



Aviation Investigation Final Report

Location:	Cold Springs, Nevada	Accident Number:	LAX00GA297
Date & Time:	August 13, 2000, 16:45 Local	Registration:	N174EH
Aircraft:	Bell 412	Aircraft Damage:	Destroyed
Defining Event:		Injuries:	1 Fatal
Flight Conducted Under:	Public aircraft		

Analysis

While flying along a mountain ridgeline to make a water drop on a wild fire, the helicopter lost power in one engine and collided with terrain as the pilot turned downslope toward a landing area. Ground crews watching the helicopter make its drop run observed smoke emanating from the right engine, then the helicopter made a left descending turn and impacted the downsloping mountainous terrain. A trailing pilot saw the helicopter about 150 feet above the ridgeline, then it made a sudden left descending turn. He did not see the pilot jettison either the water or the bucket. A teardown inspection and metallurgical examination of the No. 1 and No. 2 power sections was conducted. The examination of the No. 1 power section CT disc revealed that the firtree serrations adjacent to the No.s 24 and 25 blade positions were fractured above the blade retaining rivet hole, and that the No.s 27-29 firtree serrations were fractured at the blade roots. During the metallurgical examination, the failure of the CT disc was attributed to cyclic stress rupture due to extended and repeated operation of the engine at, near, or above its temperature/power limits. Dimensional measurements of the blades showed growth and deformation to the disk in the areas of the fractures. There were no material, manufacture, or design deficiencies identified during the metallurgical examination of the CT disc. The examination of the No. 2 power section revealed that the intermediate drive shaft fractured in a counterclockwise direction due to sudden stoppage of the left engine while it was at a high power level. Due to the degree of destruction and lack of dispatch records, the investigation was not able to accurately determine the operating weight of the helicopter at the time of the accident; however, for the 9,500-foot density altitude, it is believed that the helicopter's weight with the water load was at a point that resulted in marginal single engine capability at best. The accident helicopter had been modified with the installation of a water bucket and long line system. The long line and water bucket circuit breakers, and the emergency electrical release, were connected to the nonessential bus. This system was installed on a Form 337 field approval. According to the helicopter manufacturer, the electrical system is designed so that if one generator and/or engine failed both of the nonessential buses would automatically drop offline. Thus the emergency electrical release of the water

bucket and long line would have been rendered inoperable in the event of a generator and/or engine failure. An override switch on the electrical panel can restore power to the nonessential buses; however, based on the event timeline reported by the witnesses, it is unlikely that the pilot could have restored power to the nonessential buses in time to prevent a collision with the ground.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: failure of the compressor turbine disc due to cyclic fatigue brought about by repeated operation near or above the engines' temperature/power limits by company personnel over an extended period of time. Factors in the accident were: 1) the high density altitude, mountainous terrain, and the helicopter's resulting marginal single engine performance capability; 2) the design, fabrication, and installation of the emergency external load release system, which had the power supply wired to the nonessential bus that would automatically drop offline during an engine or generator failure; and 3) the pilot's resulting inability to electrically release the water load, bucket, or line while dealing with the engine failure.

Findings

Occurrence #1: LOSS OF ENGINE POWER(PARTIAL) - MECH FAILURE/MALF
Phase of Operation: MANEUVERING - AERIAL APPLICATION

Findings

1. 1 ENGINE
2. (C) TURBINE ASSEMBLY, TURBINE BLADE - OVERTEMPERATURE
3. (C) THROTTLE/POWER CONTROL - IMPROPER USE OF - UNKNOWN
4. (C) TURBINE ASSEMBLY, TURBINE BLADE - FATIGUE
5. (F) AIRCRAFT PERFORMANCE, ENGINE OUT CAPABILITY - EXCEEDED
6. (F) EXTERNAL LOAD RELEASE SYSTEM - INOPERATIVE
7. (F) ACFT/EQUIP, INADEQUATE DESIGN - OTHER INSTITUTION
8. (F) REMEDIAL ACTION - NOT POSSIBLE - PILOT IN COMMAND

Occurrence #2: FORCED LANDING
Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: EMERGENCY DESCENT/LANDING

