Bundesstelle für
Flugunfalluntersuchung

German Federal Bureau of
Aircraft Accident Investigation

Investigation Report

The investigation was completed stating facts only, i.e. no analysis and conclusions.

Identification

Type of Occurrence:	Serious Incident
Date:	23 May 2022
Location:	Schwäbisch Hall
Aircraft:	Airplane
Manufacturer:	Cessna Aircraft Company
Type:	Citation 560XLS +
Injuries to persons:	No injuries
Damage:	Minor damage to aircraft
Other Damage:	None

Abstract

During take-off run, the right main landing gear tire burst. The airplane’s right main landing gear and the nose landing gear veered right off the runway.

Factual Information

History of the Flight

On 23 May 2022 at 1350 hrs[1], the Citation 560XLS + flight crew began take-off run on runway 28 of Schwäbisch Hall Airport to conduct a positioning flight without any passengers. They noticed that the airplane accelerated much slower than usual. The right main landing gear tire burst and the airplane veered right off the runway. According to the flight crew's description and the visual images provided, the airplane veered off the runway with slow speed. It came to a stop with the right main landing gear and the nose landing gear in the grass.

According to the FDR recording, which was read out at the BFU, the flight crew aborted take-off at a speed of about 59 kt (Fig. 1). According to the CVR (1380:52 hrs: „*Die Bremse ist angezogen!* (The brake is engaged)"), the parking brake had not been released.

The two pilots had not suffered any injuries and the aircraft was slightly damaged.

Personnel Information

Pilot in Command

The 69-year-old pilot in command held an Airline Transport Pilot License (ATPL(A)) of the European Union with the following ratings:

- C560XL/XLS PIC IR, valid until 31 December 2022

His class 1 medical certificate for other commercial operation was valid until 27 June 2022 with the restriction VML (correction for defective distant, intermediate and near vision).

He had a total flying experience of about 15,400 hours; 3,500 hours of which were flown on type. In the last 90 days, he had flown about 57 hours and performed 63 take-off and landings.

Co-pilot

The 59-year-old pilot held an Airline Transport Pilot License (ATPL(A)) of the European Union with the following ratings:

[1] All times local, unless otherwise stated.

- C560XL/XLS PIC IR, valid until 30 November 2022
- Falcon 7X PIC IR, valid until 28 February 2023
- TBM SET PIC IR, valid until 30 September 2022
- SEP (land) PIC, valid until 31 August 2023
- SEP (sea) PIC, valid until 30 June 2022

His class 1 medical certificate for other commercial operations was valid until 30 October 2022.

He had a total flying experience of about 8,500 hours, of which about 1,204 hours were flown on type. In the last 90 days, he had flown about 27 hours and performed 31 take-off and landings.

Aircraft Information

The Cessna Citation 560 XLS is a low-wing business jet in all-metal construction. It is equipped with a retractable tricycle nose wheel landing gear.

Year of manufacture of the aircraft involved was 2011 and it received a German certificate of registration on 29 December 2011. The 560XLS + version has improved avionics and engine and a new nose compared with the 560XLS. Maximum Take-off Mass (MTOM) is 9,163 kg. It was equipped with two Pratt & Whitney Canada PW545C engines. At the time of the occurrence, total operating time was 3,694:52 hours and 4,702 cycles.

Meteorological Information

At the time of take-off, weather conditions with visibilities of more than 10 km prevailed. In the vicinity of the airport, thunder cells were present which prompted the flight crew to activate the weather radar already on the runway.

The aviation routine weather report (METAR) at Schwäbisch Hall Airport of 1150 hrs read:

230950Z 14007KT 090V180 CAVOK 20/14 Q1005=

The terminal aerodrome forecast (TAF) at Schwäbisch Hall Airport of 1000 hrs read:

230800Z 2309/2318 11006KT 9999FEW045 BECMG 2311/2313 24008KT PROB40 TEMPO 2311/2312 24020G35KT 3500 TSRA SCT035CB TEMPO 2314/2318 28035G50KT 3000 TSGRRA BKN020CB=

Radio Communications

Radio communications were recorded by the air navigation service provider and made available to the BFU for evaluation.

Aerodrome Information

Schwäbisch Hall Airport (EDTY) is located at 1,311 ft AMSL. It had one asphalt runway with a length of 1,660 m and a width of 30 m with the orientation 097°/277° (10/28). For landing direction 28, landing distance available was 1,540 m. In addition, the airport had one grass strip with a length of 750 m. The airport was certified for operation of aircraft with an MTOM of 14 t.

