
----- **SYSTEMS GROUP CHAIRMAN'S FACTUAL REPORT** -----

1 ACCIDENT:

Location: Oroville, California
Date: August 21, 2019
Time: About 1132 LCL
Aircraft: Cessna Citation 560XL
Serial Number: 560-5314
Registration: N91GY

2 SYSTEMS GROUP:

Chairman: Michael Bauer
National Transportation Safety Board
Washington, D.C.

Member: Patrick Lusch
Federal Aviation Administration
Washington, D.C.

Member: Henry Soderlund
Textron Aviation Inc.
Wichita, Kansas

Member: Julian Dodge
Delta Private Jets
Cincinnati, Ohio

3 SUMMARY

3.1 Event Summary

On August 21, 2019, about 1132 Pacific daylight time, a Cessna 560XL airplane, N91GY, was destroyed when it was involved in an accident near Oroville, California. The two airline transport pilots, and eight passengers were not injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 135 on-demand charter flight.

3.2 Systems Group Summary

The systems group was formed on August 22, 2019 during the on-scene phase of the investigation. The group documented the flight controls, cockpit, landing gear, brakes and associated systems from August 22 to 25, 2019.

The systems and operations group chairmen along with the Textron Aviation party member examined an exemplar aircraft at the Textron Aviation Service Center located in Sacramento, California on August 26, 2019. The examination consisted of the parking brake system components and operation.

This report contains factual information related to the group's inspection and documentation of the aircraft's parking brake system and additional systems as noted.

3.3 Acronyms

ATA	Airline Transport Association
AGL	Above Ground Level
CFR	Code of Federal Regulations
CT	Computed Tomography
FWD	Forward
ft	Feet (unit of measure)
KIAS	Knots Indicated Air Speed
KOVE, OVE	Oroville Municipal Airport
LCL	Local
LH	Left Hand
NTSB	National Transportation Safety Board
PSI	Pounds Per Square Inch
RH	Right Hand
RPM	Revolutions Per Minute
T/R	Thrust Reverser
TCDS	Type Certificate Data Sheet
TEU	Trailing Edge Up
UAS	Unmanned Aircraft Systems

4 DETAILS OF THE INVESTIGATION:

4.1 Aircraft Information

Customer/Model Series:	Cessna Citation 560XL (Citation Excel)
Aircraft Registration:	N91GY
Aircraft Serial Number:	560-5314
Manufactured Date:	2003

At the time of the accident, the aircraft had the following flight hours and cycles.

Total Flight Hours:	9,877.4
Total Flight Cycles:	7,400

The aircraft was initially delivered from the factory and registered to a foreign operator in Portugal, prior to returning to a new owner/operator and being registered in the United States.

The operator provided the group with the 30-day flight history and maintenance records from the preceding 6 months.

The review of the records did not show any noted discrepancies with the aircraft brakes over the preceding 6 months.

The left main tire was replaced on August 18, 2019. The right main tire was replaced on July 2, 2019. The nose landing gear tire was replaced on July 29, 2019.

All landing gear checks were within maintenance manual compliance limits.

4.2 Accident Site Information

Information on the wreckage site and runway information can be found in the unmanned Aircraft Systems (UAS) Aerial Imagery Factual Report.

The aircraft came to rest on a heading of approximately of 78° based on Google Earth imagery processed from the NTSB UAS data.

During the runway excursion, the aircraft ignited a brush fire, ref Figure 1. After the crew and passengers exited the aircraft, the brush fire spread and consumed a majority of the aircraft, ref Figure 2.



Figure 1 – Photograph of aircraft just after accident (Source: social media)

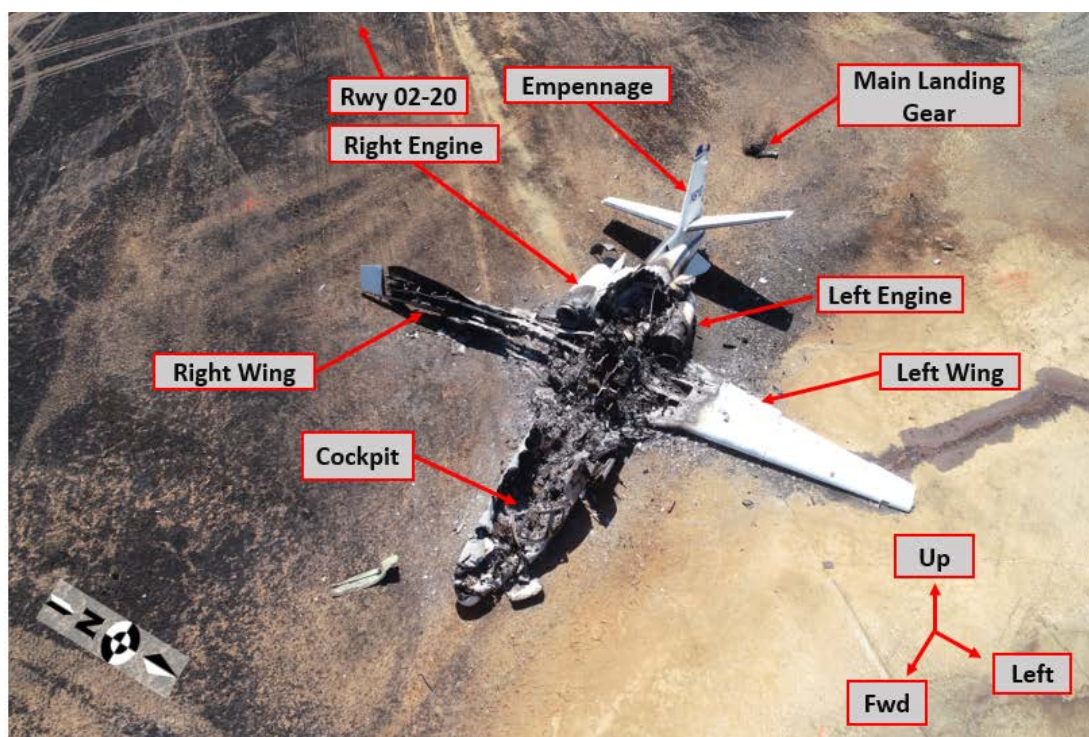


Figure 2 - Photograph of aircraft after brush fire extinguished



Figure 3 – Google Earth Image for KOVE

Refer to Figure 3 with the following information. The aircraft arrived at OVE on August 20th at approximately 1803 LCL. After departing the runway, the aircraft came to rest on the north end of airport property (position 1). A survey of the runway was performed and tire marks from the nose, left and right main landing could be seen on the taxiway on the paved area where the aircraft departed the paved area (position 2), ref Figure 4. The aircraft continued off the paved surface between (position 2 and position 3) with distinctive gear markings in the dried grass. Tire marks from the left and right main landing gear could be seen on the runway 13-31 where the aircraft departed the paved area (position 3). The tire markings could be seen all the way through the displaced threshold all the way down runway 02-20 (position 4), ref Figure 5. Based on Google Earth measurements, the length of the visible tire marks on runway 02-20, from both the left and right main landing gear wheels was approximately 6,900 ft.

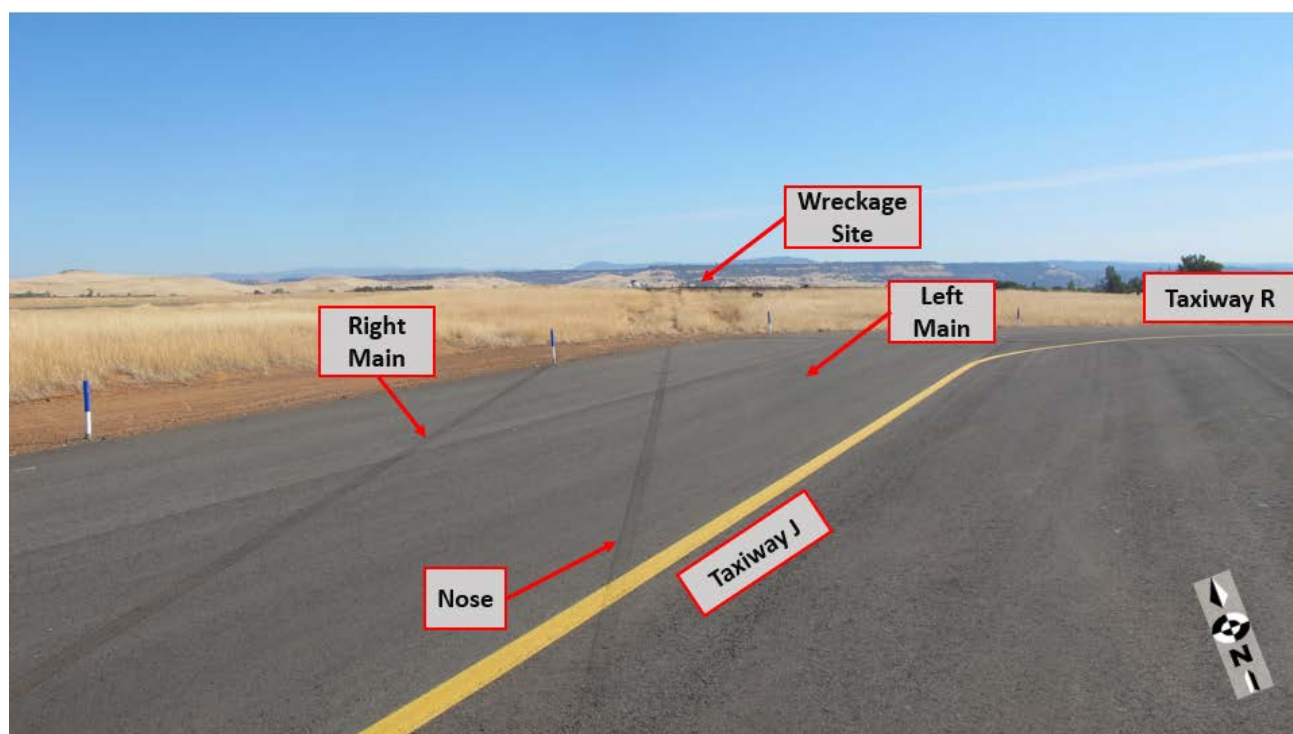


Figure 4 - Tire marks on taxiway (area 2)