Findings

9. (F) WEATHER CONDITION - HIGH DENSITY ALTITUDE
10. (F) TERRAIN CONDITION - MOUNTAINOUS/HILLY

Factual Information

1.1 HISTORY OF FLIGHT

On August 13, 2000, at 1645 Pacific daylight time, a Bell 412 twin-engine helicopter, N174EH, collided with mountainous terrain while conducting a long line water drop along a ridgeline during a wildfire suppression operation near Cold Springs, Nevada. The wildfire was named the Twin Peaks fire. The helicopter was certified under 14 CFR Part 133 for external load operations and was being operated by the Bureau of Land Management (BLM) as a public-use firefighting aircraft. The helicopter, owned by Era Aviation, was destroyed. The airline transport pilot, the sole occupant, sustained fatal injuries. Visual meteorological conditions prevailed, and a company visual flight rules (VFR) flight plan had been filed. The helicopter departed the Twin Peaks helibase, located at Cold Springs, at 1605. The primary wreckage was at 39.34.83 north latitude and 117.48.56 west longitude.

The accident pilot flew several missions the day of the accident. On the accident flight the pilot flew to the dip site, 3 miles south of the accident location, and then flew to the accident area to make a water drop.

According to another pilot working the same dip site and fire, the accident helicopter was to make a water drop along the ridgeline to support the ground fire crews. The trailing pilot was going to make his water drop behind the accident helicopter. He was about 1 mile behind the accident helicopter, and observed the accident helicopter flying along the ridgeline. The accident helicopter made a sudden 90-degree left descending turn and impacted the downsloping mountainous terrain. There were no radio communications with the accident pilot immediately prior to the turn. The trailing pilot estimated the accident helicopter's altitude to be about 150 feet above the ridgeline, and that the accident helicopter was flying into the wind, which was 10 to 15 knots along the ridgeline.

The trailing pilot indicated that the helicopter was "very low until impact" about 2/3 of the way down the hill. He did not know if the accident pilot had gotten rid of the bucket. He indicated that he did not see the accident pilot jettison the water.

The fire crew from the Texas Initial Attack (IA) #1 were witnesses to the accident. A compilation of the witness statements indicated that they were about 1 ¼ miles away from the accident site. The witnesses stated that they observed the helicopter make a sudden left descending turn and impact the ground. They did not see the bucket release from the helicopter.

One witness stated that he saw the helicopter start a climb along the ridgeline and saw a "puff of gray smoke come from his engine exhaust." Another witness stated that he saw the

helicopter start up the ridgeline when he saw "white [and] blue smoke" coming from the right side of the engine.

The crew boss assigned to the Texas IA #1 indicated that he was standing with the crew boss trainee just south of the crew bus. He stated that the crew boss trainee had just finished communicating via radio with the accident pilot; however, it was unclear if the pilot responded. The crew boss stated that the helicopter's forward motion "halted," and he saw about three or four "puffs of white smoke" coming from the exhaust area. The helicopter began to "roll and yaw," dropping to the side of the slope that he was traveling beside.

Fueling records were not obtained at the accident site. However, in the operator's written statement (Pilot/Operator Aircraft Accident Report, NTSB Form 6120.1/2), they estimated that the pilot departed the helibase with 1,000 pounds of Jet A fuel on board.

1.1.1 Helicopter Activities Prior to the Accident

A couple of days before the accident, two ground crewmen from the Nevada Army National Guard watched for about an hour as the accident pilot filled up the Bambi bucket at a pond used as a helicopter dip site. On the east side of the pond there was a 5-foot berm. On the northwest corner was a small dry creek bed. According to the witnesses, the pilot would try and maneuver through the dry creek bed so that he didn't have to climb over the berm.

One witness indicated that on some of his flares to fill the bucket, the pilot had "flared so hard the rotor wash would catch the Bambi and flip it up towards the rotor blades and come right out in front." The witness indicated that there was an abrupt manner when the pilot was filling the bucket. He observed the nose pitch down "quite a bit" to where it was about 6 feet off the water and then the pilot would try and get the bucket out of the water. There were a couple of times that the pilot would get the bucket "flying about 6 or 8 inches off the water," and if "he was not pulling enough power" the bucket would "go slamming back into the water." He stated, "It was a pretty abrupt move again to try and stop the aircraft and the bucket from going into the berm." A couple of times he had to put the bucket back into the water because the helicopter couldn't make it over the berm.