Flight Recorder

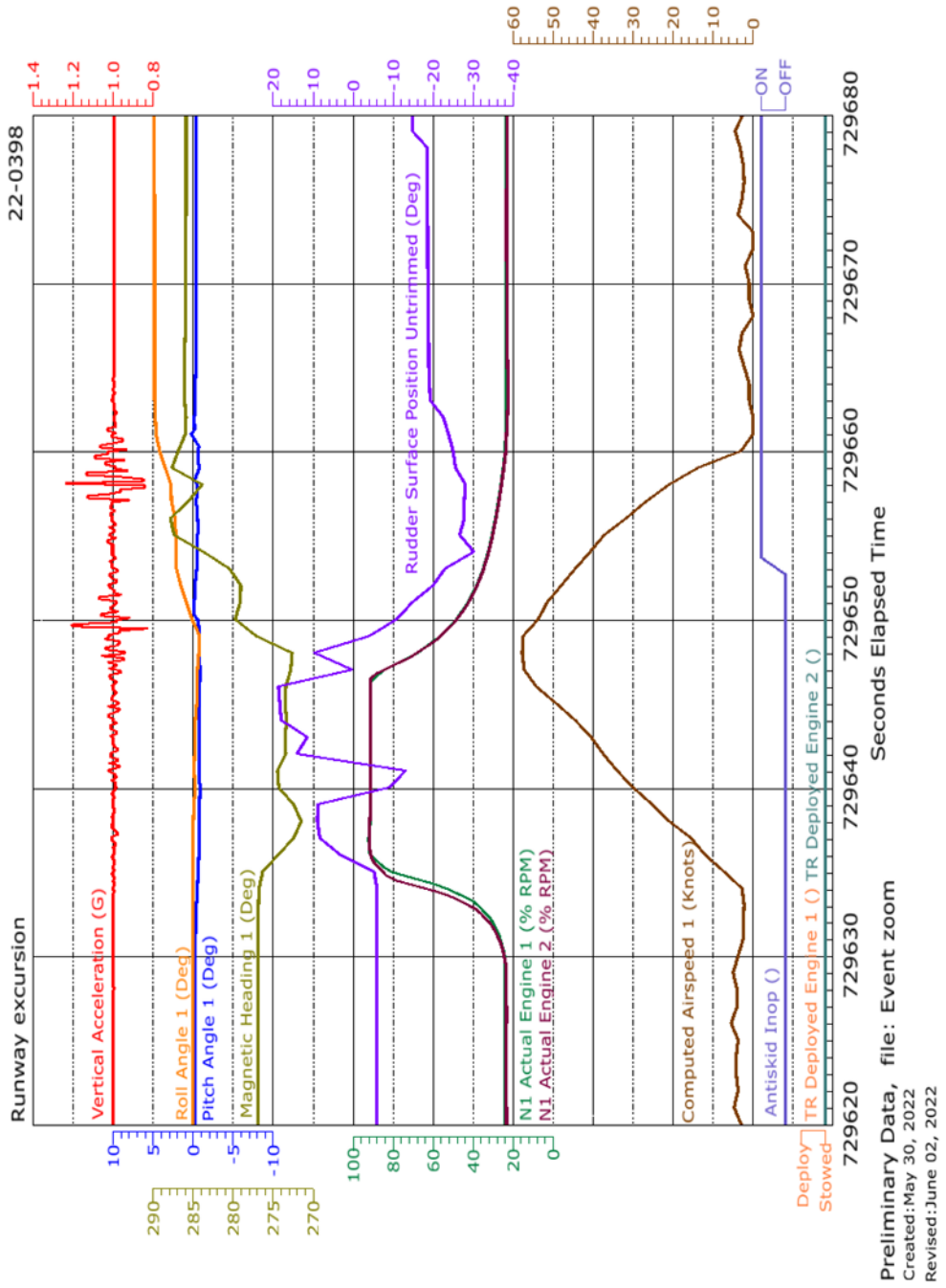

Fig. 1: FDR recordings Source: BFU

The airplane was equipped with a L3 Harries FA2100 FDR, PN: 2100-2043-00. The BFU read out the FDR data, these are depicted in Figure 1.

The brown line in Figure 1 (Computed Airspeed 1 (Knots)) shows the course of the speed. The graph shows that until the rejected take-off a maximum speed of about 59 kt was reached.

