



# Aviation Investigation Final Report

<b>Location:</b>	Estes Park, Colorado	<b>Accident Number:</b>	DEN02GA074
<b>Date &amp; Time:</b>	July 18, 2002, 18:40 Local	<b>Registration:</b>	N7620C
<b>Aircraft:</b>	Consolidated-Vultee P4Y-2	<b>Aircraft Damage:</b>	Destroyed
<b>Defining Event:</b>		<b>Injuries:</b>	2 Fatal
<b>Flight Conducted Under:</b>	Public aircraft		

## Analysis

The airplane was maneuvering to deliver fire retardant when its left wing separated. Aircraft control was lost and the airplane crashed into mountainous terrain. A witness on the ground took a series of photographs that showed the airtanker's left wing separating at the wing root and the remaining airplane entering a 45-degree dive to the ground in a counterclockwise roll. An examination of the airplane wreckage revealed extensive areas of preexisting fatigue in the left wing's forward spar lower spar cap, the adjacent spar web, and the adjacent area of the lower wing skin. The portion of the wing containing the fatigue crack was obscured by the retardant tanks and would not have been detectable by an exterior visual inspection. An examination of two other airtankers of the same make and model revealed the area where the failure occurred on the accident airplane was in a location masked by the airplane's fuselage construction. The airplane was manufactured in 1945 and was in military service until 1956. It was not designed with the intention of operating as a firefighting airplane. In 1958, the airplane was converted to civilian use as an airtanker and served in that capacity until the time of the accident. The investigation revealed that the owner developed service and inspection procedures for the airtanker; however, the information contained in the procedures did not adequately describe where and how to inspect for critical fatigue cracks. The procedures were based on U.S Navy PB4Y-2 airplane structural repair manuals that had not been revised since 1948.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: the inflight failure of the left wing due to fatigue cracking in the left wing's forward spar and wing skin. A factor contributing to the accident was inadequate maintenance procedures to detect fatigue cracking.

## Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION

Phase of Operation: MANEUVERING - AERIAL APPLICATION

Findings

1. WING - FAILURE, TOTAL
2. (C) WING, SPAR - FATIGUE
3. (C) WING, SKIN - FATIGUE
4. (F) MAINTENANCE, INSPECTION - INADEQUATE - COMPANY/OPERATOR MANAGEMENT

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Occurrence #2: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: DESCENT - UNCONTROLLED

Findings

5. AIRCRAFT CONTROL - NOT POSSIBLE

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Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT - UNCONTROLLED

Findings

6. TERRAIN CONDITION - MOUNTAINOUS/HILLY

## Factual Information

### HISTORY OF FLIGHT

On July 18, 2002, at 1840 mountain daylight time, a Consolidated-Vultee P4Y-2, N7620C, under contract to the U. S. Department of Agriculture Forest Service and piloted by a commercial pilot, was destroyed when it impacted into mountainous terrain 6 miles southwest of Estes Park, Colorado. A post-crash explosion and fire ensued. Prior to the impact, the airplane's left wing separated and aircraft control was lost while maneuvering to deliver fire retardant on the Big Elk wildfire, burning in an area northwest of Lyons, Colorado. Visual meteorological conditions prevailed at the time of the accident. The aerial attack flight was being conducted under the provisions of Title 14 CFR Part 91, public use. A company visual flight rules flight plan was on file. The pilot and second pilot on board the airplane were fatally injured. The flight originated at Broomfield, Colorado, at 1814.

According to the Airtanker Base Manager at Jeffco Airport, Broomfield, Colorado, the airplane, Tanker 123, was dispatched to join other airtankers, Tanker 161 and Tanker 22, a helitanker, number T-16, and a U. S. Forest Service lead airplane, Lead Bravo 8, to drop fire retardant on the Big Elk Fire. The airplane had flown seven previous air attack missions on the fire that day. Prior to the accident mission, the airplane was loaded with approximately 2,000 gallons of fire retardant, and 550 gallons of fuel.

The captain of T-161 said, "Tanker 22 had just completed his drop and Tanker 123 had observed the drop and was preparing to drop. All communication between 123 and Lead Bravo 8 was normal. I fell behind T-123 on downwind and base. I looked away momentarily and I again focused on T-123. I noticed his left wing was falling. The aircraft was in a 15 to 20 degree bank. I next saw fire near the fuselage as the wing failed inboard of the number 2 engine. The aircraft pitched nose down in a huge fireball and plunged into the ground vertically starting an immediate large fire."

The copilot of T-161 said Tanker 123 was in his base turn for the drop and in a "smooth 15 to 20 degree bank turn", when the left wing separated from the airplane. "The aircraft then went into a rotation and impacted the ground." The copilot said that operations were normal and the weather in the area consisted of "the smoothest, least turbulent conditions of the day."

The pilot in the Forest Service leadplane said, "The conditions were perfect for a tanker drop. No turbulence and no smoke in that area." The pilot said, "I had just made two runs with Tanker 22 on the same drop area. He had departed and I allowed helicopter 72D to make a water drop on the area. Tanker 123 was on scene when Tanker 22 made his split load drop, two different runs. I instructed Tanker 123 that we would be extending Tanker 22's first drop. Tanker 123 responded with something like, 'We can do that' or 'We see that,' and that he was

on downwind for the drop. I told him I was at his 8 o'clock and [he] said that he had me in sight. I then told him I would come up on his left side and continue downwind with him until he was ready to turn back. He then responded with 'I think I'm going to use this nice big valley to turn around in.' I told him that sounded like a good idea to me. We flew approximately 15 seconds before he began a gentle turn to final. We continued in the turn from downwind to final without squaring off for a base, which is normal on tanker runs." The pilot said that after he turned on final, he told the captain on Tanker 123 that his attack run would require a pitch over which was approximately 1/2 mile ahead. The pilot said after he finished that transmission, the captain of Tanker 161 called him and said that the left wing had just come off of Tanker 123 and the airplane had gone in.