The witness indicated that a couple of times, from his vantage point, it appeared that the bucket slid across the top of the berm. He further stated that at times during the pilot's maneuvers, he could see the tail boom "actually kind of almost wrinkle up," with some coning of the main rotor blades. At one point the pilot had to abort the dip because it appeared that he wasn't going to clear the berm. When the bucket went in "it pulled the back of the aircraft up. The back of the aircraft settled in and the second witness made a comment about how he [the pilot] had almost struck the tail rotor in the water." At that point both ground crew moved farther up the hill for safety concerns.

The second witness indicated that the accident helicopter seemed to be in more of a hurry to fill the bucket than the other aircraft in the area. He also noted that the pilot's approach to

"dipping" was very different from the other helicopter pilots. The pilot made a high speed pass, "kind of a high angle of bank turn then basically let the collective out of the [helicopter] and autorotate into the dip site and as the bucket hit the water he started to dragging it to fill it and then just pulled in all the power that he had." The accident pilot flew the bucket down the drainage area due to "bleeding rotor as he was going through translational lift." The second witness also observed, on a couple of passes, where the bucket swung out in front of the helicopter. The witness further indicated that the accident pilot appeared impatient, and that at one point tried to "sneak in front of the other helicopters."

1.5 PERSONNEL INFORMATION

The National Transportation Safety Board investigator-in-charge (IIC) reviewed the pilot's Federal Aviation Administration (FAA) certified Airman and Medical information, as well as flight training records from Era Aviation, and Era's daily flight duty logs for the Twin Peaks fire.

1.5.1 Federal Aviation Administration Records

Review of the pilot's medical information revealed that the most recent first-class medical certificate was issued on March 29, 2000. The medical contained limitations for vision, which indicated that the holder shall wear lenses that correct for distance vision and possess glasses that correct for near vision. On his medical application he reported having accumulated 14,200 hours of total pilot flight time, with 100 hours in the last 6 months.

Review of the pilot's airman certification records disclosed that the pilot held an airline transport pilot certificate, as well as a commercial pilot certificate, both with ratings for rotorcraft-helicopter, along with an instrument rating for the BV-234. The pilot was type rated for the BH-212, BH-206 (VFR only), and BV-234.

1.5.2 Operator Records

1.5.2.1 Operator's Pilot Training Records

The accident pilot's training records from Era Aviation indicated that he took a 14 CFR 135.293/.297, and 14 CFR 135.299 check ride for airman competency/proficiency on March 29, 2000.

His training records further indicated that he received an Office of Aircraft Services (OAS) Interagency Helicopter Pilot Qualifications and Approval (OAS Card) on April 6, 2000. His most recent sling load recurrency check was done at the time of the OAS check.

1.5.2.2 Operator's Daily Flight Logs

Review of the daily flight logs for July and August 2000 revealed that the accident pilot reported for duty on July 24 - 29th, and flew 36.8 hours. He was off duty July 30-31, and

returned to duty August 1, 2000. He flew from the 1st to the 8th and accrued 32.4 hours of flight time. He went off duty August 9-10, and reported back for duty on August 11th. A relief pilot flew the accident helicopter during the time when the accident pilot was off duty. Between August 11th and 12th the pilot accrued 12 hours of flight time. His total flight time for the month of August was 44.4 hours.

Not all of the daily flight logs were completely filled out. According to the operator, the responsibility to fill out the form was with the pilot. Two days prior to the accident, and the day before the accident, the pilot wrote in the ON/OFF block: 905.4, 906.4, 908.4, 910.0, 912.3, and 913.0. In the FLT. TIME block the pilot recorded the corresponding flight times as 1.0, 2.0, 1.7, 2.2, and 0.7. There was not a daily flight log for the day of the accident.

1.5.3 Bureau of Land Management (BLM) Duty Limitations

On August 6, 2000, a Phase 2 Duty Limitations (24.13.C.1 of the National Interagency Mobilization Guide) were issued for helicopter firefighting operations. The Phase 2 Duty Limitations was enacted due to the sustained high volume of fire suppression activities throughout the United States. The Phase 2 Duty Limitations are more restrictive than the standard Interagency Fire requirements for crew rest. The Duty Limitation required specific rest periods for pilots, with exemptions and provisions set aside for duty days. During each duty day cycle, flight crewmembers were required to have a minimum of 12 consecutive hours of uninterrupted rest (off duty). The standard day was no longer than 12 hours, except with a crew duty extension not to exceed a cumulative 14-hour duty day. (Document contained in the Docket file for this accident.)

