National Transportation Safety Board
Office of Aviation Safety
Washington, DC 20594

WPR21FA266

AIRWORTHINESS

Group Chair's Factual Report

June 21, 2022

A. ACCIDENT

Location: Wikieup, Arizona
Date: July 10, 2021
Time: 1254 mountain standard time (MST)
1954 coordinated universal time (UTC)
Airplane: Beech C90 King Air, N3688P

B. AIRWORTHINESS GROUP

Group Chair	Clinton R. Crookshanks National Transportation Safety Board Denver, CO
Group Member	Tara Shawn Federal Aviation Administration Wichita, Kansas
Group Member	Bruce Brown Falcon Executive Aviation, Inc. Mesa, Arizona
Group Member	Richard Petty Falcon Aviation Services, Inc. Mesa, Arizona
Group Member	Johnny Smith Textron Aviation Wichita, Kansas
Group Member	John Nelson USDA Forest Service Boise, Idaho
Group Member	Joshua Martin USDA Forest Service Boise, Idaho

C. DETAILS OF THE INVESTIGATION

The group visited the Falcon Aviation Services facility in Mesa, AZ, August 17-18, 2021, to examine the maintenance records from the accident airplane and to examine a sister airplane. The group also interviewed the inspector that performed the most recent non-destructive inspection of the accident airplane's wings.

D. FACTUAL INFORMATION

1.0 Aircraft

The Beech C90 King Air is a twin turbine engine, propeller driven, low wing airplane that was certified in 1971, Figure 1. The airplane is equipped with a conventional tail, retractable tricycle landing gear, and can carry two pilots and 6 passengers. The airplane is 35 feet, 6 inches long, 14 feet, 3 inches high at the tail and has a wingspan of 50 feet, 3 inches. The airplane is powered by two Pratt & Whitney Canada PT6A turbine engines that drive three, four or five-blade constant speed, full feathering, reversible propellers. The accident airplane was serial number LJ-915 and was manufactured in 1980.

