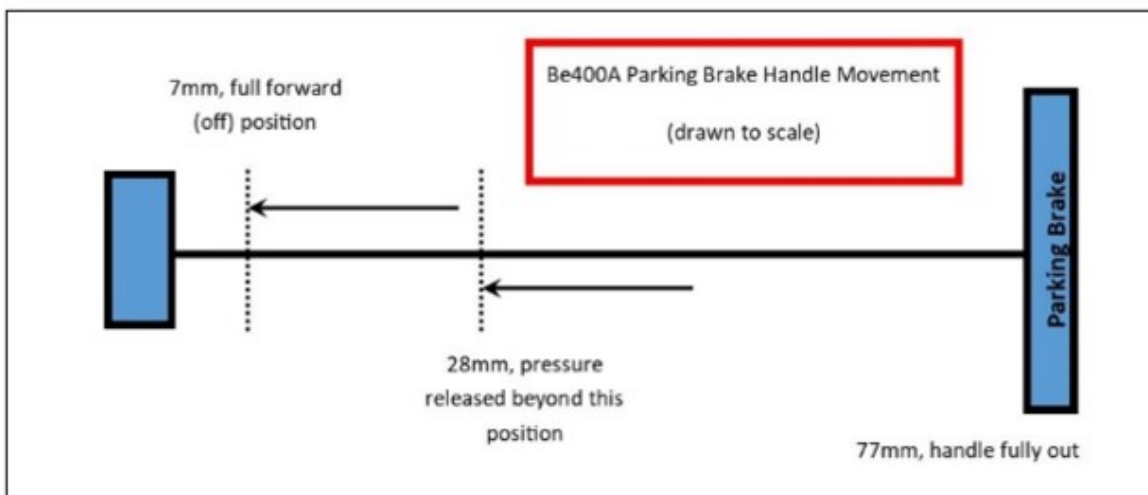
Left and right mainwheel tyres after the incident landing

The operator's maintenance organisation examined the parking brake system and did not find any faults. It then carried out tests to determine at what parking brake handle position the brake pressure was released. When the handle was pushed fully in, there was 7 mm of metal shaft exposed, and when it was pulled fully out there was 77 mm of shaft exposed (Figure 4). When the handle was slowly pushed inwards from the fully out position the parking brake remained on until it reached a position where 28 mm of shaft was exposed, at which point pressure started to release (Figure 5). The total travel of the handle from 'out' to 'in' was 70 mm, but the travel from brakes ON to OFF was only 21 mm. The first 49 mm of inwards travel did not change the brake pressure.



**Figure 4**

Parking brake handle on N709EL: left image, fully in (OFF); centre image, 28 mm out (ON); right image, fully out (ON)



**Figure 5**

Measurements of parking brake handle position

**Aircraft manufacturer information**

The aircraft manufacturer stated that the parking brake rigging instructions do not specify a mid-position of the handle at which the parking brake valve should actuate. The parking brake handle only has two lock positions: ‘in’ and ‘out’. If the parking brake is ON when the handle is fully out, and OFF when the handle is fully in, the system is rigged correctly.

The aircraft manufacturer was not aware of any incidents similar to this one on the Beech 400.

### Checklist

The aircraft checklist in the Approved Airplane Flight Manual<sup>2</sup> states 'Parking Brake...SET' at the beginning of the 'Starting Engines' checklist, and then there is no further reference to the parking brake in any subsequent checklist until the 'Shutdown' checklist. The 'Taxi' checklist includes 'Wheel Brakes check' which is a check carried out by pressing the toe brakes. The 'Before Takeoff' checklist, which would normally be carried out before entering the runway, does not include any reference to brakes. The 'Takeoff' checklist, which is normally done by memory once lined up on the runway, states:

1. Thrust.....APPROXIMATELY 90%  $N_1$
2. Engine Instruments.....CHECK
3. Wheel Brakes.....RELEASE'

The commander was using a checklist published by an international training organisation that was based on the Approved Airplane Flight Manual checklist. The 'Before Takeoff' checklist was the same in that it did not contain any reference to brakes. The 'Takeoff' checklist was not included in this checklist as it was intended to be carried out by memory.

