Aviation Investigation Final Report

Location:	Wikieup, Arizona	**Accident Number:**	WPR21FA266
Date & Time:	July 10, 2021, 12:54 Local	**Registration:**	N3688P
Aircraft:	Beech C90	**Aircraft Damage:**	Destroyed
Defining Event:	Aircraft structural failure	**Injuries:**	2 Fatal
Flight Conducted Under:	Public aircraft		

Analysis

The pilot was conducting a firefighting support flight, with an Air Tactical Group Supervisor on board the airplane. Automatic Dependent Surveillance Broadcast (ADS-B) data indicated that the airplane was on station for about 45 minutes completing multiple orbits over the area of the fire. The last ADS-B data point showed the airplane in a descent, and its airspeed was about 151 knots at an altitude of about 2,300 ft agl.

According to a witness, the airplane descended in a steep dive and impacted the side of a ridgeline in mountainous desert terrain. No distress call from the airplane was overheard on the radio. Another witness observed the outboard left wing falling to the ground after the aircraft had impacted the terrain. The outboard left wing, which had separated outboard of the engine nacelle, was located about 0.79 miles northeast of the main wreckage and did not sustain thermal damage.

During a scheduled maintenance inspection several months before the accident, eddy current (EC) non-destructive testing (NDT) of a left wing's lower forward spar cap detected a crack in a fastener hole. The hole was then oversized/reamed to a larger size, but the EC reinspection still produced a crack indication. The operator then submitted a structural damage report and service request detailing the crack indication to the aircraft manufacturer. The aircraft manufacturer responded to the operator that the crack indication necessitated the replacement of "the center section forward spar cap, center section forward lower fittings and both outboard main spar assemblies."

However, the operator and their maintenance provider elected to repair the wing spar instead of replacing the spars, as indicated by the aircraft manufacturer. The maintenance facility owner contacted a Federal Aviation Administration (FAA) Designated Engineering Representative (DER) for the design of the repair. The repair involved oversizing the affected

fastener hole and installing an external doubler around the hole location. The repair was installed and signed off several months before the accident. The DER claimed no knowledge of the communication between the aircraft manufacturer and the maintenance provider about the crack indication, though the maintenance provider claimed otherwise.

After the repair, an eddy current inspection conducted by a commercial NDT inspector showed the wing spar repair to be successful and did not reveal a crack indication. Further, there were no other crack indications on the airplane.

A postaccident examination of the spar fracture surface revealed that the left wing's lower spar cap fractured from a fatigue crack that initiated at the aft inboard fastener hole. The fatigue crack measured 2.484 inches in length and exhibited striations consistent with crack propagation. A study comparing the crack length. striations, flight hours, and number of cycles suggests the crack was large enough to have been seen visually at the last inspection. Therefore, it is likely that the NDT inspector omitted the EC inspection of the fastener hole or missed the fatigue crack indication given its length.

The fatigue separation of the lower spar cap was not in the same area where the repair was accomplished. The repaired area was inboard of where the left wing separated. The DER-approved repaired area was not identified in the recovered wreckage and therefore could not be examined. Nevertheless, the area of the wing spar fatigue crack would have been removed from the airplane if the airplane's operator and maintenance provider had followed the procedure outlined by the aircraft manufacturer, which noted that the crack indication necessitated the replacement of the spars.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The failure and separation of the left wing's outboard section due to a fatigue crack in the lower spar cap. Contributing to the accident was the operator's decision to repair the wing spar instead of replacing it as recommended by the aircraft manufacturer. Also contributing to the accident was the failure of the Non-Destructive Testing inspector to detect the fatigue crack during inspection.

Findings

Aircraft	Spar (on wing) - Fatigue/wear/corrosion
Aircraft	Spar (on wing) - Failure
Aircraft	Spar (on wing) - Inadequate inspection
Aircraft	Spar (on wing) - Incorrect service/maintenance
Personnel issues	Decision making/judgment - Owner/builder
Personnel issues	Decision making/judgment - Maintenance personnel
Personnel issues	Post maintenance inspection - Other

Factual Information

History of Flight

Enroute-cruise	Aircraft structural failure (Defining event)
Enroute-cruise	Loss of control in flight
Enroute-cruise	Collision with terr/obj (non-CFIT)

On July 10, 2021, about 1254 mountain standard time, a Beech C-90, turbo prop airplane, N3688P, was destroyed when it was involved in an accident near Wikieup, Arizona. The pilot and Air Tactical Group supervisor were fatally injured. The airplane was operated as a public-use firefighting aircraft in support of the Bureau of Land Management conducting aerial reconnaissance and supervision.