The airplane was equipped with a L3 Harries FA2100 CVR, PN: 2100-1025-22. The BFU read out the CVR data.

Wreckage and Impact Information

Fig. 2: Final position of the aircraft Source: Airport, adaptation BFU

The aircraft came to a stop on runway 28 in the area of the touch down zone of the glide path of ILS runway 28. The airplane's left main landing gear was on the runway, the nose landing gear and the right main landing gear were in the grass to the right of the runway. The right main landing gear tire was destroyed. The rubber abrasion marks of the left main landing gear tire are clearly visible in Figure 2. Parts of the right tire were found on the runway.

Fire

No fire was detected.

Additional Information

In the past, several partially severe events occurred internationally in connection with the Cessna 560XL/XLS parking brake.

The respective investigation authorities determined that an engaged/not entirely released parking brake was not indicated in the Cessna 560XL/XLS cockpit. The parking brake was not part of the Take-off Configuration Warning. The manufacturer had offered a conversion which in the meantime has been taken from the market. The parking brake's position cannot be seen from the right-hand seat if the left is occupied. The Australian, Nigerian and US-American investigation authorities have already issued Safety Recommendations. The last Safety Recommendation (including report) of the National Transportation Safety Board (NTSB) dated 4 May 2022 (NSB-AIR-22-06) addressed the Federal Aviation Administration (FAA) (Appendix).

Investigator in charge:	Pfefferl
Assistance:	Buchwald, Beckert
Braunschweig,	23 August 2023

Appendices

May 4, 2022 AIR-22-06

Require Safeguards to Prevent Cessna 560XL Takeoff with Parking Brake Engaged

Introduction

The National Transportation Safety Board (NTSB) is providing the following information to urge the Federal Aviation Administration (FAA) to take action on the safety recommendations in this report. We identified transportation safety issues during one ongoing investigation and one previous investigation involving Cessna 560XL airplanes in which parking brake pressure was not fully released before attempted takeoffs, which prevented the airplanes from rotating for takeoff. Once the airplanes reached this point in the takeoff sequence, they were beyond the point at which they could be stopped safely, leading to fatal or serious injuries. The NTSB is issuing three safety recommendations to the FAA.

Background and Analysis

On September 2, 2021, a Cessna 560XL airplane, N560AR, overran the departure end of the runway during the takeoff roll near Farmington, Connecticut. The preliminary report for this investigation included a witness's statement that when the airplane departed the runway, it was in a level attitude but that after clearing the departure end of the runway and becoming briefly airborne, it pitched up then impacted a pole. After that, the airplane impacted the ground then a building and was destroyed, and the two pilots and two passengers were fatally injured. One occupant of the building that was impacted sustained serious injury and three occupants sustained minor injuries.

A preliminary review of parameters from the airplane's flight data recorder revealed that the airplane had exceeded the speed required to take off (rotational speed or V_r) and did not lift off the ground in response to the pilot pulling the yoke aft. However, the airplane rapidly pitched up once the terrain dropped away beyond the departure end of the runway. An on-site examination revealed that the airplane's parking brake valve and pull knob were in the set position, which indicated that the

airplane's parking brake had likely not been fully released before the attempted takeoff.[1]

A similar accident occurred on August 21, 2019, near Oroville, California. The pilots reported that after the Cessna 560XL airplane, N91GY, reached V_r during the takeoff roll, the airplane did not respond to the pilot flying pulling the yoke aft for takeoff. The pilot flying stated that he applied full thrust reversers and maximum braking to reject the takeoff, but the airplane overran the departure end of the runway. The pilots and passengers were not injured, and the airplane was destroyed by a postimpact fire. Postaccident examination of the parking brake valve, which was closed, and interviews with the pilot flying, who was seated in the left seat, indicated that he had not released the airplane's parking brake pull knob, which was located next to his left knee, before the takeoff roll.

According to the pilot flying, he believed that the airplane "shouldn't move" if the parking brake was set and takeoff power was applied.[2] The NTSB determined the probable cause of this accident to be "the pilot's failure to release the parking brake before attempting to initiate the takeoff, which produced an unexpected retarding force and airplane nose down pitching moment. Also causal was the flight crew's delayed decision to abort the takeoff, which resulted in a runway excursion. Contributing to the accident was the lack of a 'no takeoff' annunciation warning that the parking brake was engaged, and lack of a checklist item to ensure the parking brake was fully released immediately before takeoff."