### Commander's comments

The commander stated that he could not recall setting the parking brake at the holding point but that it is possible he did. There was a delay to the departure clearance which involved some negotiation as the clearance was not as filed; this resulted in an extended period at the holding point. There was a slight uphill gradient at the holding point and it is likely that he only needed to apply a small amount of brake pressure to prevent the aircraft from rolling forwards under idle power. He reported that historic fleet problems with releasing the parking brake, after it has been applied to hot brakes, had conditioned him to only apply sufficient brake pressure required for the situation when manoeuvring on the ground and applying the parking brake. He stated that even when the brakes were not hot, he had experiences in the past where considerable force was required to release the parking brake at the holding point. By applying only sufficient brake pressure helped him to avoid this issue. He had never considered that the aircraft could be taxied onto the runway and accelerate seemingly normally with the parking brake applied. The suggestion of applying higher than necessary brake pressure had never been highlighted during his training nor had the thought crossed his mind prior to the incident. He stated that full parking brake pressure was not defined, unlike on some types, and there was no minimum or threshold of brake pressure which must be applied before the parking brake can be selected ON. And since there was no parking brake ON caption, there was no indication of when full parking brake pressure was achieved. He considered that the only objective measure of parking brake pressure was whether it was sufficient or not for the conditions.

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### Footnote

<sup>2</sup> Beechcraft Beechjet 400A FAA Approved Airplane Flight Manual (RK-24 thru RK-92). P/N 128-590001-109 (last amended 3 November 2006).

He also stated that it did not help that there was no item for 'Parking brake.....Release' in the 'Before Takeoff' checklist, and he considered a possible contributing factor was his lack of recency on type which may have reduced his ability to perceive reduced acceleration.

### Operator comments

The operator was asked if they had considered adding a 'release parking brake' item to their 'Before Takeoff' checklist. They stated that they had considered this but after reviewing checklists of other aircraft types they decided it was unnecessary. They stated that checklists for other similar types and light business jets do not have a 'release parking brake' item in the 'Before Takeoff' checklist and that it is down to airmanship to remember to select it off if it is used, because the parking brake will not always be used. They stated that an event like this had never previously happened in their operation.

It is possible that there have been unreported cases of aircraft lining up and commencing takeoff with the parking brake applied, which has been noticed and corrected at the last minute, but not been reported.

### Certification requirements

The Beech 400A was certified to US Federal Aviation Regulations 14 CFR Part 25 Airworthiness Standards: transport category airplanes effective 1 February 1965 with some amendments, with the most recent amendment dated 18 June 1990. 14 CFR Part 25 section 25.735 on 'Brakes' stated:

*'d) The airplane must have a parking control that, when set by the pilot, will without further attention, prevent the airplane from rolling on a paved, level runway with takeoff power on the critical engine.'*

There was no requirement for the parking brake to hold the aircraft when takeoff power was applied to all engines, and there was no requirement for a parking brake light or for a warning system when takeoff power is applied while the parking brake is set.

On 24 May 2002, section 25.735 was amended (Amendment 25-107) to include the following requirement<sup>3</sup> for new aircraft certified after that date:

*'There must be an indication in the cockpit when the parking brake is not fully released.'*

There is still no requirement for the parking brake to hold the aircraft with all engines at takeoff power, and there is no requirement for a warning system when takeoff power is applied while the parking brake is set. However, many large jet airliners have such a warning system installed.

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### Footnote

<sup>3</sup> Amendment No 25-107 on 26 December 2002 is also the most recent amendment – the section on the parking brake is the same in EASA CS 25.735



## Previous incidents of takeoffs with the parking brake on

The AAIB published a report in October 2003<sup>4</sup> about a Cessna Citation 560 Ultra business jet (registration VP-CSN) that had departed with the parking brake partially applied, which then suffered a similar rapid deceleration and tyre deflation during landing to that of N709EL. Various distractions had led to the parking brake being left on, and there was no light or caption to indicate the parking brake was on. There was also no aural or visual warning that the parking brake was on when takeoff power was applied, and there was no 'parking brake off' check in the pre-takeoff checklist.