The airplane was on station for about 45 minutes over the area of the Cedar Basin fire. The ADS-B data showed the airplane had accomplished multiple orbits over the area of the fire about 2,500 ft above ground level (agl). The last ADS-B data point showed the airplane's airspeed as 151 knots, its altitude about 2,300 ft agl, and in a descent, about 805 ft east southeast of the accident site. No distress call from the airplane was overheard on the radio.

According to a witness, the airplane was observed in a steep dive towards the ground. The airplane impacted the side of a ridgeline in mountainous desert terrain. The main wreckage was mostly consumed by a post-crash fire. Debris was scattered over an area of several acres. Another witness observed the left wing falling to the ground after the aircraft had impacted the terrain. The left wing had separated outboard of the nacelle and was located about 0.79 miles northeast of the main wreckage and did not sustain thermal damage.

Pilot Information

Certificate:	Airline transport; Flight instructor	**Age:**	48,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Unknown
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	May 28, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 10400 hours (Total, all aircraft), 10300 hours (Pilot In Command, all aircraft), 23 hours (Last 30 days, all aircraft)		

Other flight crew Information

Certificate:	None	**Age:**	62,Male
Airplane Rating(s):		**Seat Occupied:**	Unknown
Other Aircraft Rating(s):		**Restraint Used:**	Unknown
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:		**Last Flight Review or Equivalent:**	
Flight Time:			

The pilot held an airline transport pilot certificate, airplane single and multi-engine land ratings. He also held flight instructor and ground instructor certificates, and instrument ratings. His was issued a second- class medical certificate on his FAA medical examination on May 28, 2021, At the time of the examination, he had accumulated 10,000 total hours of flight experience, of which 150 were in the last six months.

Aircraft and Owner/Operator Information

Aircraft Make:	Beech	**Registration:**	N3688P
Model/Series:	C90	**Aircraft Category:**	Airplane
Year of Manufacture:	1980	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	LJ-915
Landing Gear Type:	Retractable - Tricycle	**Seats:**	8
Date/Type of Last Inspection:	September 12, 2020 AAIP	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	2 Turbo prop
Airframe Total Time:	17126 Hrs as of last inspection	**Engine Manufacturer:**	U/A CANADA
ELT:	C126 installed	**Engine Model/Series:**	PT6A SERIES
Registered Owner:	FNB Investments LLC	**Rated Power:**	550 Horsepower
Operator:	Falcon Executive Aviation, Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Falcon Executive Aviation, Inc.	**Operator Designator Code:**	X0FA

The airplane was a Beechcraft King Air C90 manufactured in 1980. It was configured in accordance with the contract for wildland fire aerial supervision. The aircraft status sheet from July 9, 2021, showed that the aircraft had 17,262.6 hours total time and 15,475 cycles.

The airplane started flying under contract to the Unites States Forest Service (USFS) in April 2007, and was under contract each year since then. The airplane was only used in the aerial supervision role while under USFS contract and was not used in the lead plane role. Up through 2016, the airplane was also used under the operator's Part 135 operation. Since then, it had only been used on contract to the USFS, for flight training, or for check rides. The airplane was used fewer than 365 hours for the USFS mission each year it was on contract, with some years fewer than 100 hours.

The aerial supervision mission, as defined in the USFS contract, consisted of cruise flight from the airplane's base to the assigned target area, a descent to the target at altitudes between 1,000 to 3,500 ft agl, circling the target in a right-hand orbit for about 3-4 hours, and returning to base. The crew for the missions consisted of a pilot provided by the contractor and 1 or 2 USFS Air Tactical Group Supervisor(s) that would coordinate the tactical use of all aircraft. The mission limits flight profiles requiring steep bank angles or increased lateral distances from the target as they may obstruct the ground view of the aerial supervisor. The mission is typically flown at speeds from 120 to 150 kts and may require higher angles of attack or flap extension.