Similarly, the Australian Transport Safety Bureau's (ATSB's) investigation of a September 2015 accident near Lismore, New South Wales, Australia, determined that the pilots in a Cessna 550 had set the parking brake during a lengthy hold waiting to depart and did not release it before attempting to takeoff, which led to a rejected takeoff and runway overrun.[3] The ATSB's investigation found that Cessna Citation airplanes, which include both the Cessna 550 and 560XL, did not have a cockpit annunciation to alert the pilots that the parking brake was set or an unambiguous checklist item to direct pilots to fully release the parking brake before takeoff is initiated.[4] The ATSB made a recommendation to Textron Aviation (Textron), the

[1] Visit ntsb.gov to find additional preliminary information for this NTSB investigation (case number ERA21FA346). Use the CAROL Query to search safety recommendations and investigations.

[2] Visit ntsb.gov to find additional information in the public docket for this NTSB investigation (case number WPR19FA230).

[3] The accident airplane had the parking brake pull knob in the same location as the 560XL and did not have a visual indicator for a parking brake that is not fully released.

[4] The airplane's "before start" checklist directs the left-seat pilot to set the parking brake before starting the engine; its taxi checklist directs the pilot flying to check the brakes before taxiing but does not specify which brakes. The airplane's static and rolling takeoff checklists direct the pilot to "release brakes," but that item could be misinterpreted to refer only to the toe brakes.

airplane manufacturer, to address these findings.[5] In an October 2017 response, Textron stated that the recommended actions were not needed because it was "simple airmanship" to remember to release the parking brake before the takeoff run; Textron neither updated its pretakeoff checklists nor added a parking brake annunciation.

The Accident Investigation Bureau, Nigeria is currently investigating an October 2018 incident near Bauchi, Nigeria, where the pilot of a Cessna 560XL rejected the takeoff after the airplane reached V_1 but did not become airborne.[6]

Only the left-seat pilot of a Cessna 560XL may set the parking brake at various points before takeoff, such as when holding short of the runway, before receiving clearance to take off, or before initiating takeoff. For example, the pilot flying (who was in the left seat of the Oroville accident airplane) recalled that he likely set the parking brake while holding short of the runway as he finished the items in the taxi checklist.[7] To set the parking brake in a Cessna 560XL airplane, the left-seat pilot depresses the toe brakes while pulling the parking brake pull knob, which is shown in the figure below. The amount of wheel brake pressure applied depends on how fully the toe brakes are depressed when the parking brake pull knob is pulled. To release the parking brake pressure, the left-seat pilot pushes the parking brake pull knob forward. Given the Cessna 560XL parking brake pull knob's location on the lower left side of the left-seat pilot near that pilot's knee, the pull knob is not visible to the right-seat pilot.

[5] For more information, see ATSB. 2016. *Runway excursion involving Cessna 550, VH-FGK, Lismore Airport, New South Wales, 25 December 2015.* AO-2015-114.

[6] Accident Investigation Bureau, Nigeria. 2021. *Interim statement on the serious incident involving Cessna Citation 560 XLS+ aircraft with nationality and registration marks 5N-HAR operated by the Nigeria Police which occurred at Sir Abubakar Tafawa Balewa Airport Bauchi, Bauchi State; Nigeria on 3rd October, 2018.* NPF/2018/10/03/INTR/03.

[7] The pilot reported that he engaged the parking brake to check the airplane's rudder bias, which is the last item on the airplane's taxi checklist.

Figure 1. The location of the parking brake pull knob in a Cessna 560XL exemplar airplane (XLS model). (Source: Delta Private Jets)

Based on the results of an airplane performance study completed during the Oroville investigation, if a Cessna 560XL airplane is accelerating with partial parking brake pressure applied, the resulting retarding force at the wheel-runway interface creates a pitching moment that opposes airplane nose-up rotation. When the airplane reaches V_r, the pitching moment opposing the airplane nose-up rotation may overpower the elevator's ability to rotate the airplane nose up and prevent the airplane from taking off. If the takeoff is rejected after reaching V_r, the airplane may not be able to stop safely on the remaining runway and may impact hazards beyond the runway.[8] The identified accidents demonstrate that, contrary to the Oroville pilot's expectation, a Cessna 560XL airplane with both engines at takeoff power and at least partial parking brake pressure applied can accelerate and reach or exceed V_r, not be able to lift off, and be unable to stop on the remaining runway.