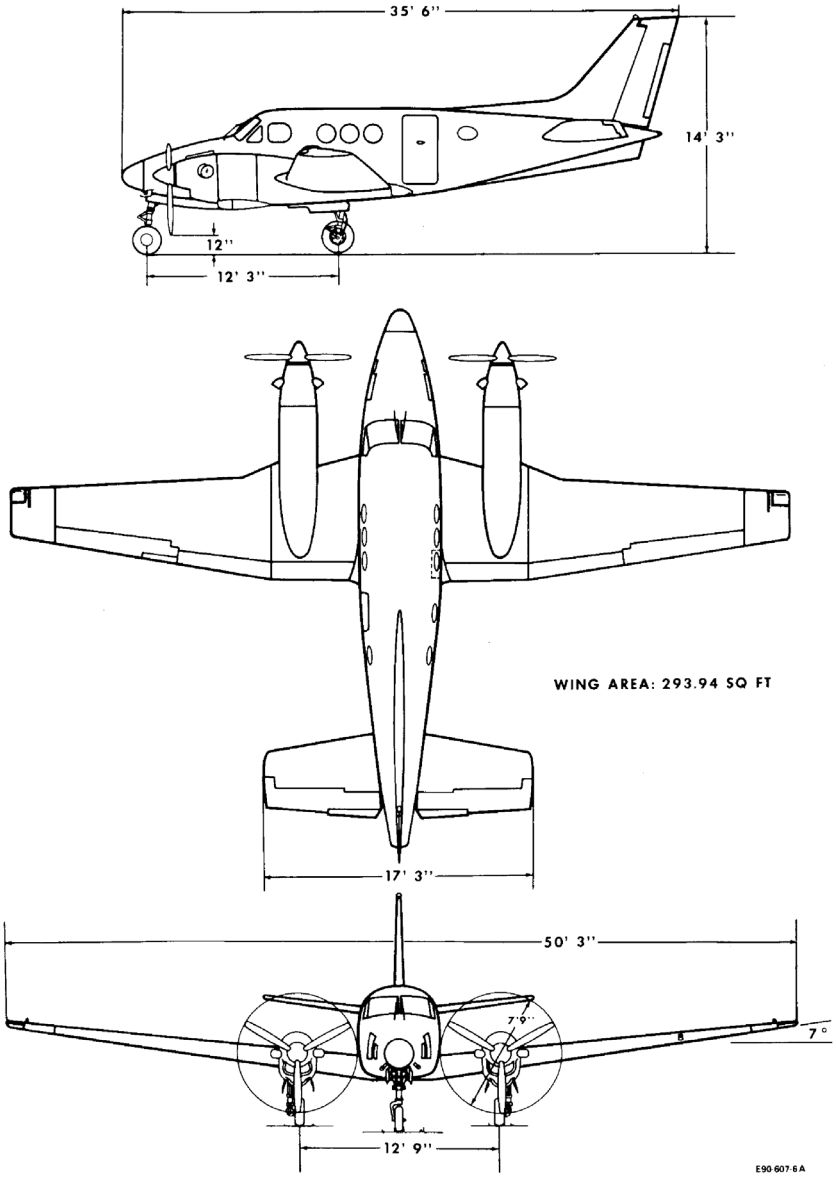

Figure 1. Beech C90 King Air 3-view drawing

2.0 Accident Flight and Wreckage

At the time of the accident, the airplane was being 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 had operational control for the flight, the airplane was under contract to the U.S. Forest Service (USFS) as a call-when-needed asset. A pilot and Air Tactical Group Supervisor were on board the airplane for the flight. Radar data showed that the airplane was on station for about 45 minutes over the fire prior to the accident and had completed multiple orbits over the area about 2,500 ft above ground level (agl). Subsequently, the left wing separated in-flight outboard of the nacelle and the airplane impacted mountainous desert terrain about 15 miles northeast of Wikieup. The main wreckage was mostly consumed by a post-crash fire. The mostly intact but separated left wing was found about 0.8 miles northeast of the main wreckage and did not sustain fire damage.

Examination of the left wing showed that the forward spar was fractured about 11 inches inboard of the outboard wing attach point near the inboard ends of the upper and lower bathtub fittings. There was an area of pre-exiting fracture evident in the lower spar cap through a fastener hole located at buttock line (BL) 88.50. Both the upper and lower forward spar wing attach bolts remained intact and installed through the inboard and outboard bathtub fittings. The wing attach bolts were disassembled, and the fractured portion of forward spar was sent to the NTSB Materials Laboratory for further examination. The mating left wing forward spar fractured upper and lower caps and the right wing forward spar attach points were retrieved from the main wreckage and also shipped to the NTSB Material Laboratory. See the Materials Laboratory Factual Report 22-014 and the Materials Laboratory Addendum Report 22-014B in the public docket for the details of the examination.

3.0 Textron Aviation Service Information

Textron Aviation has published instructions for wing structure inspections in the Structural Inspection and Repair Manual (SIRM) 57-13-01. The SIRM was first published in December 1982 and was at revision level D2 at the time of the accident (Attachment 1). SIRM 57-13-01 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, eddy current (EC), or fluorescent penetrant inspection (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 (Index 9) has an annual recurrence and the visual inspection of the nacelle splice plates (Index 11) has a 1,000-hour recurrence time. The following warning is contained in SIRM 57-13-01.

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. All inspections must be documented and approved by Textron Aviation or a person who has completed the SIRM training course offered by a Textron Aviation authorized training facility, no alternate courses are approved." Textron Aviation offers a 2-day SIRM training course to familiarize attendees with the King Air wing structure, the SIRM, and the inspection methods utilized.

SIRM 57-13-01, Table 201, Index 2 and Figure 202, detail 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 located at BL 88.50 and a surface eddy current examination of the aft flange of the lower spar cap.