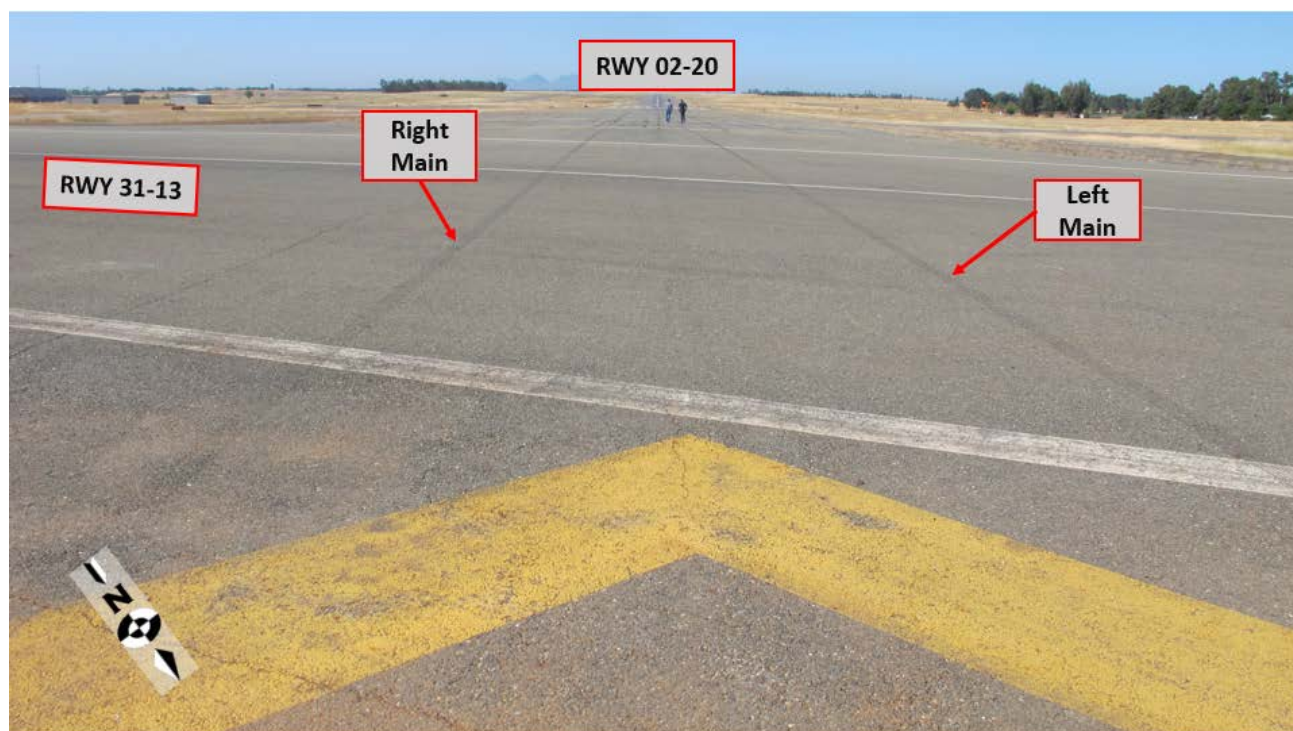


Figure 5 - View looking from RWY 13-31 towards departure end of RWY 02-20

Additional information regarding the tire marks can be found in the UAS Aerial Imagery Factual Report.

4.3 Systems Descriptions, Inspections and Testing

The following sections contain descriptions and operation information for the respective systems. The information is based on aircraft flight manual and manufacturer documentation.

4.3.1 Aircraft Cockpit

The parking brake handle is located on the pilot side of the cockpit at the base of the instrument panel next to the side panel, ref Figure 6. The parking brake handle, when “On”, extends aft and travel is 4 inches from the “Off” position, ref Figure 7. When in the “Off” position, the handle is close to the instrument panel.



Figure 6 - View of the pilot side of the cockpit

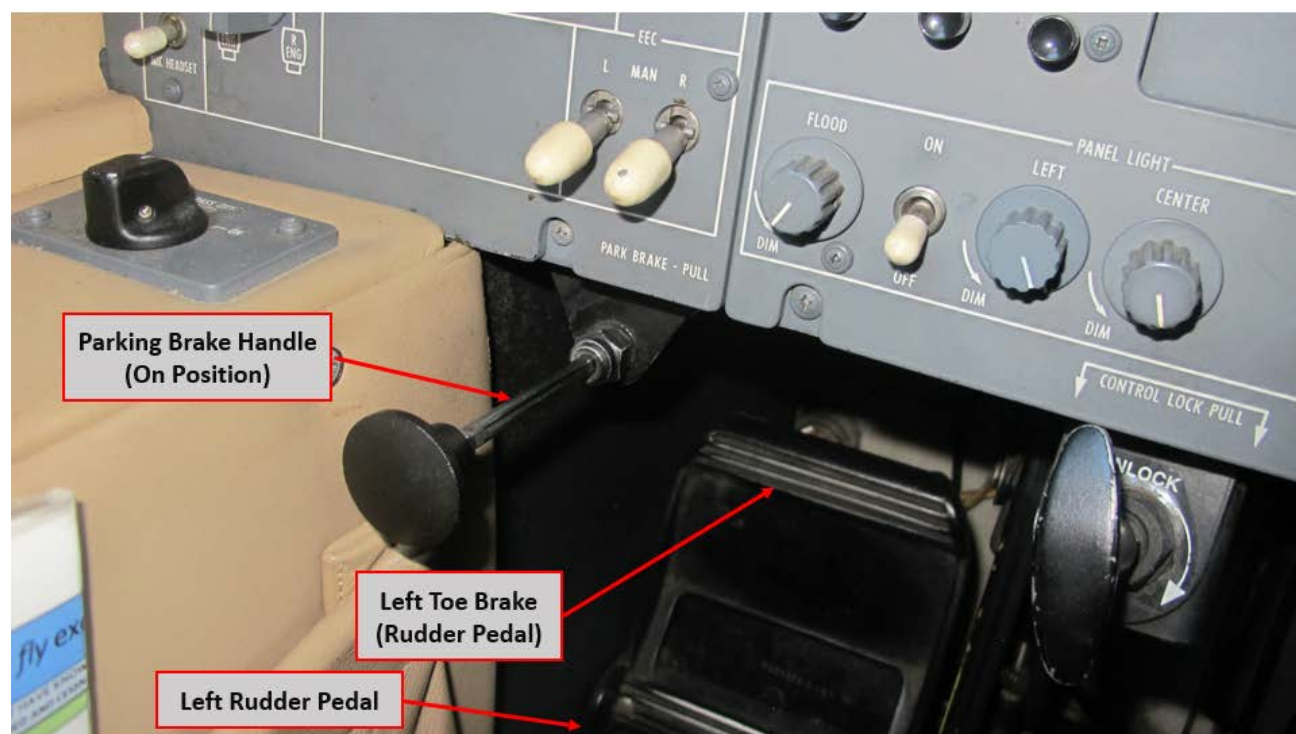


Figure 7 - View of the area of cockpit highlighting parking brake handle (On position) and brake pedal location

4.3.1.1 Aircraft Cockpit On-scene Inspection

The cockpit area was heavily damaged by the post-crash fire, Figure 8. Most avionics components were burned beyond recognition and unidentifiable.