To meet the requirements of Title 14 *Code of Federal Regulations* (*CFR*) Section 25.735, Brakes and Braking Systems, a parking brake must prevent the airplane from rolling on a paved, level runway when set by the pilot and with takeoff

[8] Potential hazards beyond the runway include steep slopes, fences, hills, buildings, bodies of water, and highways.

power on the critical engine.[9] The parking brake for the Cessna 560XL, which was first certified in 1998, met the requirements of the 1965 standard by demonstrating that the parking brake prevented the airplane from rolling when it was set with full parking brake pressure applied and one engine at takeoff power.

Effective May 2002, the FAA amended 14 *CFR* 25.735 (Amendment 25-107) to state, in part, "There must be indication in the cockpit when the parking brake is not fully released."[10] However, because the Cessna 560XL was initially certificated 4 years before the parking brake indication amendment, there is no requirement for a cockpit indication if the parking brake is not fully released. The FAA also approved two subsequent derivative models (or "changed aeronautical products") of the Cessna 560XL, the XLS, and XLS+; because Textron did not change the function of the parking brake in those models, it only had to meet the 1965 standard.[11]

A visual indication in the pilots' expected scan range would attract attention and increase the likelihood that pilots will notice and address an unsafe condition, in this case by fully releasing the parking brake before takeoff.[12] The effectiveness of a visual indication (for the horizontal stabilizer trim setting) was demonstrated shortly before the pilots involved in the Oroville accident began the takeoff. They received a "no takeoff" indication on the cockpit indicator panel alerting them of an unsafe horizontal stabilizer trim setting, which they successfully identified and addressed.

The NTSB notes that, because other countries require that pilots be alerted when the parking brake is not fully released before takeoff, Textron wired the airplane's "no takeoff" annunciator to include a parking brake indication for initial

[9] The parking brake standard in 14 *CFR* 25.735 was first issued in 1965, and this was the standard until May 2002, which will be discussed later.

[10] Title 14 *CFR* 25.735 Amendment 25-107 was effective May 24, 2002, and incorporated the parking brake indication and other changes to federal requirements for airplane braking systems based on the recommendations of the Aviation Rulemaking Advisory Committee, which was directed to harmonize European, Canadian, and US braking standards.

[11] (a) According to 14 *CFR* 21.101, the FAA approves changes for derivative models if it finds that the changes are not significant enough to warrant application for a new type certificate. The regulation also outlines four exceptions to this requirement: (1) if the change was not significant, (2) for those areas or components not affected by the change, (3) if such compliance would not contribute materially to the level of safety, and (4) if such compliance would be impractical. This process enables a manufacturer to introduce design updates without resubmitting the entire airplane design for certification review. (b) The Oroville accident airplane was manufactured in 2003 in accordance with the initial certification standard, the Farmington accident airplane was manufactured in 2009 as an XLS+ derivative model, and the Bauchi accident airplane was manufactured in 2011 as an XLS+ derivative model.

[12] Berman, B.A., Kochan, J.A., Burian, B.K., Pruchnicki, S., Christopher, B., and Silverman, E. 2017. *Alerts and Cues on the Flight Deck: Analysis and Applications*. National Aeronautics and Space Administration (NASA) report NASA/TM-2017-219720. Moffett Field, CA: NASA Ames Research Center.

certification models and XLS derivatives manufactured for export to Ireland and the UK since 2002 and 2007, respectively.[13] Beginning in 2002, Textron offered buyers the option for the existing "no takeoff" annunciation to include a visual and aural annunciation if the parking brake was not fully released on some newly manufactured models of the Cessna 560XL, including those in the United States. No Cessna 560XLs delivered in the United States have been produced with this feature to date.[14] Textron continues to manufacture Cessna 560XL airplanes without a parking brake indication, including the XLS+ derivative model, and the option is no longer available on newly manufactured Cessna 560XL airplanes.

As the FAA's updated parking brake standard in 14 *CFR* 25.735 suggests and the Oroville accident pilots' actions to address the "no takeoff" visual indication show, an indication to alert pilots to fully release the parking brake before starting the takeoff roll is an important safeguard. However, Cessna 560XL airplanes continue to operate in the United States without a parking brake indication, and Textron continues to manufacture and deliver airplanes in the United States without such an alert. The NTSB concludes that, without a parking brake indication, some Cessna 560XL pilots may not recognize that the parking brake is not fully released and attempt to take off, which could result in a runway overrun. Thus, the NTSB recommends that the FAA issue an airworthiness directive for in-service Cessna 560XL airplanes to require that they meet the parking brake indication requirements of Amendment 25-107 of 14 *CFR* 25.735. The NTSB also recommends that the FAA revise the type certification basis for Cessna 560XL airplanes and future derivative models to require that newly manufactured airplanes meet the parking brake indication requirements of Amendment 25-107 of 14 *CFR* 25.735.