4.0 Maintenance

Falcon Executive Aviation, Inc. (FEA) held a Part 135 Operating Certificate (X0FA185J) and a Part 145 Repair Station Certificate (X0FR185J) and maintained the accident 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 done 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. The airplane was placed on the FEA AAIP on May 22, 2006, at an airplane total time of 13,245.8 hours and 13,246 cycles. In January 2021, the FEA repair station was split from the charter company. The new maintenance company with the Repair Station Certificate (X0FR185J) was Falcon Aviation Services, Inc (FAS). From this point forward, FEA still maintained the airplane in accordance with the AAIP

but all maintenance on the airplane was performed by FAS. All relevant maintenance records are contained in Attachment 2.

The most recent phase 1 and phase 2 inspections were completed on May 14, 2020, at an airplane total time of 16,933.5 hours and 15,335 cycles. The most recent phase 3 and phase 4 inspections were completed on September 12, 2020, at an airplane total time of 17,126.0 hours and 15,410 cycles.

The airplane was completely stripped and repainted January 26, 2021. The airplane was last weighed in Forest Service configuration with useable fuel drained on March 24, 2021, at an airplane total time of 17,213.7 hours and 15,447 cycles. AD 2020-25-01 requiring an inspection of the wing bolt washers was found to be not applicable on May 12, 2021.

The most recent maintenance on the accident airplane was performed in May 2021, at an airplane total time of 17,213.7 hours and 15,447 cycles. The AD 89-25-10 (SIRM 57-13-01) wing inspections were performed during this maintenance visit. The EC and FPI inspections were performed by CrossPoint Testing and Inspection Services, LLC. The FPI inspection of the wing attach bolts and EC inspections of the wing attach fittings and lower surface of the lower forward spar were performed on February 18, 2021, with no indications, including the fastener hole at BL 88.50. The EC inspection of a fastener hole located at BL 29.27 (SIRM Index 5) had a crack like indication according to the inspection report dated March 4, 2021. The hole was oversized/reamed to a larger size and a reinspection still produced an indication.

FAS submitted a structural damage report and service request detailing the crack indication to the Textron Aviation structures group on April 12, 2021 and followed up with photos of the hole location on April 13. Textron Aviation responded to FAS on April 14 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 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 FAS elected to repair the wing spar at BL 29.27 instead of replacing the spars and contracted with a FAA Designated Engineering Representative (DER) at Callahan Aircraft Services, LLC for the design of the repair. The repair involved oversizing the affected fastener hole to 0.328 inch and installing an external doubler around the hole location. The repair was installed and signed off on May 24, 2021, with an FAA Form 337 Major Repair and Alteration and included a FAA Form 8110-3 Statement of Compliance with Airworthiness Standards from the DER. AD 89-25-10

was also signed off at this time. The DER claimed no knowledge of the communication between Textron Aviation and FAS about the crack indication though FAS claimed otherwise. CrossPoint performed an additional EC inspection of 4 adjacent fastener holes after the BL 29.27 hole was oversized with no indications on May 24, 2021. The repaired area was not identified in the recovered wreckage and could not be examined.

The group examined the maintenance records from 1990 to the present to document the wing spar inspections accomplished per AD 89-25-10 and the annual visual inspection of the wing spar caps for cracks and corrosion as contained in SIRM 57-13-01, Index 9. The group also noted any repairs made to the wings. The first AD 89-25-10 inspection of the wing spars occurred on March 22, 1990, at an airplane total time of 4,812.3 hours and the first visual inspection of the spar caps was performed on November 29, 1995, at an airplane total time of 10,593.3 hours. The AD 89-25-10 inspection of the wing spars has been performed 16 times since it became effective and 6 times since the airplane first went on contract to the USFS in 2007. The AD 89-25-10 inspection of the wing spars and fittings has been performed within the 1000-hour requirement imposed by the AD since the airplane has been on contract to the USFS. All the NDT inspections since the airplane went on contract except the most recent May 2021 inspection were performed by Canyon State Inspection. Canyon State performed the AD (SIRM) inspections on October 4, 2017, at an airplane total time of 16,507.5 hours and 15,094 cycles. The annual spar cap visual inspection for cracks and corrosion was performed 16 times since 2007, and 24 times in total.