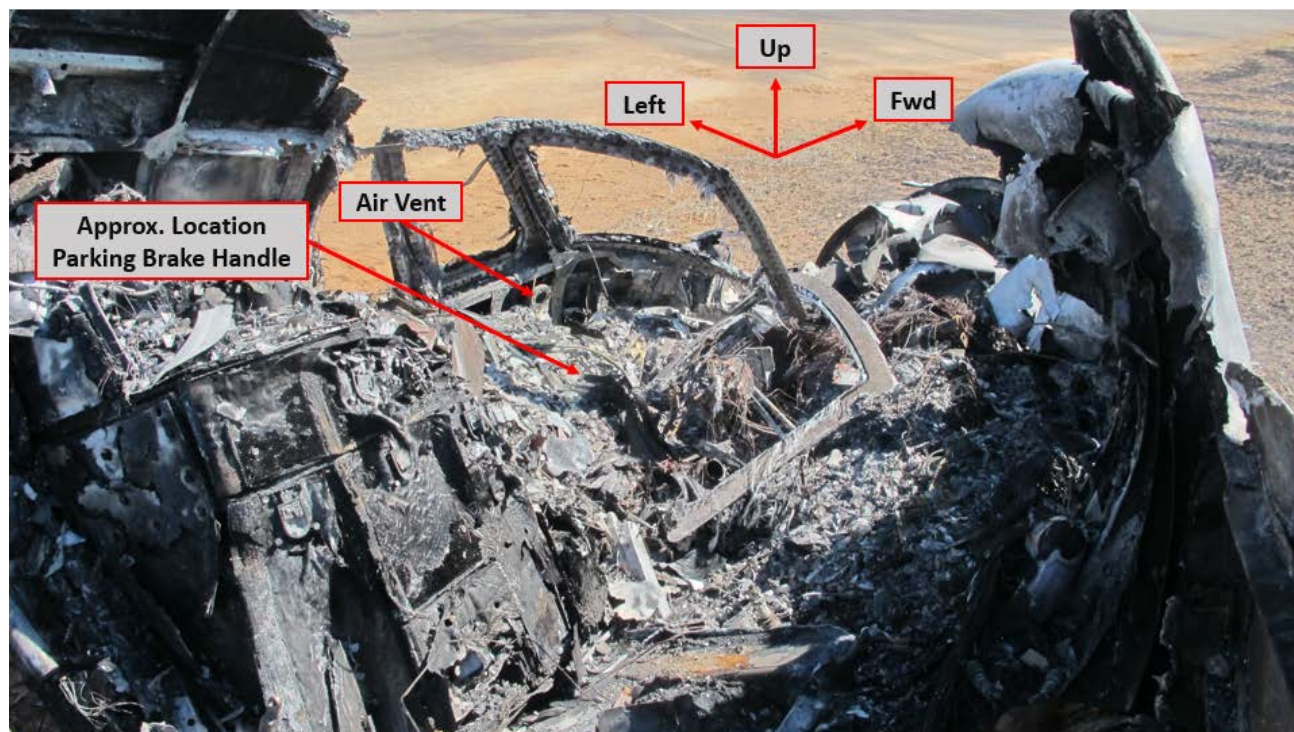


Figure 8 - View of Aircraft Cockpit

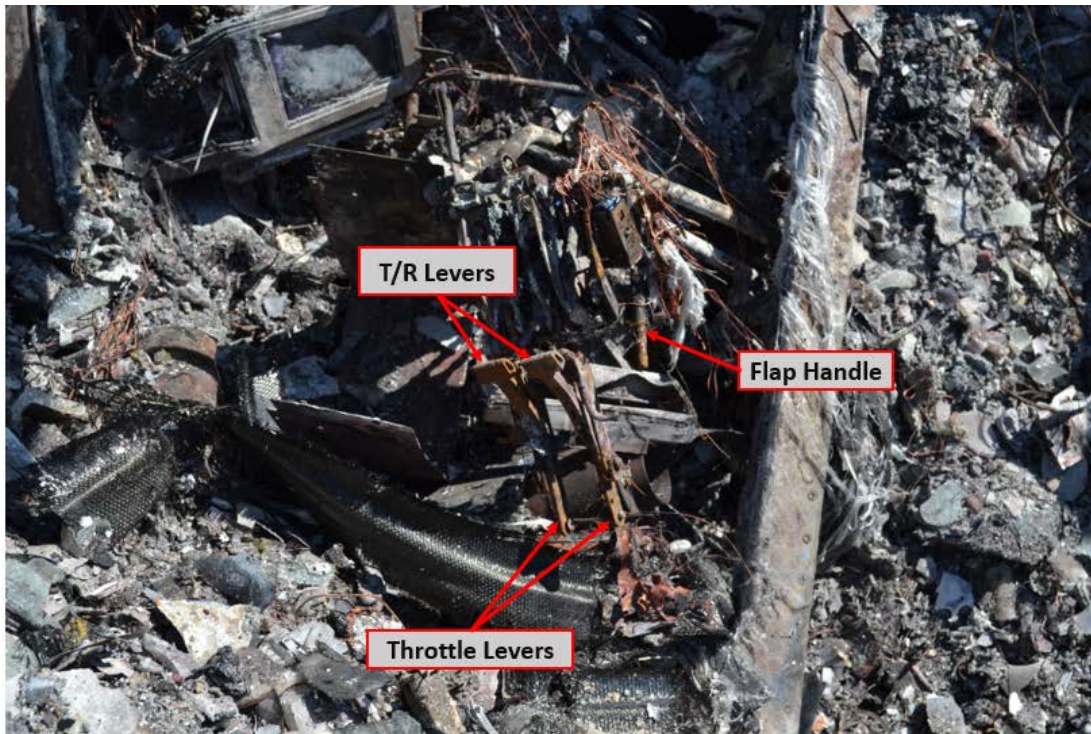


Figure 9 - Throttle Quadrant/Flap Handle

The throttle quadrant/flap handle/pitch trim was identified in the wreckage, Figure 9. The throttle positions were at the idle stops. The thrust reverser levers were in the stowed position. The flap handle position could not be determined.

The parking brake cable and handle was located in the wreckage, Figure 10. The parking brake plastic knob was not present. The cockpit end of the parking brake cable/handle was found in a position consistent with the "OFF" position. The cable was traced from the handle to the parking brake valve and was continuous. After the parking brake valve was disconnected, an attempt was made to actuate the cable from the cockpit. The cable could not be actuated due to unknown obstructions/interference within the cable run. The obstructions/interference could not be determined on scene.



Figure 10 - Parking brake handle (glove added for picture) (DSC_0012.jpg)

Components of the pilot, Figure 11, and copilots, Figure 12, control column were located in the wreckage but were extensively fire damaged and could not be manipulated.



Figure 11 - Pilot control yoke components



Figure 12 – Copilot control column base

4.3.1.2 Aircraft Cockpit – Additional Testing

Due to the extensive thermal damage to the aircraft cockpit area, testing was not performed on any of the components in the aircraft cockpit area.

4.3.2 ATA 27 - Flight Controls System Description and Operation:

All aerodynamic controls, with the exception of the flaps, speed brakes and two-position stabilizer are mechanically actuated by cables. The ailerons, elevator and rudder have trimmed control surfaces and cockpit trim position indicators. Flaps are hydraulically powered and can be operated to 15° at 200 KIAS or below and 35° (full travel) at 175 KIAS or below. Spoiler-type speed brakes are hydraulically actuated and electrically controlled and can be extended throughout the flight envelope but must be retracted by 50 ft AGL when landing.

The two-position stabilizer utilizes a hydraulic pump coupled to a jack screw to provide a takeoff/landing setting (nose down 2°) or cruise setting (nose up 1°) for the horizontal stabilizer. The pump and jack screw assembly are located at the horizontal/vertical stabilizer intersection and drive the leading edge of the horizontal stabilizer up or down based on flap handle position. Cycle time for the stabilizer to move from one position to another is approximately 25 seconds.

4.3.2.1 ATA 27 – On-scene Inspection

Unless noted in separate sections below, flight control continuity was traced from both the cockpit control and the flight control surface. Due to fire damage to the center section of the aircraft the

flight control cables could be identified on the structure but attempts at continuity and movement could not be confirmed. Cable tensions could not be measured.

4.3.2.1.1 Ailerons

Control cables for each aileron were identified along the rear spar of the wing. Cable continuity was confirmed for the left and right aileron from the aileron to the rear bell crank. Visual identification of the aileron cables from the rear bell crank to the forward bell crank could be obtained in multiple areas along the fuselage. The cables could not be actuated by hand.

At the forward and rear bell cranks, cable ends were visible, along with attaching hardware. The aileron cables from the forward bell crank to the pilot and copilot yoke were visible but could not be actuated by hand. The attachment points on each control yoke were not present due to the fire damage.

4.3.2.1.2 Rudder

Control continuity from the rudder bell crank to the rear spar was confirmed.

Visual identification of the rudder cables from the rear spar to the area of the forward elevator bell crank could be obtained in multiple areas along the fuselage. The cables could not be actuated in the center wing portion of the aircraft.

4.3.2.1.3 Elevators

The pilot and copilots control columns are connected to the forward bell crank via torque tubes. The torque tubes were fire damaged and the center sections were not present in the cockpit area but the connecting rod ends were attached to the bell crank.

Control continuity from the rear elevator bell crank to the rear spar was confirmed.

Visual identification of the elevator cables from the rear spar to the forward bell crank could be obtained in multiple areas along the fuselage. The cables could not be actuated in the center wing portion of the aircraft. Additional visual inspection and control continuity of the cables in the area of the canted bulkhead were completed, Figure 13.