According to the daily flight duty logs, the pilot met the requirements for the duty limitation rest periods.

1.6 AIRCRAFT INFORMATION

1.6.1 Airframe

The accident helicopter was a Bell 412, serial number 33085. A review of the helicopter's maintenance records revealed that it accumulated a total airframe time of 7,683.1 hours prior to the accident flight. The helicopter was inspected under the company's approved Continuous Airworthiness program. The last inspection was completed on August 8, 2000. The aircraft total time at the last inspection was 7,651.4 hours, with 31.7 hours flown since the last inspection.

According to Era's maintenance records, the last visual inspection of the temperature strips (heat sensor strips) was on August 10, 2000. The aircraft total time was 7,671.1 hours, with the next inspection of the temperature strips due at an aircraft total time of 7,696.1.

The helicopter was equipped with two emergency cargo release mechanisms. One was

electrical, and activated by depressing a button on the cyclic. The other was mechanical, and activated by depressing a foot pedal located in between the antitorque pedals for either the pilot or copilot positions.

On March 6, 1998, the helicopter had been modified in accordance with FAA Form 337, Major Repair and Alteration (Airframe, Powerplant, Propeller, or Appliance), with the installation of a water bucket and long line system. The installation called for the long line circuit breaker and the water bucket circuit breaker to be installed on a fabricated bracket located in the "cabin overhead at station 82." According to FAA Form 337, the installation required that the circuit breakers be connected to the nonessential bus.

According to the manufacturer's approved flight manual, section 2 (Systems Description), pg. 2-11 under electrical systems:

"In the event that one generator or engine should fail, both nonessential buses are automatically dropped, and all essential dc loads are supplied by the remaining generator. An override switch is available so that the pilot, at his discretion, can manually restore power to the nonessential buses."

Era's recurring maintenance records indicated that the cargo hook inspection is a daily requirement. The last check was on August 12, 2000, at an aircraft total time of 7,681.3. There were no entries for the accident date.

According to the manufacturer, the belly cargo hook release mechanism is powered by the emergency bus and would operate in any scenario where one or both generators failed, and one or both engines failed. The emergency bus is a continuous electrical system.

1.6.2 Power Plants

The helicopter utilized Pratt and Whitney's PT6T-3B twin-pack system. The system utilizes two PT6 engines (labeled #1 Power Section (left engine) and #2 Power Section (right engine)), and a combining gearbox.

1.6.2.1 Number 1 Power Section (left engine)

Review of aircraft records indicated that the engine had been installed on N415EH. UNC Airwork Corporation, in Miami, Florida, overhauled the No. 1 engine on July 30, 1996 (work order F07705), at a total time of 10,043.8 hours since new. They installed a new compressor turbine disc P/N 3024211, S/N 23B827, on the No. 1 Power Section during the 1996 overhaul.

On December 8, 1997, UNC sent the compressor turbine to Coltec Industries in Peabody, Massachusetts, for repair following an overtemp condition.

December 11, 1997

Coltec rejected the CT disc, and shipped it back to UNC Airwork Corporation.

According to UNC Airwork Corporation paperwork, their engineering department examined the CT disc and the following work was completed:

January 7-9, 1998

UNC Airwork Corporation paperwork indicated that the repair to the CT disc was to "Polish rivet head area per PI 002-384-01" followed by nondestructive testing, and a final inspection.

January 22, 1998

UNC Airwork Corporation rejected the CT disc with no remarks listed in the "Reason for Replacement and Remarks" section.

February 3, 1998

FAA form 337 MAJOR REPAIR AND ALTERATION, the power section (work order F09113) was "inspected and repaired for over-temperature in accordance with the manufacturer's specifications and requirements."

FAA form 337 also indicated that "Airwork authorized repairs in accordance with SFAR 36: A01-510-01." Once the repairs were completed the part was installed on the No. 1 power section and returned to service.