In contrast, the lead plane mission is flown by a USFS pilot in a leased airplane and involves significant maneuvering at low altitudes (below 500 ft agl) in steep mountainous terrain and turbulent conditions as they lead air tankers to their designated drop zones in the fire environment. The lead plane can perform multiple lead runs during a single flight. The airplanes used as the lead plane can be used for the aerial supervision mission, but the converse is not true.

The airplane's operator, Falcon Executive Aviation, Inc. (FEA) provided the flight logs from May 26, 2021, through July 9, 2021, to include everything up until the accident flight. The airplane accrued 42.8 hours of flight time and 17 cycles under contract to the USFS and 5 hours of flight time and 9 cycles for maintenance or flight training prior to the accident flight. Since the airplane went on contract in 2007, it had accumulated 2,997 hours and 1,359 cycles on contract and 3,507 hours and 1,877 cycles total.

A review of the airplane's maintenance records since 1990 revealed that the wing spar inspections were accomplished per Federal Aviation Administration Airworthiness Directive (AD) 89-25-10, Wing Main Spar Inspection, which became effective at the beginning of 1990 and required inspection of the wing lower forward spar attach fittings, center section, and outboard wing spar caps adjacent to the attach fitting as specified in the Beech Structural Inspection and Repair Manual (SIRM) 57-13-01. Additionally, the visual inspections of the wing spar caps for cracks and corrosion per the SIRM were accomplished. A total of 16 wing spar inspections were accomplished since the AD became effective and 6 times since the airplane went on contract to the USFS in 2007. Further, the annual spar cap visual inspection for cracks and corrosion was accomplished 16 times since 2007.

During a scheduled maintenance inspection, a couple of months before the accident, AD 89-25-10 and SIRM 57-13-01 wing spar inspections were being accomplished. A third party certified commercial NDT technician conducted EC and NDT testing in March 2021. An area in the fastener hole on the left wing's lower forward spar cap on the wing root was found to have a crack indication and was out of limits. The hole was oversized/reamed to a larger size, but the EC reinspection still produced a crack indication.

FEA's maintenance provider, Falcon Air Service (FAS), then submitted a structural damage report and service request detailing the crack indication to the Textron Aviation structures group in April 2021. Textron Aviation responded to FAS in April 2021, that the crack indication necessitated the replacement of "the center section forward spar cap, center section forward lower fittings and both outboard main spar assemblies." The email response from Textron Aviation to FAS also included the warning below from their published instructions for wing structure inspections in the SIRM 57-13-01, (in part):

> ***WARNING: A crack in the center section lower forward spar cap necessitates the replacement of all lower forward inboard fittings, the lower forward spar cap on the center section, and both outboard forward wing panel main spar assemblies.***

FEA and their maintenance provider, FAS, elected to repair the wing spar instead of replacing the spars as recommended by Textron Aviation. Subsequently, the maintenance facility owner contacted a FAA DER for the design of the repair. The repair involved oversizing the affected fastener hole and installing an external doubler around the hole location. The repair was installed and signed off in May 2021, with an FAA Form 337, Major Repair and Alteration, and included FAA Form 8110-3, Statement of Compliance with Airworthiness Standards, from the DER. A FAS mechanic completed the repair in accordance with the DER's instructions. The DER claimed no knowledge of the communications between Textron Aviation and FAS about the crack indication, though FAS claimed otherwise.

Afterwards, an eddy current NDT conducted by the commercial NDT inspector, completed in May 2021, showed the repair to be successful. The inspector performing the work was current and appropriately certified as a Level II inspector in EC, Fluorescent Penetrant Inspection (FPI) inspection, in accordance with National Aerospace Standard (NAS) 410 Rev. 4. Furthermore, the inspector completed the Textron Aviation SIRM training course and held an FAA repairman certificate, issued on March 2019, that was valid for NDT inspection using liquid penetrant, magnetic particle, eddy current, and ultrasonic methods. He had a visual acuity exam performed in December 2020.

The NDT inspector provided documentation of his on-the-job experience for December 2020 through July 2021. The records showed that he had performed EC and/or FPI inspections on King Air airplanes 6 times during this timeframe in addition to the inspections on the accident airplane, with 4 of those occurring prior to the inspection of the accident airplane. Further, the calibration and conformance certificates for the equipment used was current. He remembered during the last inspection of the accident airplane that the first oversize of the hole did not remove the crack and after the hole was further oversized, an additional inspection did not reveal a crack indication and there were no other crack indications on the airplane.