5.0 Crosspoint Testing and Inspection Services, LLC

FAS utilized the services of CrossPoint testing and Inspection for performing the most recent NDT of the accident airplane in accordance with the AD (SIRM). The inspector performing the work was certified as a Level II inspector in EC inspection in accordance with NAS 410 Rev. 4 on January 5, 2018, which was valid for 5 years (Attachment 3). He was certified as a Level II inspector in FPI in accordance with NAS 410 on March 19, 2018, which was valid for 5 years. The inspector completed the Textron Aviation SIRM training course on August 21, 2019. He held an FAA repairman certificate issued on March 21, 2019, that was valid for NDT inspection using liquid penetrant, magnetic particle, eddy current, and ultrasonic methods while employed by CrossPoint Testing and Inspection Services, LLC. He had a visual acuity exam performed on December 23, 2020.

The 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.

Crosspoint provided the calibration and conformance certificates for the equipment and standard used for the inspection of the accident airplane. The Nortec 600S Eddy Current Flaw Detector and Mini-Mite Scanner were last calibrated on January 4, 2021, by Olympus. The certificate of conformance for the standard used was dated June 16, 2020, and it included the manufacturing quality checklist.

The group interviewed the inspector on August 18, 2021, regarding the inspection of the accident airplane in February. He was previously employed by Canyon State Inspection for about 10 years and left to join CrossPoint in 2017. He has performed the King Air inspections for many years and estimated that he performed 5 SIRM inspections per year. He could not recall previously inspecting the accident airplane at Canyon State. He did not report any difficulties with the inspection procedures and could remember finding indications on at least 2 other airplanes previously. He remembered finding the indication at BL 29.27 on the accident airplane and recalled that it was obvious. The first oversize attempt did not remove the crack. After the hole was further oversized, an additional inspection did not find an indication. There were no other indications on the airplane.

The inspector walked the group through his typical process for a King Air inspection. His typical workflow involved bringing his equipment to the shop and letting the calibration standard acclimate before beginning. The probe would be calibrated to the standard prior to beginning. He would examine each hole visually for cleanliness and anomalies before performing the eddy current inspection. If he finds an indication, he re-calibrates the probe and re-inspects the location. This may be performed several times to ensure the indication is valid. He marks the probe with a pen when examining stacked structure to make sure he knows where the probe is depth wise. He does occasionally encounter indications from tooling marks. He stated he is very comfortable with inspecting stacked structures. After inspecting each location, he marks the location with a red grease pencil. When finished he and the mechanic assigned would go over all the locations to ensure they covered each required location.

The group then had the inspector perform the bolt hole eddy current inspection on several holes on a sister airplane including the hole at BL 88.50. He used the same equipment and standard used for the February inspection. There were no indications found and the group did not note any discrepancies with his methods or procedures.

6.0 N3688P Flight History

The accident airplane started flying under contract to the USFS on April 29, 2007, and was under contract each year since then. The airplane was only used in the Aerial Supervision role while under USFS contract and never was used in the Lead Plane role. Up through 2016, the airplane was also used under FEAs 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 less than 365 hours for the USFS Aerial Supervision mission each year it was on contract with some years less than 100 hours (Attachment 4).

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.

7.0 FAA Information

FAA AD 89-25-10 became effective January 4, 1990, and required inspection of the wing lower forward spar attach fittings, center section, and outboard wing spar caps adjacent to the attach fittings, as specified in the Beech SIRM. The AD compliance was within 200 hours after the effective date or upon the airplane accumulating 3000 hours, whichever is later. Repeat inspections were required at intervals not to exceed 1000 hours. The AD also required that the personnel performing the inspection were specifically trained by Beech Aircraft Corporation. If any cracks were found, the AD required replacement "using the instructions and limitations specified in the Beech SIRM or other FAA approved instructions provided by Beech Aircraft Corporation" and that results be reported to the FAA.