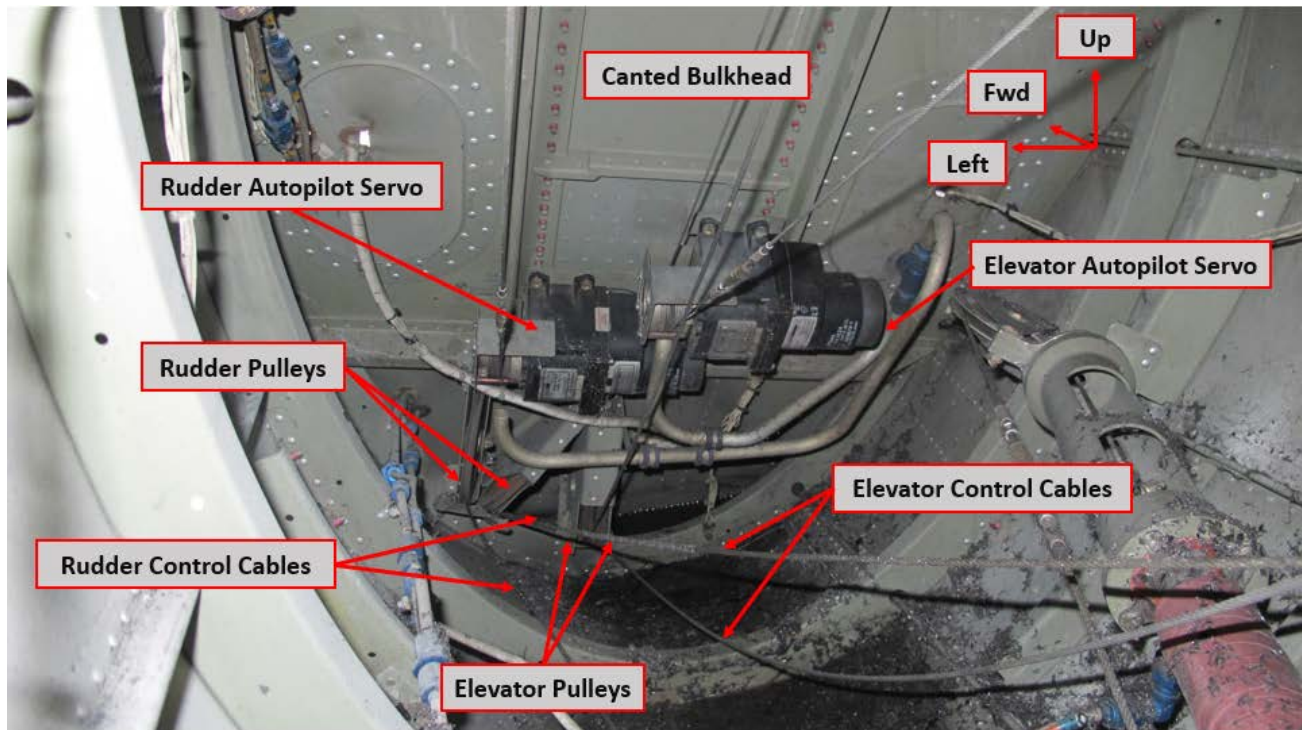


Figure 13 - View of aft side of canted bulkhead showing rudder and elevator controls

Initial movement of the elevator by hand was impeded just past elevator neutral in a trailing edge up direction. The elevator could move to the full trailing edge down stop. The elevator movement was impeded by the elevator cables. The elevator autopilot servo control cables were removed from the elevator bell crank with no change to the elevator travel. The elevator control cables were marked prior to cutting and removal from the aircraft. After all the elevator cables were removed, the elevator could be moved freely by hand to both the trailing edge up and down stop. Inspection of the elevator cable indicated a fouling condition at the pulleys at the base of the forward side of the canted bulkhead with the elevator turnbuckle. During the aircraft recovery, the rear fuselage was cut to allow access to the pulleys on the forward side of the canted bulkhead, Figure 14. No signs of a fouling condition were present, however loose debris was present in the area surrounding the elevator and rudder pulleys.

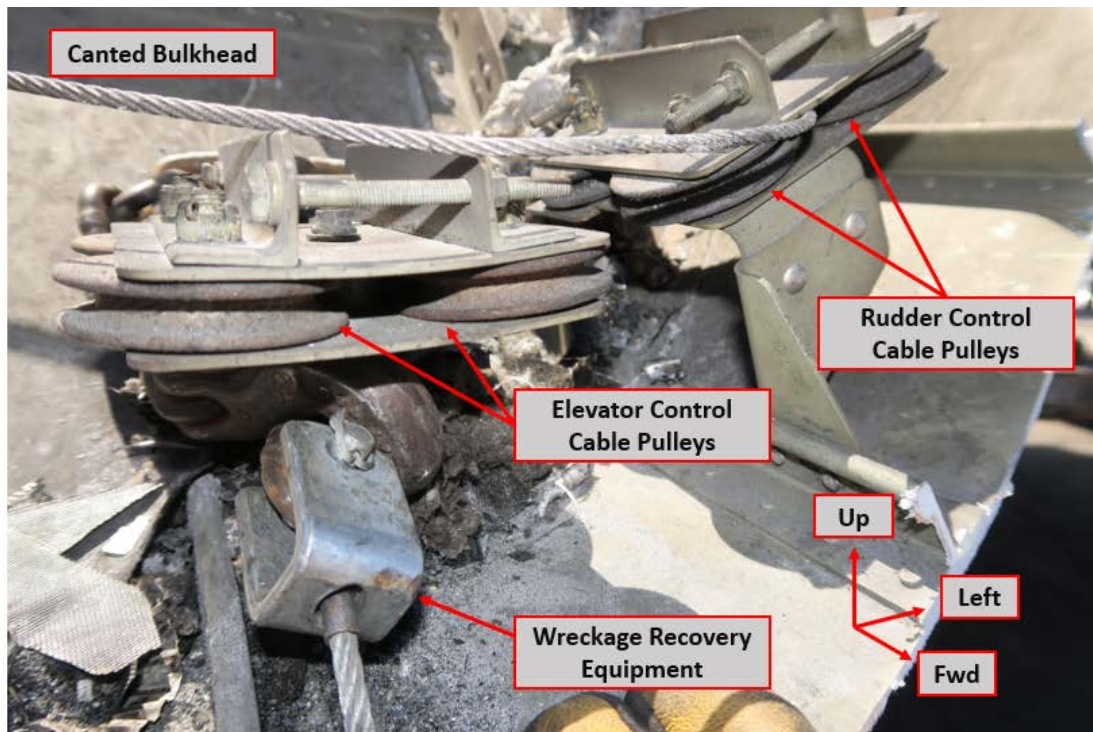


Figure 14 - Elevator pulleys at lower canted bulkhead.

The elevator cables were removed from the aircraft to take measurements from the cable ends to the turnbuckles and compared to the aircraft manufacturing drawings, Figure 15. For the up elevator cable, the distance between the cable stop and the turnbuckle was measured to be 113 inches and the manufacturer drawing measurement is 113.3 inches. For the down elevator cable the distance between the cable stop and the turnbuckle was measured to be 90 inches and the manufacturer drawing measurement is 90.35 inches.

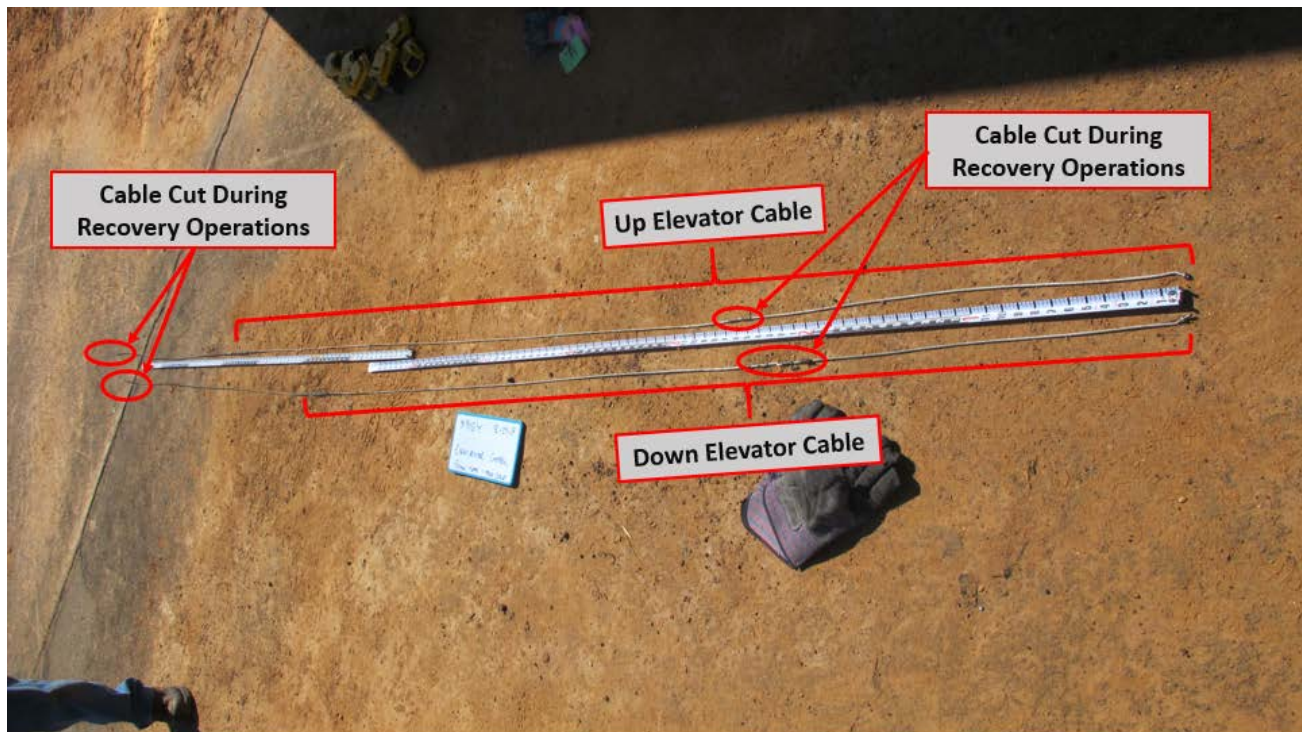


Figure 15 - Aircraft elevator cables after removal from aircraft

Angular elevator travel was recorded and calculated utilizing an inclinometer app on a smart phone. Standard shop practice is to measure travel using travel boards which were not available on scene. Trailing edge up travel is $19^{\circ} \pm 1^{\circ}$ per the maintenance manual, TEU travel was calculated to be 16.3° . Trailing edge down travel is $16^{\circ} \pm 1^{\circ}$ per the maintenance manual, TED travel was calculated to be 16.9° . The total travel of the elevator is 35° per the maintenance manual and was measured to be 33.2° utilizing a smart phone.