The No. 1 power section was installed on the accident helicopter on March 19, 1998, at an engine total time of 10,807.2 hours. The No. 1 power section, serial number 62224, had a total time of 12,784.7 hours, with 2,740.9 hours since overhaul (aircraft total time 7,683.1 hours).

1.6.2.2 Number 2 Power Section (right engine)

The No. 2 power section was serial number 62059. The No. 2 power section had a total time of 11,060.9 hours, with 2,560.0 since overhaul. The No. 2 power section was installed on the accident helicopter on January 14, 2000, at an engine total time of 10,534.0 hours. Pratt and Whitney Canada Service Centre, Quebec, Canada, overhauled the No. 2 power section on August 21, 1996, with an engine total time of 8,500.0 hours (work order No. 13819).

1.6.2.3 Combining gearbox

The combining gearbox, serial number 1936, had a total time of 1,977.5 hours.

1.6.3 Bambi Bucket

The helicopter was outfitted with an SEI Industries International Bambi Bucket model 3542. It held 420 (U.S.) gallons of water; the empty weight was 167 pounds, and the gross weight was 3,667 pounds. On-scene inspection of the bambi bucket revealed that a knot in the Frusto-Conical Arrest System (FCAS) cinch strap was adjacent to the 80-percent setting, as well as an

additional ring inside the 80-percent setting. At the 80-percent setting the bucket was capable of holding 336 U.S. gallons (2,789 pounds). According to the FCAS manual, the cinch strap allows the pilot to reduce the volume of the bucket to a preset position. The cinch strap can be found on the inside or outside of the bucket. The lowest setting for the model 3542 Bambi Bucket is 70 percent, 294 gallons (2,440 pounds). Over tightening the cinch strap can damage the bucket and inaccurate load calculations.

According to the SEI Industries International operation manual, the suggested bucket size for the Bell 412 SP is model 3542. Model 3542 capacity and weight specifications are: capacity 420 gals (U.S.); gross weight 3,667 pounds; empty weight 167 pounds. There was a note that stated the suggested bucket sizes are "guidelines only. The helicopter operator must make the decision as to which model Bambi Bucket is appropriate."

A warning in the manufacturer's operation manual stated that when filling the bucket, an abrupt 90-degree pedal turn with the helicopter close to the water should not be executed. It is a variable fill capability. A slow lift will provide minimum fill, while a fast lift provides a maximum fill. The manufacturer suggests that when flying with the Bambi Bucket empty the pilot should build up airspeed slowly to determine a safe maximum speed.

1.6.4 Weight and Balance Information

The most current weight and balance information obtained from Era Aviation was dated July 23, 2000. The maximum allowable gross weight of the accident helicopter was 11,900 pounds.

According to the manufacturer's approved flight manual, Section 1 (Limitations), page 1-5, titled Weight - Altitude - Temperature Limitations for takeoff, landing and in-ground-effect maneuvers, with an altitude of 6,280 feet mean sea level (msl), and an outside air temperature of 79 degrees Fahrenheit (26 degrees Celsius), the helicopter would have been limited to no more than 10,200 pounds gross weight.

Investigators could not determine the amount of water that was contained in the Bambi Bucket, or how much fuel was on board prior to the accident. Due to those two considerations a weight and balance computation for the accident flight could not be accurately conducted.

1.6.4.1 OAS LOAD CALCULATIONS

In accordance with the Interagency Helicopter Operations Guide, Chapter 7, the pilot is responsible to complete a U.S. Department of the Interior Helicopter Load Calculation form OAS-67 (02/81) for each wildfire mission. On the day of the accident the accident pilot indicated that the pressure altitude was 5,500 feet, with a temperature of +30 Celsius.

The section entitled "Responsibility for completion of Load Calculations" subsection A. indicated that it is the pilot's responsibility to complete the load calculation form correctly

using the proper performance charts. The pilot also is responsible for computing allowable payload, and checking any "subsequent passenger/cargo manifested weights completed under the initial load calculation to ensure allowable payloads are not exceeded."

Subsection B entitled "Government Representative" indicated that the helicopter manager is responsible for "checking the load calculation to ensure accuracy and completeness."

Subsection C entitled "Mutual Responsibility" indicated that after the form was completed both the pilot and the government representative "shall sign the form."