The FAA Wichita Aircraft Certification Office (ACO) provided the following history of reports received per AD 89-25-10.

- 38 reports of cracks in wing attach fittings. (Reference SIRM 57-13-01, Figure 201)
- 5 reports of cracks in the lower spar cap at WS 88.50 (Reference SIRM 57-13-01, Figure 202)
- 11 reports of oversized/elongated holes and cracks in the wheel well. (Reference SIRM 57-13-01, Figure 203)
- 7 reports of oversized holes and cracks in the lower forward spar cap on inboard side of nacelle. (Reference SIRM 57-13-01, Figure 204)
- 3 reports of discrepant holes and crack indications in the lower forward spar cap at the wing root. (Reference SIRM 57-13-01, Figure 205)
- 1 report of corrosion at a fastener hole in the lower forward spar cap at the wing root (Reference SIRM, Figure 205)
- 17 reports of cracks in the lower spar cap lacking detail to define a specific location

• 2 reports of damage, not related to fatigue cracking, to the lower spar that required repairs

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 at BL 29.27 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 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."

8.0 USFS Information

Following the accident and based on preliminary examination of the left wing spar fracture, the USFS grounded all King Air airplanes under contract. The USFS issued instructions to all their contract operators on July 14, 2021, requiring that every King Air airplane with a similar spar configuration would need to comply with AD 2020-25-01 (wing bolt washer inspection), the published turbulence inspection,

and the SIRM wing inspections with detailed results provided back to the USFS before they could operate on contract again.

The Aerial Supervision mission as defined in the USFS contract consists of cruise flight from the airplane's base to the assigned target area, descent to the target altitude of 1,000 to 3,500 feet agl, circling the target in a right-hand orbit for 3-4 hours, and returning to base. The crew for the mission consists of a pilot provided by the contractor and 1 or 2 USFS Air Tactical Group Supervisors that coordinate the tactical use of all aircraft. The mission limits flight profiles requiring steep bank angles or increased lateral distances from the target. 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 Lead Plane airplanes can be used for the Aerial Supervision mission, but the converse is not true.

9.0 Previous NTSB Recommendation

In 2002, the NTSB investigated two in-flight wing separation accidents on large air tankers in the firefighting environment. As a result of these investigations, the NTSB recommended that the USFS "develop maintenance and inspection programs for aircraft that are used in firefighting operations that take into account and are based on: . . . 3) the magnitude of maneuver loading and the level of turbulence in the firefighting environment and the effect of these factors on remaining operational life".

Since that time, the USFS, Wichita State University, and the FAA have done extensive work to gather and analyze flight data from different platforms used in the firefighting environment. Some of this work included King Air airplanes operated in the Lead Plane mission as published in FAA report *Further Airframe Usage and Operational Loads Monitoring of ASM/Lead Aircraft (DOT/FAA/TC-17-40)*. The report concluded that the frequency of occurrence of gust loads for the firefighting mission was higher than a typical ferry mission and the maneuver loads occurred two orders of magnitude more frequently during the firefighting mission than a typical ferry mission.

The ferry mission is most similar to the typical general aviation flight profile that the King Air airplane was designed for. To date, there has been no specific examination of the loads for the Aerial Supervision mission in which the accident airplane was operated. It has been assumed that the gust loading in the Aerial Supervision mission would be similar to that published in the above report, but the maneuver loads would be much less severe.

Hawker Beechcraft (now Textron Aviation) performed a damage tolerance analysis at the request of the USFS for the King Air 90 wing used in the Lead Plane role in 2009. The analysis recommended that the SIRM inspection intervals be reduced from 1000 hours/3 years to 300 hours/3 years. The USFS requires these reduced inspection intervals for airplanes leased for the Lead Plane role.

E. LIST OF ATTACHMENTS

1. Attachment 1 – Structural Inspection and Repair Manual 57-13-01
2. Attachment 2 – N3688P Maintenance Records
3. Attachment 3 – Inspector Records
4. Attachment 4 – N3688P Flight History

Submitted by:

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