Unambiguous and mandatory checklist items that are correctly sequenced serve as important redundancies to a visual indication. The existence of a physical stimulus in the cockpit, such as a pull knob or indication, does not guarantee that the

[13] The Cessna 560XL has a "no takeoff" visual and aural annunciation for other items that would impede a safe takeoff, such as an unsafe horizontal stabilator trim setting. The Irish Aviation Authority requires the annunciator to be wired for the parking brake for Cessna 560XL airplanes; at least eight Cessna 560XL airplanes have been built to the United Kingdom standard, which includes a "no takeoff" annunciation for a parking brake that is not fully released. The Cessna 560XL airplane flight manual supplement 39 (approved by the FAA in 2002) and supplement 57 (approved by the FAA in 2007) state that the Irish and United Kingdom standards, respectively, for the "no takeoff" annunciator include a parking brake that is not fully released.

[14] All Cessna 560XL airplanes have a "no takeoff" annunciation for other items that would impede a safe takeoff, such as an unsafe horizontal stabilator trim setting. According to Textron, for some initial certification and XLS derivative models, it offered the option to install a "no takeoff" annunciation to include a parking brake that is not fully released; it did not offer that option for the XLS+ derivative model. Both the Oroville and Farmington accident airplanes had "no takeoff" annunciation systems installed, but neither airplane had been built with the parking brake option.

pilot will perceive an unsafe condition, as noted in the ATSB investigation.[15] Thus, the NTSB concludes that a checklist item before takeoff is initiated would aid pilots of Cessna 560XL airplanes in ensuring the full release of the parking brake before the takeoff roll and prevent hazardous runway overruns. Therefore, the NTSB recommends that the FAA require Textron to include a checklist item on the Cessna 560XL pretakeoff checklist for pilots to verify that the airplane's parking brake is fully released before takeoff is initiated.

Conclusions

Findings

Without a parking brake indication, some Cessna 560XL pilots may not recognize that the parking brake is not fully released and attempt to take off, which could result in a runway overrun.

A checklist item before takeoff is initiated would aid pilots of Cessna 560XL airplanes in ensuring the full release of the parking brake before the takeoff roll and prevent hazardous runway overruns.

Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following safety recommendations:

To the Federal Aviation Administration:

Issue an airworthiness directive for in-service Cessna 560XL airplanes to require that they meet the parking brake indication requirements of Amendment 25-107 of Title 14 *Code of Federal Regulations* Part 25 section 735. (A-22-8)

Revise the type certification basis for Cessna 560XL airplanes and future derivative models to require that newly manufactured airplanes meet the parking brake indication requirements of Amendment 25-107 of Title 14 *Code of Federal Regulations* Part 25 section 735. (A-22-9)

[15] Degani, A., and Wiener, E.L. 1993. "Cockpit Checklists: Concepts, Design, and Use." *Human Factors* 35 (2): 28-43.

Require Textron Aviation to include a checklist item on the Cessna 560XL pretakeoff checklist for pilots to verify that the airplane's parking brake is fully released before takeoff is initiated. (A-22-10)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER HOMENDY
Chair

MICHAEL GRAHAM
Member

BRUCE LANDSBERG
Vice Chairman

THOMAS CHAPMAN
Member

Report Date: May 4, 2022

The National Transportation Safety Board (NTSB) is an independent federal agency dedicated to promoting aviation, railroad, highway, marine, and pipeline safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974, to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)).

For more detailed background information on this report, visit the NTSB investigations website and search for NTSB accident IDs ERA21FA346 and WPR19FA230. Recent publications are available in their entirety on the NTSB website. Other information about available publications also may be obtained from the website or by contacting–

National Transportation Safety Board
Records Management Division, CIO-40
490 L'Enfant Plaza, SW
Washington, DC 20594
(800) 877-6799 or (202) 314-6551

This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (*Flugunfall-Untersuchungs-Gesetz - FlUUG*) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

Published by:

Bundesstelle für
Flugunfalluntersuchung
Hermann-Blenk-Str. 16
38108 Braunschweig

Phone +49 531 35 48 - 0
Fax +49 531 35 48 - 246

Mail box@bfu-web.de
Internet www.bfu-web.de