The elevator trim servo, which is mounted in the fuselage, aft of the pressure bulkhead and in between the engines, was fire damaged. The elevator trim cables were all connected to the elevator trim actuator. The trim cables could be actuated by hand.

4.3.2.1.4 Horizontal Stabilizer

The horizontal stabilizer was in the take-off/landing setting. This was confirmed by visual examination of the horizontal stabilizer actuator position and the external marking, Figure 16.



Figure 16 - Horizontal stabilizer position marking in take-off/landing setting

The fairing was removed to inspect the horizontal stabilizer actuator and attach fittings. Nesting material was found in the area of the aft rotation mount, Figure 17. The nesting material was not in contact with any components that would have obstructed movement of the horizontal stabilizer or elevator system.

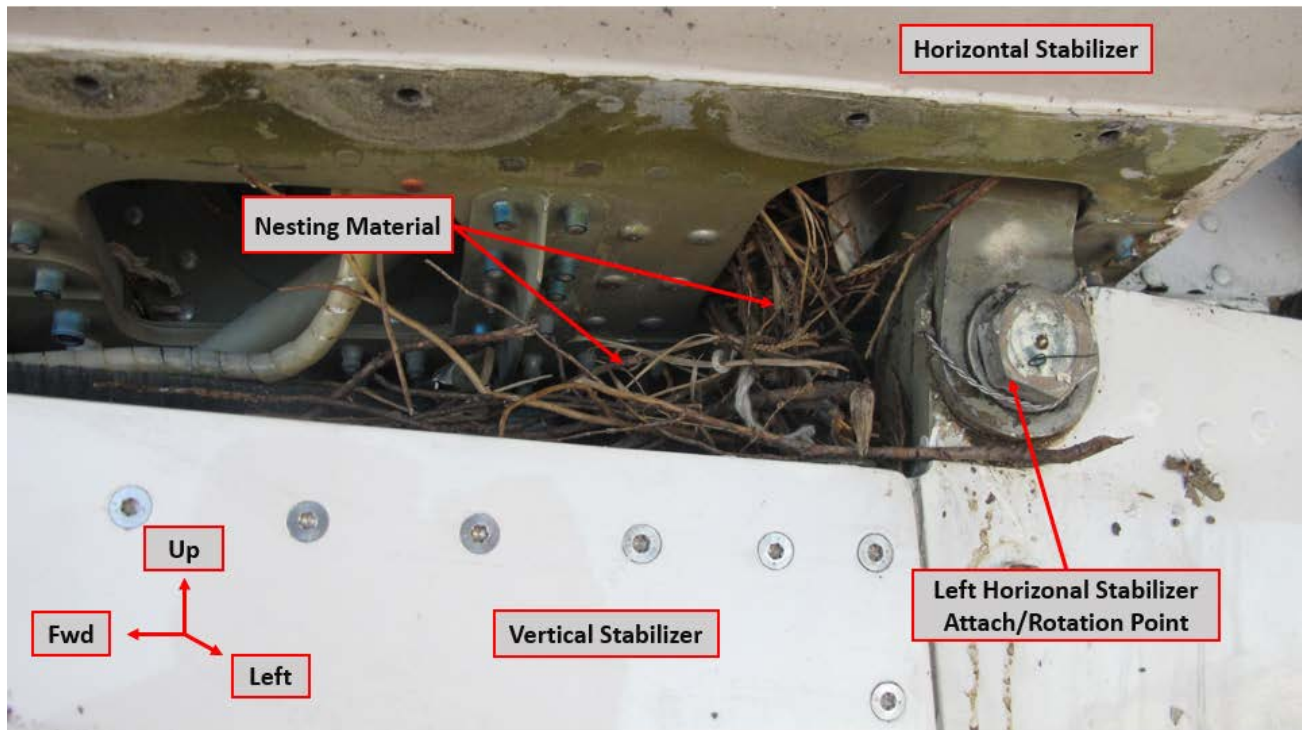


Figure 17 - Nesting material at aft rotation point.

4.3.2.2 ATA 27 – Additional Testing

Due to the extensive thermal damage along the flight control cable runs, no additional testing was performed on the flight control system.

4.3.3 ATA-32 Brakes System Description and Operation:

The aircraft operating manual provides the following description of the power brake and anti-skid system.

“The power brake and anti-skid installation is a closed center, phosphate-ester based system with its own separate independent powerpack assembly, accumulator and reservoir. These components provide pressurized hydraulic fluid to the power brake and anti-skid servo valve, which in turn regulates a maximum of 1000 PSI, +20 or -20 PSI pressure to the brakes. This pressure is based upon pilot/co-pilot input through the brake master cylinders, and electronic inputs from the anti-skid control box.

RPM transducers at each wheel sense the beginning of a skid and transmit this information to the anti-skid control. A hand-controllable pneumatic emergency brake valve is provided in the event of a power brake failure. Pneumatic pressure is transmitted to brakes through a shuttle valve integral to

each brake assembly. Additionally, a parking brake is included in the basic hydraulic brake system.”¹

The aircraft was equipped with a parking brake and the aircraft operating manual provides the following description of the parking brake.

“The parking brake is a part of the normal brake system and employs controllable check valves that can prevent the return of fluid after the brakes have been set. Parking brakes are set by depressing the toe brakes and pulling out the black parking brake handle located under the lower left side of the instrument panel. The parking brake should not be set if the brakes are very hot. This increases brake cool-down time due to decreased airflow, and may result in sufficient heat transfer from the brakes to cause the parking brake thermal relief valves to open or to melt the thermal relief plugs in the wheel, causing deflation of the tire.”¹

Additionally, certain Citation Excel aircraft certified for operations in some foreign countries (i.e. Denmark, Ireland and United Kingdom certified aircraft) are delivered with a proximity switch installed by the parking brake valve. The proximity switch is used in the aircraft “NO TAKEOFF” annunciator logic.

4.3.3.1 ATA 32 – Parking Brake On-scene Inspection

After the on-scene investigation was complete, the parking brake valve was removed from the wreckage and subjected to computed tomography (CT) scanning to document the internal condition of the components. The results from the CT scanning are documented in the “Computed Tomography Specialist’s Factual Report”.

The parking brake handle information is contained in the cockpit section of the notes. The parking brake valve was located loose in the wreckage and was damaged by fire. The parking brake control cable was attached to the valve and all attaching hardware was present. The cable was removed from the valve, without disturbing the valve lever position. Based on a visual inspection of the lever position, the brake valve was in the “ON” position. No part identification or data plate could be found on the component.

¹ Excerpt from Textron Aviation Citation Excel Operating Manual, aircraft serial numbers 560XL -5001 thru -5500, Revision 5, Dated 15 June 2006

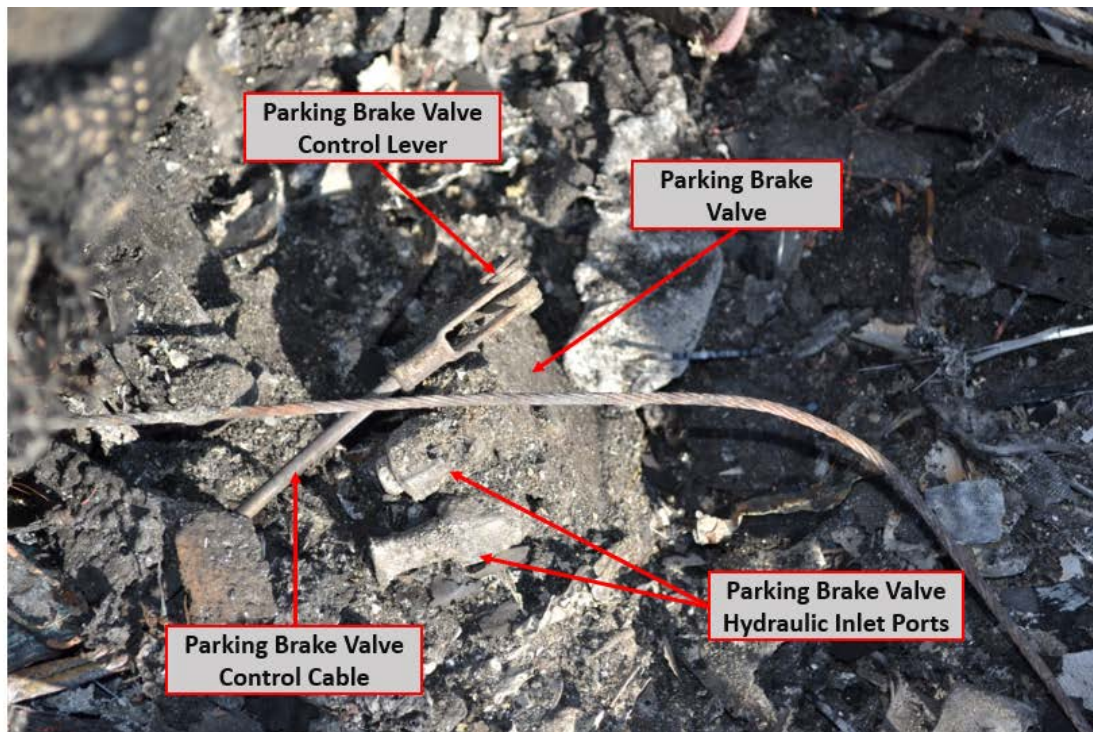


Figure 18 - Parking Brake Valve as found



Figure 19 - Parking Brake Valve after removal from aircraft

4.3.3.2 ATA 32 – Parking Brake – Additional Testing

Due the thermal damage to the parking brake valve and after review of the CT results, no further testing or inspections of the accident parking brake valve was performed.