A witness on the ground, approximately 6 miles east of the accident location, using a digital camera with a telephoto lens and automatic shutter, took a series of eight still photographs of the airplane at the time of the accident. The photo series shows the airplane's left wing separate at the wing root and fuselage, a fire ensues at the separation, and the airplane enters an approximately 45-degree dive to the ground. The photos also show the airplane in a counter-clockwise roll during its dive toward the ground. The witness said when he saw what was happening, he depressed the shutter button and held it until the airplane went behind a treed ridge. Copies of the eight photographs are provided as an attachment to this report.

Several witnesses on the ground in the vicinity of the accident location said they saw the airplane in a left banking turn. Some of the witnesses described the turn as "steep" or "tight." One witness said the airplane had rolled out of the turn after making a "hard banking turn." At this time, none of the witnesses indicated that there were any apparent problems with the airplane. The witnesses then said the left wing "folded upward" and severed at the "left wing-fuselage point." They all described "slurry" coming out and "fire erupting" from the area where the wing separated. The witnesses said the airplane rapidly descended and impacted into the hillside.

Radar information provided by the Denver Air Route Traffic Control Center showed the airplane come out of the Broomfield area and proceeding northwest to the Lyons-Estes Park area where the Big Elk fire was burning. The airplane is shown entering a series of counter-clockwise 3.5 to 4 nautical mile diameter orbits at an altitude averaging 8,900 feet mean sea level (msl), over Lion's Gulch, and in the vicinity of Moose Mountain. Terrain in this area is mountainous averaging from 7,300 feet msl to 8,500 feet msl. The radar information showed the airplane make five orbits over this area. On the last half of the fifth orbit, the radar information shows the airplane at an altitude of 8,500 feet msl and heading approximately 315 degrees. The airplane is shown on a 315-degree heading for 1.3 nautical miles. The airplane is then shown making a left turn to 260 degrees. The airplane is shown on a 260-degree heading for 1.1 nautical miles and at an altitude of 8,400 feet msl. The airplane is then shown making a left turn and rolling out on a 195-degree heading. The airplane remains on this heading for 0.6 nautical miles, when radar contact is lost. The accident site was approximately 0.1 nautical miles southwest of the last radar plot.

## PERSONNEL INFORMATION

The pilot-in-command held a commercial pilot license with single and multiengine land, instrument airplane ratings, dated January 17, 1996. The pilot was type-rated in CV-P4Y airplanes. The pilot also held a flight instructor certificate with endorsements for instruction in single-engine land airplanes. The pilot-in-command held a second-class medical certificate dated January 18, 2002. The certificate contained no restrictions or limitations. The pilot-in-command met contract qualifications for the U. S. Department of Agriculture (USDA) and U. S. Department of the Interior (DOI) as a pilot-in-command for special mission, low level, airtanker initial attack in PB4Y-2 airplanes. The pilot-in-command completed a company pilot proficiency check in the P4Y-2 on January 31, 2002. At the time of his proficiency check, the pilot had 3,416 total flying hours and 1,094 hours in P4Y-2 airplanes. Information provided by the Forest Service indicated that at the time of the accident, the pilot-in-command had 3,658 total flying hours, and 1,328 hours in P4Y-2 airplanes.

The second pilot held a commercial pilot license with single-engine land and sea, multiengine land and sea, instrument airplane ratings, dated October 15, 1997. The second pilot was type-rated in CV-P4Y, DC-3, DC-B26, M-202, M-404, and N-B25 airplanes. The second pilot held a second-class medical certificate dated January 22, 2002. The certificate contained the following restrictions/limitations: Holder must wear corrective lenses for near and distant vision. The second pilot met contract qualifications for the USDA and DOI as a pilot-in-command for special mission, low level, airtanker initial attack in PB4Y-2 airplanes. The second pilot completed a company pilot proficiency check in the P4Y-2 on January 23, 2002. At the time of his proficiency check, the pilot had 6,403.7 total flying hours and 668.7 hours in P4Y-2 airplanes. Information provided by the Forest Service indicated that at the time of the accident, the second pilot had 6,689 total flying hours and 913 hours in P4Y-2 airplanes.

## AIRCRAFT INFORMATION

The airplane, serial number 66260, was manufactured by the Consolidated-Vultee, Corporation, in San Diego, California, in 1945. The airplane, then designated a PB4Y-2, was delivered on July 28, 1945, to the United States Navy for the purpose of conducting coastal sea patrol. The airplane was transferred from Navy service to the United States Coast Guard (USCG) in October 1952. The airplane served with a USCG Air Detachment at San Francisco, California, until being retired from military service and placed into storage on August 6, 1956. At that time, the airplane had 2,861.4 total flying hours.

On July 14, 1958, the airplane was removed from storage and converted to an airtanker. The military markings were removed, a spray system was installed, and the airplane was certified airworthy under Civil Aviation Regulation (CAR) Part 8. The airplane was registered to Big Piney Aviation Company, Rey, Utah, as N7620, and entered contract U. S. Forest Service operations on August 30, 1958. On March 14, 1969, the airplane was purchased by Avery Aviation, Incorporated, Greybull, Wyoming. In April 1969, the company took the name Hawkins and Powers Aviation, Incorporated. The airplane was then redesignated as a P4Y-2.