Textron published instructions for wing structure inspections in the SIRM 57-13-01. The SIRM was first published in December 1982 and was at revision level D2 at the time of the accident. The SIRM provides inspection intervals and instructions for inspecting the wing attach fittings, center section and outboard wing spar caps, and the nacelle splice plates for cracks, corrosion, and damage. There are 11 specific items detailed for visual, magnified visual, EC, or FPI with 9 items having a recurring inspection interval of 1,000 hours or 3 years, whichever occurs first. The visual inspection of the outboard upper and lower wing spar caps for corrosion has an annual recurrence and the visual inspection of the nacelle splice plates has a 1,000-hour recurrence time. The following warning is contained in the SIRM:

> *WARNING: A crack in the center section lower forward spar cap necessitates the replacement of all lower forward inboard fittings, the lower forward spar cap on the center section, and both outboard forward wing panel main spar assemblies. A crack in an outboard wing panel spar cap requires replacement of the outboard forward spar assembly. A crack in a center section spar fitting requires replacement of the affected fitting only. A crack in an outboard wing*

panel main spar fitting necessitates replacement of the entire outboard wing panel spar assembly. Textron Aviation Technical Support should be contacted for an operational safety evaluation anytime a crack is found in a wing attach fitting or spar.

The introduction section of the SIRM states that "all personnel performing Non-Destructive Testing Inspections (NDT) in this manual must be qualified and Certified Level II or Level III in accordance with NAS 410, ASNT/SNT-TC-1A, or an equivalent NDT certification program in the method which they are performing." Further it states that all personnel performing the NDT must have completed the SIRM training course.

The SIRM detailed the inspections of the forward spar lower cap required where the accident wing failed. The instructions call for a bolt hole eddy current examination of the aft inboard fastener hole through the wing fitting and spar cap and a surface eddy current examination of the aft flange of the lower spar cap.

An Alternate Method of Compliance (AMOC) or adjustment of the initial or repetitive compliance times that provides an equivalent level of safety, may be approved by the Manager of the assigned FAA Aircraft Certification Office (ACO). An AMOC was not sought for the crack repaired from the inspection findings.

The Wichita ACO provided the following explanation on repairs allowed under the AD:

"Compliance to AD 89-25-10 for a crack found in the main spar lower cap or fitting is accomplished by a repair or replacement following the Beech SIRM or FAA approved instructions provided by Beech Aircraft Corporation. For purposes of this AD, the operator can use any instructions provided by Beech that have been approved by the FAA, a designee, or a CAA under a bilateral agreement. Additionally, AD 89-25-10, Paragraph (g) allows the Wichita ACOB to approve alternative methods of compliance if it is determined that the proposed repair provides an equivalent level of safety. Note: FAA Order 8110.103B defines AMOC as providing an acceptable level of safety. In this context, the FAA uses equivalent and acceptable in the same manner."

The Wichita ACO also provided the following explanation in reference to the DER-approved repair for the crack indication performed on the accident airplane in May 2021.

"A DER, acting on behalf of the FAA, approved the repair data via FAA Form 8110-3. As noted on the 8110-3, the DER approval was only for the engineering data necessary for defining and substantiating the repair, not the installation. Therefore, although the repair data was FAA approved, the instructions were not provided by Beech, so it was not done in compliance with the with the AD. However, had an AMOC been requested for this repair through the Wichita ACOB, we most likely would have approved it. The FAA has previously received requests for AMOCs for repairs in this same location and has issued approval. It is our position that an AMOC should have been requested for this repair, but we have no

record of receiving such a request. Therefore, this repair appears to be more of a technical noncompliance than an airworthiness issue."

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KIGM,3420 ft msl	**Distance from Accident Site:**	37 Nautical Miles
Observation Time:	12:51 Local	**Direction from Accident Site:**	314°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	11 knots / 18 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	260°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	42°C / 12°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Marana, AZ (AVQ)	**Type of Flight Plan Filed:**	VFR/IFR
Destination:	Marana, AZ (AVQ)	**Type of Clearance:**	IFR;VFR flight following
Departure Time:	11:27 Local	**Type of Airspace:**	Class G

No significant weather was indicated over northern Arizona at time. The nearest METAR site reported clear conditions with 10 statue mile visibility, and wind 260 at 11 knots gusting to 18 knots. The were no active AIRMETs, SIGMENTs, or PIREPs reported in the area.