As stated previously, the systems group chairman, operations groups chairman and the Textron Aviation party representative, inspected an exemplar aircraft and conducted a test of the aircraft's parking brake system.

The parking brake was exercised utilizing two procedures. During the procedures, the LH main landing gear brake wear pins were monitored for travel and travel distances recorded.

Procedure 1:

1. Measure brake wear pin exposed shaft
2. Apply pressure to toe brakes
3. Pull the park brake handle to the "On" position
 - a. Measure brake wear pin exposed shaft
4. Apply additional toe brake input
 - a. Measure brake wear pin exposed shaft
5. Push the park brake handle to the "Off" position
6. Observe brake travel along brake wear pin

Procedure 1 Results:

During procedure 1, brake movement (in a direction consistent with brake application) was observed with applying pressure with the toe brakes. When the parking brake was applied (ON Position), the brake remained in the position obtained with the toe brake application. Additional toe brake pressure when the parking brake was on did not result in any additional travel. When the parking brake was released (Off Position) the brake traveled to a position consistent with no brake application. Reference photo array in Figure 20.

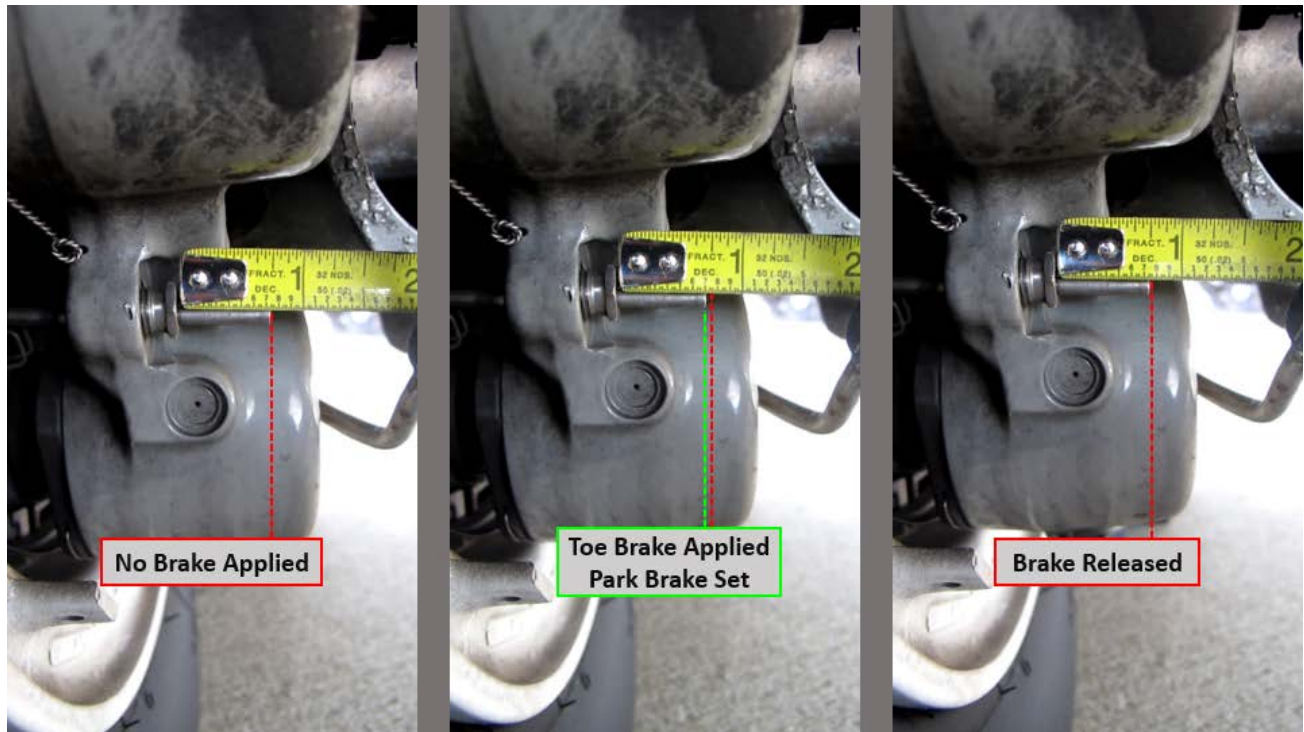


Figure 20 - Screen shots from brake application during procedure 1

Procedure 2:

1. Measure brake wear pin exposed shaft
2. Pull the park brake handle to the "On" position
 - a. Measure brake wear pin exposed shaft
3. Apply pressure to toe brakes
 - a. Measure brake wear pin exposed shaft
4. Push the park brake handle to the "Off" position
5. Observe brake travel along brake wear pin

Procedure 2 Results:

During procedure 2, brake movement (in a direction consistent with brake application) was not observed when the parking brake was applied (On Position). After applying pressure with the toe brakes and the parking brake already set, brake movement (in a direction consistent with brake application) was observed. When the parking brake was released (Off Position) the brake traveled to a position consistent with no brake application. Reference photo array in Figure 21.

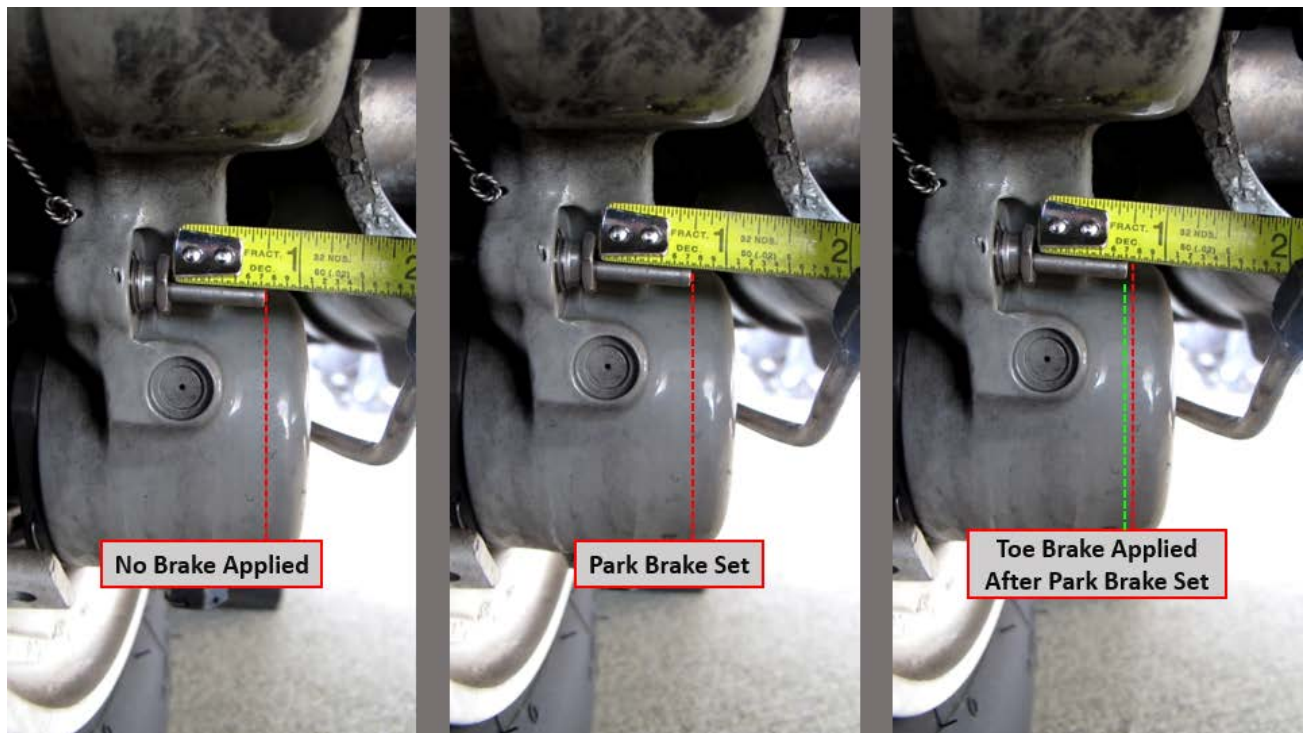


Figure 21 - Screen shots from brake application during procedure 2 (brake release not shown)

A quick access panel was opened on the belly of an exemplar aircraft and allowed for visual inspection of the parking brake valve in operation. The parking brake handle was operated, and video was recorded showing the lever arm position in both the "OFF" and "ON" position, ref Figure 22 and Figure 23.