At the time of the accident, the airplane was owned, maintained, and flown by Hawkins and Powers Aviation, Incorporated, Greybull, Wyoming. The airplane was being operated under a contract by the U. S. Forest Service to perform fire retardant application as described in the provisions of Title 14, Code of Federal Regulations Part 137, aerial application. The airplane's most recent registration certificate was issued on June 16, 1969.

The airplane operates under Type Certificate (TC) AR-29, approved on April 1, 1958. The TC describes the subject airplane model as a General Dynamics (Convair), P4Y-2. The TC holder is Transair Spraying Company, Inc., Canyon, Texas. The TC reflects the following information:

**Restricted Aircraft Specification:** An aircraft of the subject model is considered eligible for restricted airworthiness certification when modified for special purpose in accordance with Part 8 of the Civil Air Regulations.

**Operating Limitations:** To be prescribed for the particular special purpose operations in accordance with Civil Aeronautics Manual 8.30-1. For special purpose operations over congested areas, the military operating limitations must be submitted by the applicant for the use of the CAA representative in establishing civil limitations in accordance with Civil Air Regulations Part 8.30.

The airplane underwent a company "C" check inspection on June 14, 2002. The airframe time at the inspection was 8,259.01 hours. The airframe time at the accident was approximately 8,346.3 hours.

## METEOROLOGICAL INFORMATION

At 1858, the Aviation Routine Weather Report at Jeffco Airport was few clouds at 8,000 feet, ceiling 12,000 feet broken, visibility 30 statute miles, temperature 93 degrees Fahrenheit (F), dew point 52 degrees F, winds 040 degrees at 8 knots, and an altimeter setting of 30.04 inches of Mercury.

## WRECKAGE AND IMPACT INFORMATION

The NTSB on scene investigation began at 2115.

The airplane wreckage was located in four areas contained within a heavily wooded valley, approximately 6 miles southeast of Estes Park, Colorado, and in the vicinity of mile marker 8, marking a ½ mile long northwest to southeast-running segment of U. S. Highway 36. All four areas of aircraft wreckage rested along a predominately 210-degree heading.

The first area of airplane wreckage was located on the northeast side of U. S. Highway 36, and consisted of a debris field that spanned a 450-foot wide by 570-foot long area of the ridge. The debris field contained parts of hydraulic lines, oil lines, fuel tank baffling, rubber clamps,

cowling pieces from the number 1 engine, and small pieces of rubber and metal. Traces of oil and hydraulic fluid were observed on vegetation within the debris field.

The second area that contained airplane wreckage was located approximately 270 feet from the south edge of the highway. The area consisted of the two sections of the airplane's left wing, the number 2 engine, and number 2 propeller.

The inboard section of the left wing was found resting upside-down at the base of a large tree. A second broken tree was leaning over the trailing edge of the wing section near the section's mid-span. The left wing was broken aft longitudinally at wing station (WS) 2 (wing root) and downward and aft at WS 16. The leading edge of the wing at the wing root was bent upward and crushed inward. The aft spar at WS 2 showed downward bending and aft twisting. The leading edge wing skin and bottom skin showed bends and buckling. The left flap was extended approximately 20 degrees. The inboard section of the flap was crushed inward. The left main landing gear was retracted into the wing and showed no damage.

The number 2 engine was broken at the engine mounts and rested forward and right of WS 5. The ring cowling was crushed aft. The bottom cowling was crushed inward and aft. The engine was intact and remained connected to the wing by fuel and oil lines and control cables. The number 2 propeller showed two of the three blades still mounted in the hub. The first blade was straight and showed chordwise scratches along the leading edge and the blade face. The second blade was bent rearward along the bottom engine cowling and twisted outboard. The third blade was broken out of the hub and found resting on the ground approximately 10 feet east of the inboard wing section. The blade showed chordwise scratches in the front face and along the leading edge.

The left outboard wing section rested upside-down approximately 5 feet north of the inboard section. The leading edge of the outboard wing section was pushed into the base of a tree at WS 21. Approximately 2 feet outboard of the fracture were three propeller strikes in the leading edge metal. All three strikes were within an 18-inch span. The first two strikes were at 40 and 45 degrees from the lateral line and extended aft approximately 4 and 6 inches. The third strike was at 50 degrees from the lateral line and extended aft for approximately 18 inches. A crack in the upper wing skin propagated aft for another 10 inches. A c-shaped crush area was located where the wing section's leading edge was butted against the tree. The crushed area was 12 inches wide and 14 inches deep. The bottom wing skin just inboard and aft of the crushed area was buckled aft. A split in the top wing skin along the rivet seam at WS 24 extended aft 16 inches. The top wing skin was crushed inward to conform to the wing's stringers and stiffeners. The left aileron was intact and attached to the wing section. The fabric skin showed small tears in several locations along its span. Aileron and trim control cables remained intact through the fracture at WS 16 to the wing root fracture, where they showed unraveling.