The AAIB published a report in March 2011<sup>5</sup> about a Cessna Citation CJ+ business jet (registration N646VP) that carried out a rejected takeoff and overran the end of the runway. It was suspected that the parking brake was at least partially on during the takeoff run. The report states that the aircraft manufacturer was considering fitting a 'parking brake applied' warning on future models of the Citation.

The US National Transportation Safety Board (NTSB) published a report on a fatal accident to a Cessna Citation 560 (registration N560AR) that occurred on 2 September 2021. The report<sup>6</sup> states that during takeoff the aircraft hit a pole at the end of the runway; the aircraft then struck the ground and a building destroying the aircraft and fatally injuring all occupants. The parking brake was found in the ON position, and the flight data showed that the aircraft did not lift off when the pilot pulled the yoke aft at the rotation speed. Analysis revealed that the action of the parking brake caused a nosedown pitching moment that countered the attempts of the pilot to rotate the aircraft nose-up. The report refers to other previous events involving Cessna 550 and 560 aircraft which tried to take off with the parking brake applied and which resulted in runway overruns.

The NTSB made three safety recommendations<sup>7</sup> to the FAA to require:

- (1) in-service Cessna 560XL aircraft to be modified with a parking brake indication as per Amendment 25-107 of 25.735 (recommendation A-22-8);
- (2) require newly manufactured Cessna 560XL and derivative models to have a parking brake indication as per Amendment 25-107 of 25.735 (recommendation A-22-9); and
- (3) require the aircraft manufacturer to add a 'release parking brake' item to the pre-takeoff checklist of the Cessna 560XL (recommendation A-22-10).

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### Footnote

- <sup>4</sup> AAIB Bulletin 10/2003. Incident to Cessna Citation 560 Ultra, VP-CSN, on 23 April 2003 at Edinburgh Airport. [https://assets.publishing.service.gov.uk/media/54230496ed915d1371000cbb/dft\\_avsafety\\_pdf\\_024592.pdf](https://assets.publishing.service.gov.uk/media/54230496ed915d1371000cbb/dft_avsafety_pdf_024592.pdf) [accessed 20 October 2023].
- <sup>5</sup> AAIB Bulletin 3/2011. Accident to Cessna Citation CJ+, N646VP, on 7 June 2010 at Leeds Bradford Airport. [https://assets.publishing.service.gov.uk/media/5422f5b6e5274a131400055f/Cessna\\_Citation\\_CJ1\\_N646VP\\_03-11.pdf](https://assets.publishing.service.gov.uk/media/5422f5b6e5274a131400055f/Cessna_Citation_CJ1_N646VP_03-11.pdf) [accessed 20 October 2023].
- <sup>6</sup> National Transportation Safety Board (NTSB) Report ERA21FA346 on Cessna 560 registration N560AR <https://data.nts.gov/carol-repgen/api/Aviation/ReportMain/GenerateNewestReport/103791/pdf> [accessed 20 October 2023].
- <sup>7</sup> National Transportation Safety Board (NTSB) AIR-22-06 report, published 4 May 2022. Require Safeguards to Prevent Cessna 560XL Takeoff with Parking Brake Engaged, <https://www.nts.gov/investigations/AccidentReports/Reports/AIR2206.pdf> [accessed 20 October 2023].

The FAA responded that they conducted a risk assessment on the absence of a parking brake indication on the in-service Cessna 560XL fleet and determined that the concern did not constitute an unsafe condition requiring airworthiness directive action.

The FAA stated that, with regards to recommendation A-22-9, the aircraft manufacturer has agreed to voluntarily update future derivative Cessna 560XL airplane models to include an indication for the parking brake.

The FAA stated that, with regards to recommendation A-22-10, the aircraft manufacturer has proposed to voluntarily update all airplane flight manuals and pilot checklists for the Cessna 560XL with text about releasing the parking brake prior to takeoff.