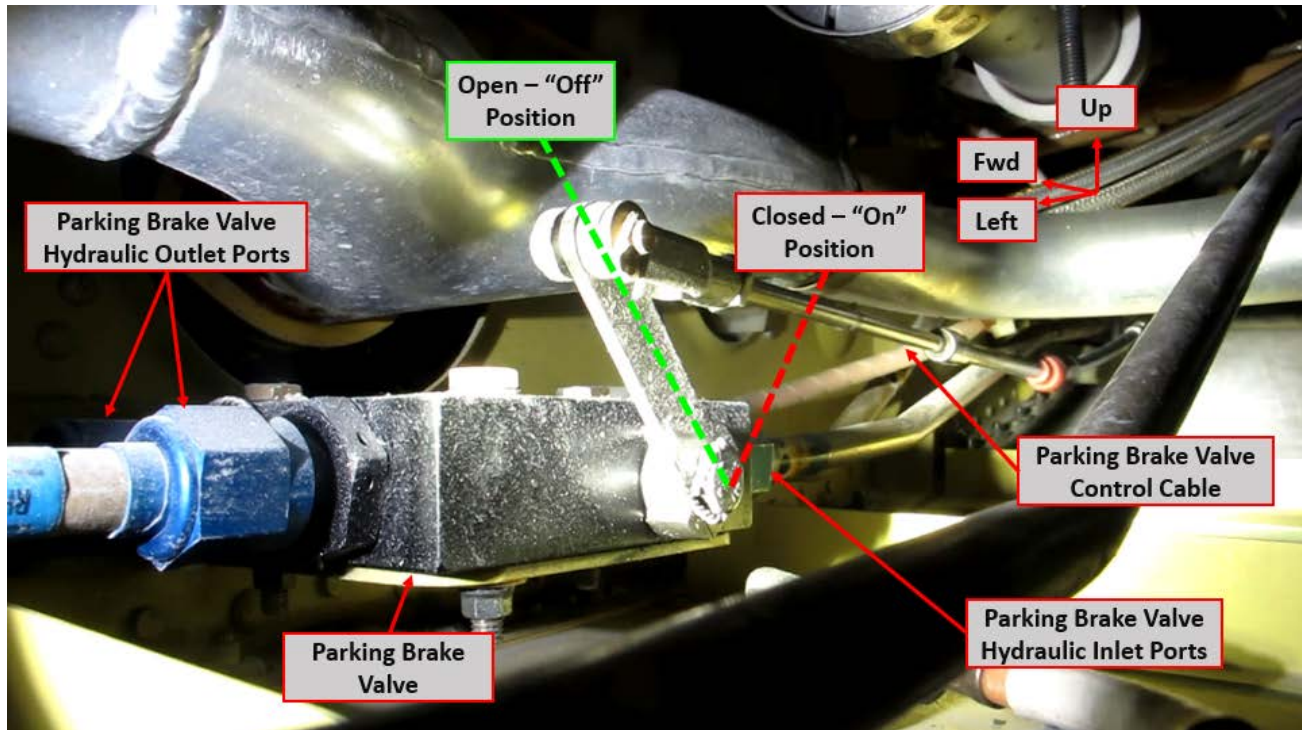


Figure 22 - Parking Brake Valve in "OFF" Position

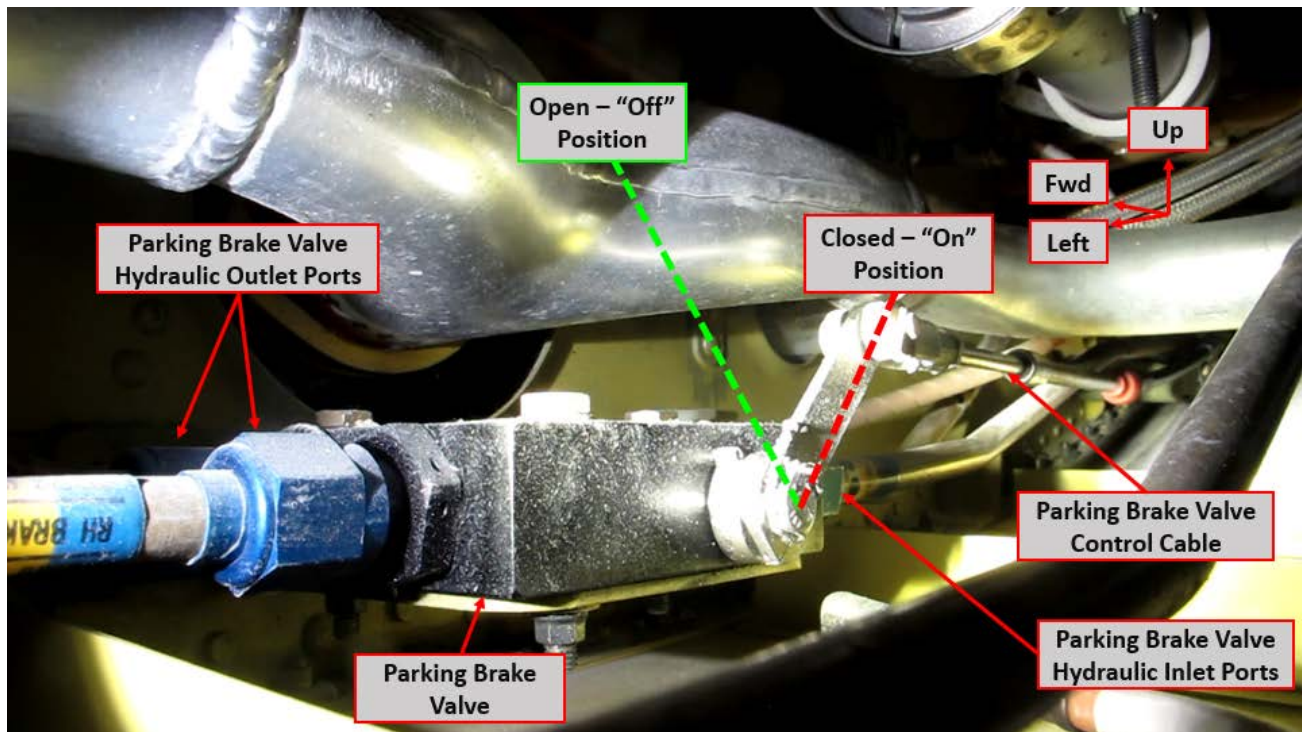


Figure 23 - Parking Brake Valve in "ON" Position

The aircraft did not have, nor was it required to have an indicator light in the cockpit to annunciate when the parking brake is on.

4.3.4 ATA-32 Main Landing Gear System Description and Operation:

The aircraft's main landing gear is of a trailing link design. Each main landing gear contains a single tire/wheel assembly with a brake assembly, Figure 24. Each main landing gear tire/wheel assembly incorporates a fuse plug. The fuse plug is designed to melt at a predetermined temperature to relieve tire pressure and prevent a tire explosion, Figure 25.

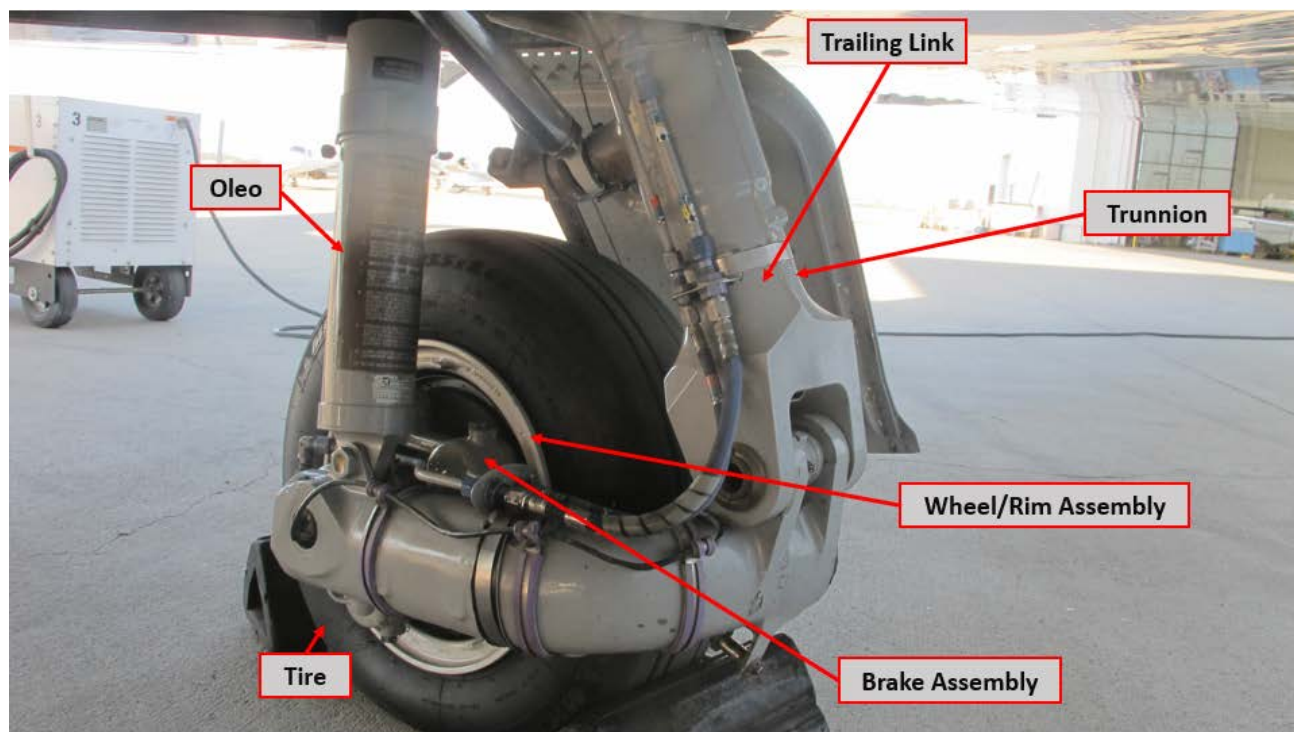


Figure 24 - Left main gear from exemplar aircraft



Figure 25 - Left main gear tire assembly from exemplar aircraft

4.3.4.1 ATA 32 – Main Landing Gear On-scene Inspection

The main landing gear was found separated from the aircraft. Both tires were thermally damaged with only remnants of steel portions of the tires present.