The third area of airplane wreckage was located at the bottom of the valley, approximately 315 feet south-southeast of the south edge of the highway. The area consisted of the airplane's

number 1 engine and propeller. The engine was embedded approximately 2 feet into ground. The lower portion of the cowling ring, several cowling panels, and nacelle skin were crushed and broken aft. Three of the four engine mounts remained with the engine. The mount seats showed circular rubs and crushing. The mount legs were bent downward 20 degrees and twisted approximately 15 degrees counterclockwise. The bolts in the three mounts were necked and broken. The two legs making up the fourth engine mount were broken near the engine mount ring behind the cylinders. One of the legs was bent and broken approximately 8 inches out from the ring. The other leg was broken approximately 1 inch from the ring. Both fractured areas showed linseed oil on the inside walls.

The first of the three propeller blades on was broken chordwise at the blade tip. The second blade was turned 90 degrees forward in the cuff. The blade was bent forward 18 inches inboard of the tip and showed chips along the leading edge. The second blade showed chordwise scratches along the trailing face of the blade beginning near the tip and extending inboard 12 inches. Each scratch was approximately 1/2-inch apart. The third blade was buried 20 inches in the ground beneath the ring cowling of the number 1 engine. The blade was bent aft and broken approximately 4 inches outboard of the propeller hub. The blade showed torsional bending chordwise scratches and tip-curling.

The fourth area contained the airplane's main wreckage. The main wreckage was located 610 feet from the south edge of the highway on the southeast side of the valley, and approximately 30 feet south of Lion's Gulch, a dry riverbed forming the lowest point of the valley floor.

The airplane's main wreckage consisted of the airplane's nose section and cockpit area, right wing, number 3 and 4 engines, a center fuselage section that contained the fuel tanks and slurry tanks for the fire retardant, the aft fuselage section and the empennage.

The fourth wreckage area began with a wooded section containing 50 to 60 foot tall pine trees, covering an area of approximately 110 feet in width and extending 120 feet along a 210 degree magnetic heading. The trees in this area showed several top branches broken. On the southeast edge of the wooded area were portions of the airplane's nose section, several pieces of fuselage skin, and the outboard section of the airplane's left horizontal stabilizer and elevator. The horizontal stabilizer and elevator sections were crushed aft and broken.

At the end of the wooded section was a ground scar extending 70 feet up the slope of the ridge. The ground scar was approximately 40 feet at its widest point and 46 inches at its deepest point near its beginning. Several broken trees were located along the northwest side of the ground scar. On the southeast edge of the ground scar was the airplane's aft fuselage from fuselage station (FS) 7.4 to FS 10.0, and the airplane's empennage. The aft fuselage section was broken open, crushed inward, and charred. The vertical stabilizer and rudder were broken clockwise and downward. The leading edge of the vertical stabilizer was crushed aft along its span. It also showed charring and melting. The rudder remained attached at the lower hinge points. The trailing portion of the rudder and the rudder trim tab were charred and consumed by fire. The inboard sections of the left horizontal stabilizer and elevator were

broken aft and downward 24 inches outboard of the fuselage. The sections were crushed and broken aft, fragmented, and consumed by fire. The right horizontal stabilizer was crushed aft along the leading edge span and charred. The right elevator was broken out, fragmented, charred and consumed by fire. Flight control continuity from the elevator and rudder bellcranks to the control yokes and rudder pedals was confirmed.

At the south-southwest end of the crater was the number 4 engine. It was broken aft at the engine mounts. The cowling was broken open, charred, and consumed by fire. Several of the cylinders and pistons were broken out. The engine accessory section was broken, charred, melted and consumed by fire. The remaining engine block was broken open, charred and melted. The number 4 propeller was broken at the hub. All of the propeller blades were broken out at the cuffs. One of the three blades rested in the south-southeast end of the ground scar near the number 4 engine. The other two blades were located approximately 40 and 75 feet west of the ground scar. All three blades showed torsional bending, chordwise scratches, and leading edge nicks. All three blades were charred and partially melted.

The number 3 engine was located approximately 20 feet southeast of the far end of the ground scar. The engine was broken out at the mounts, fragmented, charred and consumed by fire. The number 3 propeller remained attached to the crankshaft. One of the three blades remained with the propeller hub. The blade showed chordwise scratches and was charred. Blades 2 and 3 were bent and broken aft. One blade rested on the ground near the engine. The other blade was found near the center of the ground scar. Both blades showed torsional bending and chordwise scratches. Both blades were charred and melted along the trailing edges.

Approximately 15 feet beyond the end of the ground scar were the inboard and outboard sections of the airplane's right wing, the wing carry-through section, right main landing gear, and portions of the center fuselage. The inboard section of the right wing was broken aft, fragmented, charred, melted and consumed by fire. The right flap was broken out, fragmented, charred, and melted. The right main landing gear was broken out at the mounts, fragmented, charred and melted. The right main gear door was broken out, charred and consumed by fire. The right main tire was consumed by fire. The outboard section of the right wing was broken aft longitudinally at WS 15. The section was broken open, fragmented, charred, and consumed by fire. The right aileron was broken aft, melted and consumed by fire. Flight control continuity was confirmed between the right aileron and the control yokes.

The center fuselage between FS 4.1 and FS 7.0 was broken open, fragmented, charred, melted, and consumed by fire. The two body fuel tanks, two wing tanks at the carry-through section, catwalk, and slurry tanks were broken open, charred, melted, and consumed by fire. Sections of the slurry tanks, slurry tank doors, doors uplocks and actuator arms, and fuel tank baffling fanned outward from the center fuselage section in a 30-degree arc extending along a 265 degree heading. Fire retardant chemical also fanned outward along the ground in this area. Fire retardant was observed on the east-facing sides of tree trunks in the area, extending from the roots of the trees upward approximately 15 to 30 feet.