### **Analysis**

The pilots experienced a rapid deceleration immediately after touching down at Newquay Airport which could have been caused by either the tyres having already deflated due to the fuse plugs having melted, or the brakes being seized, or a combination of both. During the cruise the commander had found the parking brake handle was not fully pushed in and had noticed a reduced acceleration late during the takeoff, which meant it was highly likely that there was partial parking brake pressure applied during the takeoff which would have heated the brakes. This heat alone could have melted the fuse plugs, but the flight manual states that hot brakes can increase the parking brake pressure by heating the hydraulic fluid, which increases the brake heat and can then cause the fuse plugs to melt.

From past experience the commander would only apply sufficient toe brake pressure when setting the parking brake. He did this to prevent the brakes from seizing which was a known issue when the brakes were hot, but he had also experienced difficulty releasing the brakes when they were not hot and higher pressure had been applied. On this occasion a slight uphill gradient at the holding point helped to partially counter forward movement due to residual idle thrust, so it is likely that the commander only applied sufficient (partial) toe brake pressure when setting the parking brake at the holding point prior to takeoff, whilst the crew addressed issues with their clearance. It is possible the commander set the parking brake subconsciously which, combined with the distraction of negotiating the clearance with ATC, resulted in him not releasing the parking brake before taxiing onto the runway. If the commander had applied higher toe brake pressure when setting the parking brake, then he would have probably noticed a higher breakaway thrust being required and he would have probably noticed a more significant reduction in acceleration at the start of the takeoff roll. However, it may also be possible to take off with full brake pressure applied as there is no certification requirement for the parking brake to hold the aircraft with all engines at takeoff power.

The aircraft type was not fitted with any light or caption to indicate when the parking brake is applied, and it did not have an aural or visual warning to alert the pilot that the parking brake is on when full power is applied. Either of these features could have helped prevent a takeoff with the parking brake applied.

The parking brake handle is located just to the left of the commander's left leg and so it is unlikely that the co-pilot, in the right seat, will detect if it has been left in the ON position. The travel from ON to OFF was only 21 mm, on this aircraft, so there was only a small visual difference between a handle that has only been partially pushed in and one that is fully in. There was also no 'release parking brake' item on the 'Before Takeoff' checklist, which could have served as a reminder to help prevent taking off with the parking brake applied.

There have been previous accidents involving pilots forgetting to release the parking brake and then not noticing the reduction in acceleration during the takeoff run. These have occurred on other aircraft types that also did not have a visual caption to indicate the parking brake was applied and did not have a 'release parking brake' item in the 'Before Takeoff' checklist.

The solution most likely to help prevent recurrence would be for the aircraft fleet to be modified with at least a parking brake indication as per Amendment 25-107 of 14 CFR Part 25 Section 25.735. However, the FAA has already determined that the situation does not constitute an unsafe condition requiring airworthiness directive action for the Cessna 560XL fleet, so it is unlikely to have a different view for the Beech 400A fleet.

The Beech 400A is no longer manufactured so there is no scope for requiring a modification for future-built aircraft.

Adding an item to the checklist to remind flight crews to release the parking brake prior to takeoff is a less effective solution than a modification; however, checklists are used because they help flight crew to remember important actions. A checklist prompt to release the parking brake could help to prevent a future accident; therefore, the AAIB makes the following Safety Recommendation:

#### **Safety Recommendation 2024-007**

It is recommended that Textron Aviation Inc. amend the checklists for the Beech 400 series of aircraft to include a 'release parking brake' item in the 'Before Takeoff' checklist.

### **Conclusion**

The rapid deceleration and mainwheel tyre deflation after touchdown was caused by either the tyres having already deflated due to the fuse plugs having melted, or the brakes being seized, or a combination of both. This was the result of the brakes having been heated during the takeoff run because the parking brake had been left on. It is likely that the commander applied the parking brake while holding short of the runway, with only sufficient (partial) brake pressure applied, and then, after addressing a departure clearance issue, either did not push the handle in or did not push it fully in prior to taxiing onto the runway.

The lack of a light or caption to indicate that the parking brake is ON, or an aural or visual warning that the parking brake is ON when takeoff power is applied, may have contributed to the incident, as may have the lack of a 'release parking brake' item in the 'Before Takeoff' checklist.

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