Subsection B "Specific Requirements" of "Determining Load Capability Using Appropriate HIGE and/or HOGE Aircraft Performance Charts" indicated that a new load calculation might be completed for each flight or flight leg to determine performance. One calculation was valid between points of similar elevation, temperature, and fuel load provided that the load for each leg had been manifested.

Requirements for new calculations were required when there was a change of:

Temperature +/- 5-degrees Celsius

Altitude +/- 1,000 feet change

OR

Any increase in payload carried, "including more than five gallons of fuel load."

1.6.5 Aircraft Performance

1.6.5.1 Single engine performance capability

Reported weather was 79 degrees Fahrenheit, winds from the north-northwest at 10-15 knots. Accident site elevation was 6,280 msl.

According to the manufacturer's approved supplement, Section 4, pages 4-46 titled "Single Engine Rate of Climb gross weight 8,000 lb," with the given conditions the pilot could have expected about a 500-foot-per-minute CLIMB rate.

According to the manufacturer's approved supplement, Section 4, pages 4-47 titled "Single Engine Rate of Climb gross weight 9,000 lb," with the given conditions the pilot could have expected about a 310-foot-per-minute CLIMB rate.

According to the manufacturer's approved supplement, Section 4, pages 4-49 titled "Single Engine Rate of Climb gross weight 11,000 lb," with the given conditions the pilot could have expected about a 90-foot-per-minute DESCENT rate.

According to the manufacturer's approved supplement, Section 4, pages 4-50 titled "Single Engine Rate of Climb gross weight 11,900 lb," with the given conditions the pilot could have expected about a 260-foot-per-minute DESCENT rate.

1.7 METEOROLOGICAL INFORMATION

Another pilot flying in the area at the time of the accident reported the weather as 79 degrees Fahrenheit (26 degrees Celsius), with winds from the north-northwest at 10-15 knots. The accident site elevation was 6,280 feet msl. Safety Board software computed a density altitude of 9,571 feet for the accident location.

1.11 RECORDERS

1.11.1 Cockpit Voice Recorder (CVR)

The IIC shipped the CVR to the Safety Board Vehicle Recorder Laboratory in Washington, D.C. Examination of the CVR revealed that the extracted information had been overwritten and did not contain pertinent data to the investigation. The Safety Board specialist indicated that the CVR was capable of functioning and recording as evidenced by the extracted information. According to Era and the helicopter manufacturer, the absence of a recording indicated that the CVR had been deactivated.

1.11.2 Avionics

The helicopter was equipped with a Trimble 2101 Plus Global Positioning System (GPS) unit: serial number 7480156, part number 81439-00-240B. The IIC sent the GPS unit to the manufacturer, in Austin, Texas, to download information. The processor circuit card provided information utilizing a READNAV program. In addition to the latitude and longitude information, it also provided track, distance to way point, cross track error, cross track angle error, desired track, and active leg. The READNAV also provided the minimum safe altitude (MSA) and minimum en-route safe altitude (MESA), which were both 12,500 feet.

The GPS circuit card utilized a program called PKTMON. It provided a Pos_fix time, week, position. The Pos_fix time was Sunday 23:42:01.656 Week number 51. The Position was 39 degrees 34.930 N, 117 degrees 28.660 W 1876.00. This translated to a date of Sunday August 13, 2000 (week 51 on the GPS calendar). Time was 16.42.02 Pacific daylight time, the date and approximate time of the accident. The GPS latitude and longitude were N39 degrees 34.930, W117 degrees 28.660, at an altitude of 6,154.85 feet.

1.12 WRECKAGE AND IMPACT INFORMATION

1.12.1 On-Scene

The accident site was on the side of a mountain, 6,280 feet mean sea level (msl) on a 60-degree slope facing south towards the helibase. The first identified point of contact (FIPC), about 300-feet upslope of the main wreckage, which consisted of water erosion furrows that emanated from a circular impression centered on an unburnt scrub bush. The helicopter came to rest at an elevation of 6,000 feet. Pinion trees and scrub brush sparsely covered the

mountainside, with loose dirt and rocks typical of high desert terrain.