The carry-through section of the wing into the center fuselage section was broken out, fragmented, charred, melted, and consumed by fire.

Approximately 25 feet east-southeast of the remains of the fuselage center section and right wing sections was the beginning of a debris field containing the forward fuselage and cockpit sections of the airplane. The debris field extending outward in a 110-degree arc for approximately 150 feet, beginning at 145 degrees and extending south through southwest to approximately a 255 degree heading. The majority of the debris fanning outward in the area approximating a 155 to 170 degree arc consisted of bulkheads, stringers, skin, and broken wood floor panels from the airplane's nose section. Also in this area were broken parts of the instrument panel, cockpit sidewalls, pilot seat frames, flight instruments and switches, and the trim gears, pulleys, and cables. The airplane's nose wheel rested approximately 25 feet southeast of the center fuselage section. It was fragmented, charred, and melted. The tire was consumed by fire. Also within the debris field were the remains of pilot charts and maintenance records, several engine parts, personal effects, and numerous broken skin pieces from the airplane's fuselage and right wing. Most of these items showed severe charring and melting.

The airplane wreckage was recovered between July 20 and 23, 2002, and moved to Greeley, Colorado, where it was retained for further examination.

## FIRE

Upon the airplane's impact, a fire ensued in the wooded area south-southwest of the ground scar. Fire teams from the U. S. Forest Service, battling the nearby Big Elk fire, responded to the crash site. A firebreak was dug around the fire area. The fire was brought under control by 2100. Small spot fires continued to burn on the northwest perimeter of the burned area into the next day.

The extent of the burned area, which encompassed the majority of the airplane's main wreckage, was 310 feet north-to-south and 530 feet east-to-west.

## MEDICAL AND PATHOLOGICAL INFORMATION

Examinations of the pilot and copilot were conducted by the Larimer County, Colorado, Coroner/Medical Examiner, at Loveland, Colorado, on July 20, 2002.

The results of Federal Aviation Administration (FAA) toxicology testing of specimens from the pilot and copilot were negative for all tests conducted.

## TESTS AND RESEARCH

### Structures Examination

The airplane wreckage was examined at Greeley Colorado, on July 29-30, 2002. The airplane's left wing was observed to be broken at approximately the side of body and just outboard of the number 1 engine nacelle. The PB4Y-2 wing is a 3-piece construction consisting of a center section and a left and right outboard section. The center section carries through the fuselage and extends 331 inches to either side of the airplane centerline. The outboard wing sections extend from 331 inches to 661 inches on either side. At the airplane centerline is a truss-type rib (Rib 0). At 26 inches to either side is another truss-type rib (Rib 1). Ribs 2 through 28 are stamped sheet metal ribs and make up the chordwise structure of the wing between the front and rear spars. The left wing was observed in two pieces. The outboard section extended from Rib 16 to the wingtip, roughly 23 feet, and included the left aileron with attached trim tab. There was slashing damage to the leading edge between Ribs 19 and 20. At Rib 22, the leading edge shows circular crushing damage consistent with tree impact. The upper skin shows impact damage consistent with it impacting the ground in this orientation. The ribs observed all showed compression damage. At the separation point, the wing is bent downward and the lower skin is buckled and bent downward.

The inboard section of the left wing extended from Rib 2 to Rib 16, roughly 27.5 feet. The upper skin showed damage consistent with it impacting the ground in this orientation. Ribs 3 and 4 were visible and showed compression damage. At the separation point, the leading edge structure was crushed rearward into the forward spar. The forward spar was rotated aft about the lower cap and was fractured vertically about 7 inches inboard of Rib 2. The forward spar fracture was just inboard of the production break in the lower forward cap and continued vertically through the spar web and upper cap members. The fracture through the lower center cap, web, and lower aft cap intersected a countersunk rivet that attached the three members. The fracture also partially intersected two additional rivet holes in this portion of the forward spar. The front face of the forward spar web showed rubbing signatures extending to 6 inches above the lower spar cap. There were also rubbing signatures on the aft face of the lower cap consistent with rivet heads. The upper skin was fractured along the side-of-body from 7 inches inboard of Rib 2 at the forward end to Rib 2 at the aft end. This section of upper skin was bent downward at the inboard edge. The lower skin was fractured at the side-body similar to the upper skin from the forward spar to stringer 10 (the stringers were numbered sequentially from 1 to 15 beginning at the forward spar and moving aft). A section of the lower skin that extended outboard for 30 inches was bent forward onto itself between stringers 6 and 7. A large section of lower skin from stringer 10 to the aft spar and extending outward about 35 inches was found separate from the wing. The forward fracture point of this piece was along the fastener row attaching stringer 10. The aft fracture point was along the rear spar fasteners. Outboard, the fracture was approximately 8 inches outboard of Rib 3 extending from the rear spar forward 19 inches. The fracture then progressed inward 5 inches and then forward to stringer 10. The rear spar web was fractured vertically along the rivet row that attached Rib 2. This fracture progressed through rivet holes in the upper cap that were in line with the web fracture and through the rivet holes about an inch inboard of the web fracture in the lower cap. The entire rear spar was rotated rearward about the spar cap.

The number 1 engine was observed to have separated from the wing at the tubular mount legs. The large radial engines are mounted to a ring with four tubular strut-type mounts that then mate with four corresponding tubular strut type mounts on the wing. The two upper mounts attach to the front spar and the two lower mounts attach to the rear spar. On examining the wing side mounts, three of the four mounts showed bending consistent with the engine departing the wing in an upward and outward dynamic. These three mounts showed fractured bolts where the engine mounts attached to the wing mounts. The upper inboard mount showed some compression buckling and bending in the outboard direction. The one remaining inboard mount showed no conclusive signatures.