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	34.824722,-113.39138(est)

The accident site was located about 15 miles northeast of Wikieup and was situated in mountainous terrain, covered with rocks ranging in size from pebbles to boulders. The site was populated by sage brush about 3 ft in height. The main wreckage was mostly consumed by fire and was about 465 ft away from a ridgeline, with the slope gradually increasing from 15° at the main wreckage site to 30° at the end of the debris path.

The main wreckage was located about N 34.8173000°, W -113.3887333°, with an elevation of about 4,510 ft. The main wreckage area contained a section of the cockpit. Wreckage debris was scattered over several acres. Most major sections of the airplane were located near the main wreckage site, with the exception of the outboard left wing. The mostly intact but separated left wing section was located about 0.79 miles northeast of the main wreckage and did not sustain thermal damage. The flap and aileron were attached, and fuel was present in the wing.

Examination of the left wing revealed that the forward spar was fractured about 11 inches inboard of the outboard wing attachment point. There was an area of pre-existing fracture evident in the lower spar cap through a fastener hole. Both the upper and lower forward spar wing attach bolts remained intact and were installed. The wing attach bolts were disassembled and the fractured portions of the forward spar were sent to the National Transportation Safety Board (NTSB) Materials Laboratory for further examination.

The examination revealed that the fracture of the left wing's lower spar cap was determined to be consistent with fatigue. The upper spar cap exhibited plastic deformation adjacent to its fracture consistent with compression buckling. In contrast, the lower spar cap fracture was flat and perpendicular to the spar direction, with no gross plastic deformation at or near the fracture. Further examination of the fracture surface of the lower spar cap revealed repeated banded features consistent with crack arrest marks from progressive cracking. The examination observations were consistent with the left wing's lower spar cap fractured from a fatigue crack that initiated at the aft inboard fastener hole through the spar cap and wing attach fitting.

Additionally, the fracture surface was examined by using a scanning electron microscope. The lower cap spar fracture surface exhibited striations consistent with crack propagation. The total length of the main crack was about 2.484 inches. Additionally, there was no indication of a material defect such as a corrosion pit or inclusion.

The fatigue separation was not in the same area where the repair was accomplished. The repair was inboard of the area of the wing separation. The DER-approved repaired area was not identified in the recovered wreckage and therefore could not be examined.

Visual and fluorescent penetrant inspection (FPI) examinations did not reveal any additional cracks in the other left and right wing's spar cap remnants.

Medical and Pathological Information

The Mohave County Medical Examiner Office, Lake Havasu City, Arizona, conducted an autopsy on the pilot. The medical examiner determined that the cause of death was “multiple injuries due to a plane crash.”

Due to the condition of the remains the medical examiner’s office was unable to provide specimens for Toxicology testing.

Organizational and Management Information

The airplane was operated by Falcon Executive Aviation, Inc., as a public-use firefighting flight for the Bureau of Land Management (BLM) over the Cedar Basin fire near Wikieup. While BLM maintained operational control of the flight, the airplane was under contract to the USFS as a call-when-needed asset.

Falcon Executive Aviation, Inc. (FEA) held a Part 135 Operating Certificate and maintained the airplane under an FAA Approved Aircraft Inspection Program (AAIP) that was approved on April 18, 2008. The AAIP was based on the continuous inspection program outlined in Chapter 5 of the Beech Model 90 King Air Maintenance Manual. FEA selected the 200-hour phase inspection program for the AAIP that was comprised of 4 phase inspections accomplished at 200-hour intervals. A complete inspection of the airplane under the program would be completed each 800 hours. The AAIP required all 4 phases to be completed every 24 months even if the hour requirements were not met. In January 2021, the repair station split from the FEA charter company and the repair station Falcon Air Service (FAS) was formed as a new maintenance company. The airplane was still maintained by FEA in accordance with the AAIP, but all maintenance was performed by FAS.

Administrative Information

Investigator In Charge (IIC):	Nixon, Albert
Additional Participating Persons:	Ricardo Asensio; Textron Aviation; Wichita, KS Christopher Kennedy; FAA; Scottsdale , AZ John Mills ; DOI; Boise, ID
Original Publish Date:	August 23, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=103452

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

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)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available here.