The LH main landing gear oleo was breeched with only the lower portion remaining on the trailing link assembly, Figure 26. The main wheel assembly rim was damaged. Pieces of the rim were found early in the wreckage path. The brake pistons were extended approximately 1 inch. Based on the brake wear indicators, the brakes were within serviceable limits. The tire fill valve and fuse plug were not present on the wheel assembly, Figure 27.

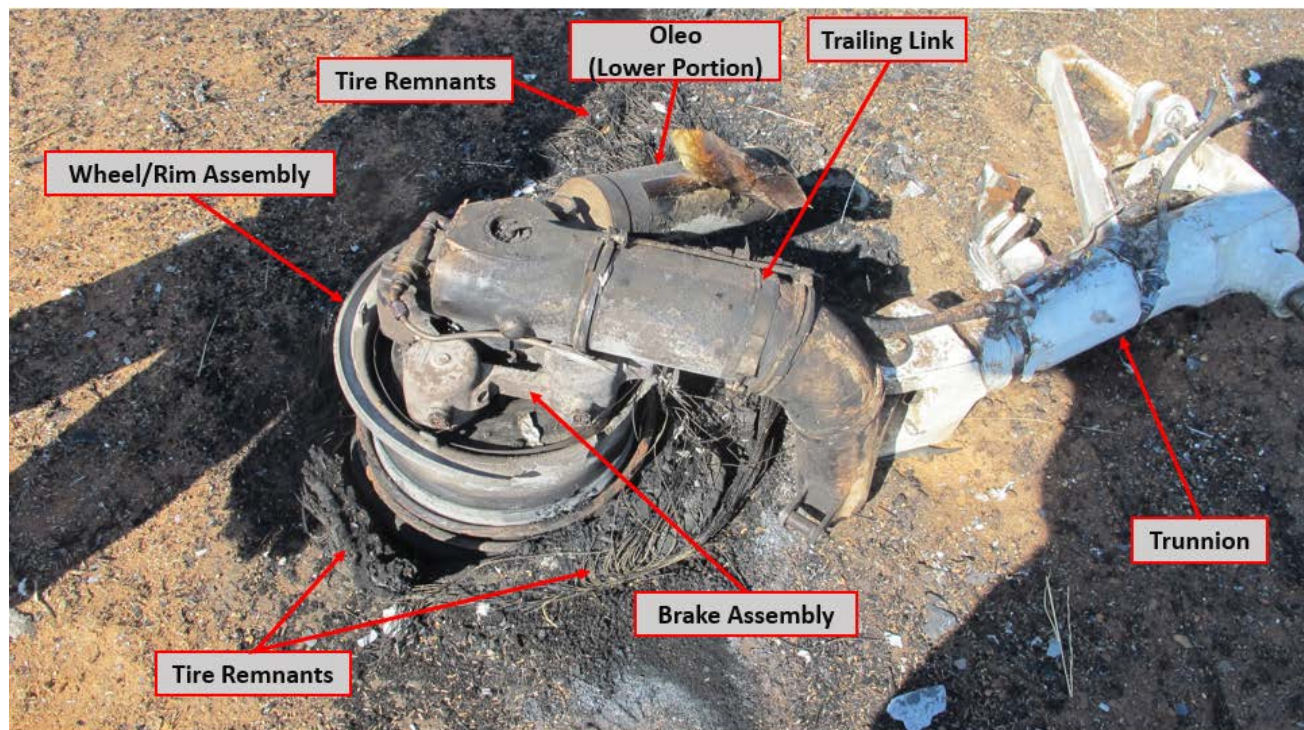


Figure 26 - LH Main landing gear showing brake assembly

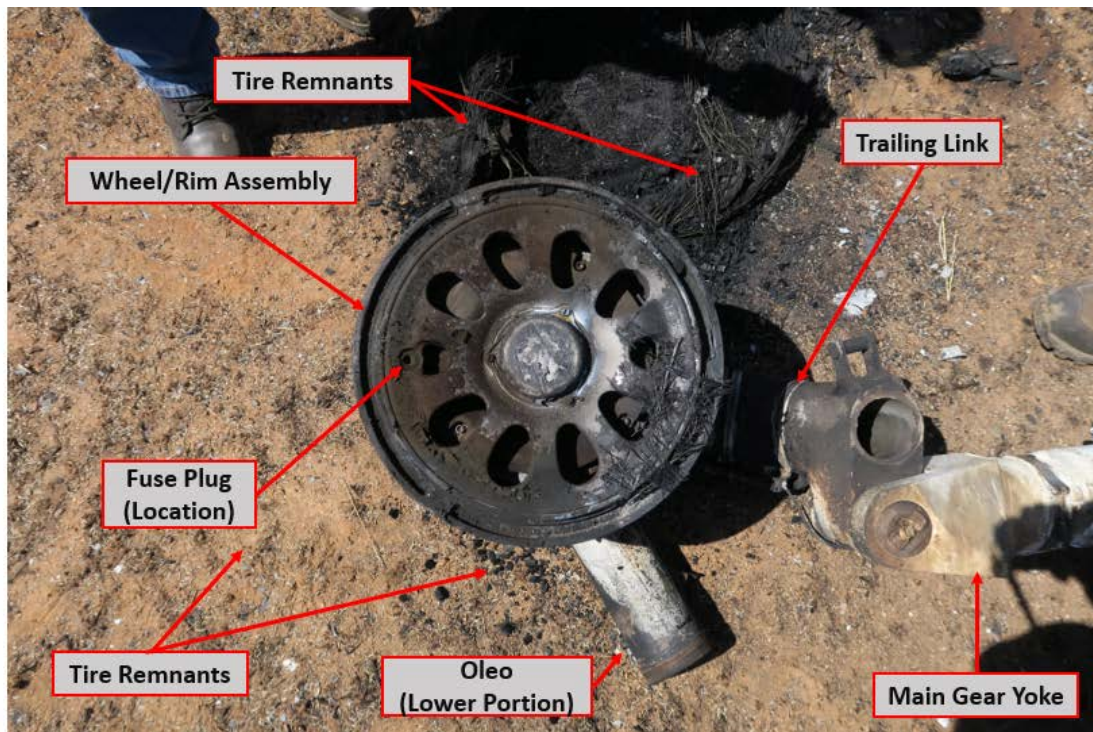


Figure 27 - LH Main Wheel Assembly showing missing fuse plug and valve

The RH main landing gear oleo was breeched and separated from the trailing link and trunnion. Based on the brake wear indicators, the brakes were within serviceable limits. The brake pistons were extended to the wheel assembly. The tire fill valve and fuse plug were present on the wheel assembly. The fuse plug appeared to be intact and not activated, Figure 28.



Figure 28 - RH Main landing gear showing brake assembly

4.3.4.2 ATA 32 – Main Landing Gear – Additional Testing

Due to the extensive thermal damage, no additional testing was performed on main landing gear components.

4.4 Aircraft Certification Information

According to the Textron Aviation Inc.² 560XL Type Certificate Data Sheet³ (TCDS), the 560XL airplane was granted transport category approval on April 22, 1998.

The applicable certification basis was the 14 Code of Federal Regulations (CFR) Part 25 Airworthiness Standards, as amended by Amendments 25-1 through Amendment 25-82 along with additional items, exceptions and special conditions as noted in the 560XL TCDS⁴.

The particular regulations regarding aircraft parking braking system for the 560XL certification are found in 14 CFR 25.735 (Amendment 25-72, effective August 20, 1990) and states:

² The type certificate was originally held by Cessna Aircraft Company and was transferred to Textron Aviation Inc. on July 29, 2015.

³ The TCDS is a formal description of the aircraft, engine or propeller. It lists limitations and information required for type certification including airspeed limits, weight limits, thrust limitations, etc.

⁴ Reference Federal Aviation Administration Type Certificate Data Sheet A22CE, Revision 70, dated May 15, 2019 for additional information.

“§ 25.735 Brakes

...

(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.

...

[Amdt. 25-72, Eff. 8/20/90]”⁵

The current regulation regarding aircraft parking braking systems in newly certified aircraft, which is not applicable to the 560XLS, is found in 14 CFR 25.735 (Amendment 25-108, effective December 26, 2002) and states:

“§ 25.735 Brakes

...

(d) Parking brake. The airplane must have a parking brake control that, when selected on, will, without further attention, prevent the airplane from rolling on a dry and level paved runway when the most adverse combination of maximum thrust on one engine and up to maximum ground idle thrust on any, or all, other engine(s) is applied. The control must be suitably located or be adequately protected to prevent inadvertent operation. There must be indication in the cockpit when the parking brake is not fully released.

...

[Amdt. 25-108, Eff. 12/26/02]”⁵

Michael Bauer
Aerospace Engineer

⁵ For the complete regulation, refer to www.faa.gov.