The remainder of the airplane wreckage showed damage consistent with a ground impact, explosion, and post-impact fire. An examination of the airplane's systems revealed no pre-existing anomalies.

The number 1 engine mount legs and pieces of the left wing's aft spar were sectioned and transported to the NTSB Materials Laboratory, Washington, DC, for detailed analysis. The results of the analysis are contained in the NTSB Materials Laboratory Factual Report, which is attached to this report. The NTSB Structures Group Chairman's Factual Report is attached as an addendum to this report.

#### Materials Laboratory Examination

The airplane's left wing spar area was again examined at Greeley, Colorado, on September 5-6, 2002. The wing fracture was located directly adjacent to the fuselage. Extensive areas of preexisting fatigue were found in the left wing lower spar cap, the adjacent spar web, and the adjacent area of the lower wing. Portions of the left wing forward spar to include the upper and lower spar cap members, the web, and part of the lower skin were sectioned and added to wreckage containing the mating inboard pieces. All of these parts were transported to the NTSB Materials Laboratory, for detailed analysis.

The Materials Laboratory Factual Report states that microscopic examinations of the fractures found extensive areas of fatigue cracking in both of the lower spar cap members, in the spar web, and in the lower skin. Close examinations established that both angle members of the lower spar were almost completely separated by fatigue. The fracture through the vertical flanges of the lower spar cap members intersected three rivet holes including the holes for the two most outboard fuselage-to-spar rivets (1/4-inch flat head) and an internal 3/16-inch 100-percent countersunk rivet between the flat head rivets. The countersink for the rivet head was contained in the forward fractured cap member and in the spar web material but did not extend into the aft cap members. The two flat head rivets stayed with the inboard fracture half while the countersunk rivet stayed with the wing side (outboard) fracture face. The fuselage side-of-body fitting originally covered and hid the head of the countersunk rivet. The aft-facing lower flanges of the cap members were fractured through a single rivet hole that connected both cap members to the lower wing skin.

Detailed inspections and examinations of the lower spar cap and web fractures found 12 separate low stress fatigue cracks in the ligaments between adjacent rivet holes or between the holes and edges of the components. All fatigue cracks initiated at or near rivet holes. Half of the cracks initiated at the countersunk head rivet hole and propagated away from the hole, both upward into the upper flat head rivet hole, and downward nearly to the lower flat head rivet hole. Three additional fatigue regions initiated at the upper (flat head) rivet hole and propagated upward. The final three cracks initiated at the lower (flat head) rivet hole and propagated downward. The later fatigue regions propagated into the horizontal flanges of the cap members and in doing so turning rearward. The fatigue regions in the horizontal flanges of the cap members and in the spar web above the cap transitioned from low stress propagation (perpendicular to the plane of the sheet) to higher stress mixed fatigue and overstress propagation as indicated by the change in fracture orientation to a 45-degree plane through the pieces.

The wing lower skin also showed low stress fatigue in the area immediately adjacent to (under) the spar cap. Magnified examinations established that the fatigue initiated at the corner of a machined cutout in the forward edge of the skin. The fatigue propagated rearward in a low stress manner in the skin for about 1 inch. Aft of the spar area, the fracture propagated on various slant planes through the skin indicative of high stress propagation. Scanning electron microscope (SEM) examinations found that the slant region was made up of mostly ductile dimples with interspersed regions of fatigue and arrest failures. Many of the arrest features, particularly toward the aft end of the cracks were consistent with mechanical damage on the fracture due to fracture face closure and recontact. Progressive fracturing was noted on the skin separation aft past three "Z" stringers riveted to the lower skin. In total, the skin was fatigue cracked for a distance of approximately 21 inches before tensile overstress. The forward 16 inches of the skin crack was partially obscured by deposits (consistent with an older section of the crack) while the aft 5 inches appeared relatively bright, shiny, and clean (consistent with a newer section of the crack). The fatigue region of the skin fracture propagated generally from forward to aft intersecting at least nine rivets. The fracture intersected each rivet hole from the forward side, then reinitiated and propagated away from the aft side. At three of the holes, small low stress fatigue cracks were found at the aft side of the hole.

Visual examinations of the wing pieces from the rear spar found that all separations were typical of overstress separations with no indications of fatigue or other progressive cracking. The deformation associated with the spar was consistent with the leading edge of the wing rotating downward about the rear spar area.

Visual examination of the tubular strut-type mount legs from the number 1 engine mount showed features consistent with overstress separations on all fractures. No evidence of preexisting cracking was uncovered.

The Materials Laboratory Factual Report is provided as an addendum to this report.

## Site Visit

A site visit was conducted at Hawkins and Powers Aviation, Incorporated, Greybull, Wyoming, on September 23-25, 2002. Two of the four remaining P4Y-2 airtankers were examined. One of the airplanes, Tanker 127, was examined in their main hanger. Another airplane, Tanker 124, was examined on the ramp. On both airplanes, the wings' inboard leading edge fairings were removed. Internally, the retardant tanks and body fuel cells were also removed so that the forward spars at the spar caps and machined cutouts could be observed. In both cases, the areas where the flathead rivets, countersunk rivet, spar webbing, and lower wing skin examined on Tanker 123 (N7620C) were located, were hidden by the fuselage walls and internal belt frames and stiffeners.

## Maintenance Inspection Procedures

The company had developed a Service and Inspection Guide outlining the elements contained within their "A," "B," and "C" check inspections on the P4Y-2.

The "A" check (lowest detailed inspection) is accomplished every 50 hours after the preceding "A," "B," or "C" check periods. The "C" check (most detailed inspection) is performed prior to the completion of 400 flying hours or 36 months, whichever occurs first, after the preceding "C" check. The Service and Inspection Guide also states that the "C" check inspection meets the requirements of "A," "B," and "C" check inspections.

According to company records, during the period between June 10 and June 14, 2002, N7620C underwent several maintenance procedures to include the following:

June 10, 2002: "A" check associated with a number 1 engine change.

June 11, 2002: number 3 engine change.

June 11 - 14, 2002: "C" check inspection,

June 14, 2002, repairs to a crack in the lower fitting of the left wing forward spar, inboard of the spar splice, a crack in the lower fitting of the right wing forward spar, outboard of the spar splice, and a crack in the lower fitting of the right wing forward spar, inboard of the spar splice.

June 14, 2002, resolution to several "flight squawks" (maintenance discrepancies identified during flight operations) associated with engine fuel pressure adjustments, and oil leaks.

With respect to the wing inspections conducted during the "A" and "C" checks, the following information was provided in the Service and Inspection Guide:

"A" Service Guide, External Inspection, Item number 5, "Right Wing" (Item 12 Left Wing reads the same):

- 1.) Inspect right wing for cracks, deformation, damaged, loose or missing fasteners.
- 2.) Inspect lower side of wing inboard for evidence of fuel leaks,

"C" Service and Inspection Guide, Left Wing and Nacelles, Item 1, Left Wing (Right Wing items

reads the same):

1.) Perform detailed inspection of wing for cracks, corrosion, deformation, damage, loose, missing and defective fasteners.

Item 4, Wing Structure reads:

1.) Detailed inspection of wing to fuselage attach fittings and bolts.

Item 9, Wing Spar reads:

1.) Inspect in detail forward and aft spar at wheel well area for corrosion and cracks.

Item 10, Wing Spar reads:

1.) Inspect in detail aft spar at aft nacelle areas for cracks and corrosion.

A company mechanic, qualified to perform "C" check inspections, explained and demonstrated how the detailed inspections were performed. The mechanic pulled the appropriate inspection card for the item (in this case it was Item 1-1, Left Wing), read the card, and then said he would get a mirror, and a flashlight, and get up on a scaffold up close to the wing, and then visually inspect the wing from wing tip to the fuselage. He said that this could take one to two days to perform. The mechanic said if he found a crack during the inspection, he would fill out a discrepancy card and write up a description of the crack and its location on the wing. The mechanic said the crack would be "investigated further" possibly using a dye penetrate or eddy current so as to determine the extent of the crack. The mechanic said, "We will support the wing as required." The mechanic said that the director of maintenance would be notified and would coordinate with their engineering firm to determine how they would support the wing.

## Manuals

Repair manuals for the airplane are based on AN 01-5EN-3, Handbook of Instructions for Structural Repair, Navy Model PB4Y-2 Airplane, published by the U. S. Navy, July 1, 1945, with a revision published June 1, 1948. The manual describes four separate types of damage requiring a type of repair or a combination of two or more types of repair, these being negligible repair, damage repairable by patching, damage repairable by insertion, and damage necessitating replacement. With respect to wing spars and their repairs, the manual states the following:

c. DAMAGE REPAIRABLE BY PATCHING (SPARS, WEBBED BULKHEADS, LEADING EDGE AND PLATING) - Torn material should be cut out well beyond the ends of the cracks. Sharp corners should be rounded. A one-half inch radius (minimum) is desirable. Bent material should be restored to shape with a mallet and wooden backing block. One-eighth diameter holes should be drilled at extremities of all cracks to prevent their extension into the material. Sheet material of the same gage as the original should be used for patching. The patch should overlap the edge of the cut-out far enough to maintain correct rivet edge distance.

d. DAMAGE REPAIRABLE BY INSERTION (SPARS, BULKHEADS AND LEADING EDGE) - Cut out

the damage portion of angles and zee sections and file the ends of the cut-out square and smooth. Insert a piece of material the same size and gage as the original. Splice the insertion in place by the use of angles or plates, as applicable. Splices should cover the entire filler if it is less than eight inches in length. For fillers longer than eight inches, splice at the butted ends only.

e. DAMAGE NECESSITATING REPLACEMENT (SPARS, BULKHEADS, LEADING EDGE AND PLATING).

(1) Entire spars cannot be replaced in an assembled wing but component parts may be replaced. Replace the damaged part with one of the same size and gage. Use the existing attachment method when possible.

### Forest Service Contract and Operational Oversight

According to a Forest Service representative, the airplane is operated under contract to the U. S. Forest Service for the retardant delivery mission. The contract describes specifications required of the aircraft, personnel involved, and flight and ground support. The contract also described deliveries or performance and its administration. The Forest Service conducts a pre-use inspection of the aircraft, personnel, and facilities prior to executing the airtanker contract. The Forest Service does not maintain qualified inspectors dedicated to examine the company's maintenance procedures or practices, nor do they have personnel trained and dedicated to conduct oversight inspections of air tanker operators. The representative said that the contract requirements specifies how the company will perform.

According to the 2002 National Airtanker Service Contract, the contractor (company/operator) is required to "maintain an inspection system acceptable to the Government covering the services under this contract." The contract also cites that "the Government has the right to inspect and test all services called for by the contract," and those inspections or tests are performed "on the premises of the Contractor or a subcontractor, the Contractor shall furnish all reasonable facilities and assistance for the safe and convenient performance of these duties." Details of what the inspections or tests shall entail are not specified in the contract.

According to an FAA Principal Maintenance Inspector who oversees Hawkins and Power Aviation, Inc., certificates, the FAA is not looking at the airtanker operation since the airplanes are being operated exclusively by the U. S. Forest Service. The FAA does oversee the company's maintenance programs, as Hawkins and Powers is a 14 CFR Part 145 aircraft repair station. The inspector said that the company has inspection programs in place for all of its aircraft. It has the appropriate manuals and equipment to perform maintenance on the airplanes, and their mechanics are trained to perform maintenance on the airplanes, in accordance with Part 145.

### ADDITIONAL INFORMATION

Parties to the investigation were the FAA Flight Standards District Office, Denver, Colorado, the

U. S. Department of Agriculture - Forest Service, and Hawkins and Powers Aviation, Incorporated.

All of the airplane wreckage was released and returned to the Forest Service on October 31, 2002.

### Pilot Information

<b>Certificate:</b>	Commercial; Flight instructor	<b>Age:</b>	39, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Airplane single-engine	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 2 Valid Medical--no waivers/lim.	<b>Last FAA Medical Exam:</b>	January 18, 2002
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	January 31, 2002
<b>Flight Time:</b>	3658 hours (Total, all aircraft), 1328 hours (Total, this make and model), 3081 hours (Pilot In Command, all aircraft), 217 hours (Last 90 days, all aircraft), 93 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

### Co-pilot Information

<b>Certificate:</b>	Commercial	<b>Age:</b>	56, Male
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land; Multi-engine sea	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	None	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 2 Valid Medical--w/ waivers/lim	<b>Last FAA Medical Exam:</b>	January 22, 2002
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	January 23, 2002
<b>Flight Time:</b>	6689 hours (Total, all aircraft), 913 hours (Total, this make and model), 5707 hours (Pilot In Command, all aircraft), 210 hours (Last 90 days, all aircraft), 93 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	Consolidated-Vultee	<b>Registration:</b>	N7620C
<b>Model/Series:</b>	P4Y-2	<b>Aircraft Category:</b>	Airplane
<b>Year of Manufacture:</b>		<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Restricted (Special)	<b>Serial Number:</b>	66260
<b>Landing Gear Type:</b>	Retractable - Tricycle	<b>Seats:</b>	3
<b>Date/Type of Last Inspection:</b>	June 14, 2002 Continuous airworthiness	<b>Certified Max Gross Wt.:</b>	69990 lbs
<b>Time Since Last Inspection:</b>	87.29 Hrs	<b>Engines:</b>	4 Reciprocating
<b>Airframe Total Time:</b>	8346.3 Hrs at time of accident	<b>Engine Manufacturer:</b>	Wright
<b>ELT:</b>	Installed, not activated	<b>Engine Model/Series:</b>	R2600-35
<b>Registered Owner:</b>	Hawkins & Powers Aviation, Inc.	<b>Rated Power:</b>	1350 Horsepower
<b>Operator:</b>		<b>Operating Certificate(s) Held:</b>	
<b>Operator Does Business As:</b>	USDA Forest Service	<b>Operator Designator Code:</b>	

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	BJC,5670 ft msl	<b>Distance from Accident Site:</b>	27 Nautical Miles
<b>Observation Time:</b>	18:58 Local	<b>Direction from Accident Site:</b>	145°
<b>Lowest Cloud Condition:</b>	Few / 8000 ft AGL	<b>Visibility</b>	30 miles
<b>Lowest Ceiling:</b>	Broken / 12000 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	8 knots / None	<b>Turbulence Type Forecast/Actual:</b>	/
<b>Wind Direction:</b>	40°	<b>Turbulence Severity Forecast/Actual:</b>	/
<b>Altimeter Setting:</b>	30.04 inches Hg	<b>Temperature/Dew Point:</b>	34°C / 11°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	Broomfield, CO (BJC )	<b>Type of Flight Plan Filed:</b>	Company VFR
<b>Destination:</b>		<b>Type of Clearance:</b>	VFR
<b>Departure Time:</b>	18:14 Local	<b>Type of Airspace:</b>	Class G

## Wreckage and Impact Information

<b>Crew Injuries:</b>	2 Fatal	<b>Aircraft Damage:</b>	Destroyed
<b>Passenger Injuries:</b>		<b>Aircraft Fire:</b>	Both in-flight and on-ground
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	Both in-flight and on-ground
<b>Total Injuries:</b>	2 Fatal	<b>Latitude, Longitude:</b>	40.312778,-105.236946

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Bowling, David
<b>Additional Participating Persons:</b>	Jack Muldoon; Federal Aviation Administration; Denver, CO Brian Richardson; Federal Aviation Administration; Denver, CO James M Morrison; USDA Forest Service; Ogden, UT Richard M Willis; USDA Forest Service; Boise, ID Gene Powers; Hawkins & Powers Aviation, Inc.; Greybull, WY George Kelly; Hawkins & Powers Aviation, Inc.; Greybull, WY
<b>Original Publish Date:</b>	July 23, 2003
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB traveled to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=55256">https://data.nts.gov/Docket?ProjectID=55256</a>

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](#).