The pilot was in the right front seat. Both the pilot and his seat were ejected from the helicopter. The seat was equipped with a shoulder harness and lap belt restraint system. First responders noted that he remained strapped into the seat.

A path of ground scars and wreckage debris was distributed over a 673-foot distance on a median magnetic bearing of 155 degrees. The hook for the bambi bucket was 90 feet from FIPC. The release mechanism and the bambi bucket were 2 feet beyond the hook, entangled in a pinion tree. The bambi bucket was on a line measuring 25 feet in length.

Visual inspection of the Bambi Bucket revealed that the bucket was cinched (set to) 80 percent, with a knot tied on the inside of the 80-percent cinch mark.

The main fuselage came to rest left nose down and partially inverted about 300-feet downslope from the FIPC. The skid toes were found in the dirt about 25 feet from the pinion tree where the bambi bucket was found. The cross tubes were attached to the main fuselage. Separated skid tube components were scattered along the wreckage path at various locations.

Six inches of one tail rotor blade separated from the tail rotor, and was about 50 feet to the right side of the FIPC (when viewed along the debris field downhill). The aft portion of the tail boom structure was about 10 feet from the main wreckage. The forward portion of the tail boom structure was approximately 65 feet downhill from the main wreckage.

All four main rotor blades were attached to the hub. The outboard 6 inches of one main rotor blade was about 20 feet from the main wreckage along in the debris field.

Due to the position of the wreckage the main transmission could not be rotated. The 42-degree and 90-degree gearboxes were manually rotated with no binding noted. The gearbox over-temperature indicator dots were examined with no evidence of an over-temperature condition.

Visual examination of the No. 1 power section (left) showed that multiple blades separated from the power turbine wheel. The blade separations were jagged in appearance, and of irregular length compared to one another. Indentations were inside the exhaust stack.

Due to the position of the No. 2 power section (right), investigators were not able to conduct a visual examination.

A visual examination of the Master Caution/Warning panel lights revealed no filament stretch on any of the caution/warning lights.

1.12.2 Wreckage Layout

The IIC and party members conducted a wreckage layout at the end of August 2000, at the Era Facility at the Reno-Stead Airport, Reno, Nevada.

Flight control continuity was established. The airframe representative indicated that separations of the flight controls were consistent with damage incurred during the accident sequence; jagged, deformed separations. The flight control's respective fasteners and security devices were in place and intact. He noted no discrepancies with the hydraulic system. The main transmission was manually rotated with no binding noted.

The 42-degree and 90-degree gearbox chip detectors were removed and no debris was noted. He laid out the main rotor blades. According to the manufacturer, damage was consistent with a low rotor rpm impact. He noted no discrepancies with the airframe.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

The Washoe County Coroner conducted an autopsy on the pilot on August 14, 2000. A toxicological analysis was performed by the FAA Civil Aeromedical Institute, Oklahoma City, Oklahoma, from samples obtained during the autopsy. The results of the analysis were negative for carbon monoxide, cyanide, ethanol, and drugs.

According to his most current medical, March 29, 2000, the pilot's weight was 230 pounds. The pilot's recorded weight during his autopsy was 287 pounds.

1.16 TEST AND RESEARCH

The twin-pack system (both engines and combining gearbox) was shipped to the Pratt and Whitney Canada Service Investigation Facilities, St. Hubert, Quebec, Canada. A powerplant inspection was conducted under the auspices of the Safety Board, on February 6 through February 9, 2001.

1.16.1 General examination

Technicians observed minimum impact damage during the external examination of the twin-pack system. Engine controls and accessories were intact and in place. They removed the engine controls and accessories for further functional testing.

The external housing for the combining gearbox was intact and the output shaft rotated freely with the No. 1 power section (left). However, the No. 2 power section (right) was decoupled. The sprag clutches operated normally.

The external housing of the No. 1 power section displayed dimpling and pockmarks adjacent to the exhaust port. The gas generator case was intact, with wrinkling around the housing circumference. The accessory gearbox was intact.

The external housing of the No. 2 power section displayed axial deformation adjacent to the right side of the exhaust port. It also had dimpling and pockmarks adjacent to the exhaust port. The compressor inlet case was deformed. The gas generator case and the accessory gearbox were intact.

The pneumatic lines, compressor discharge air (P3), and power turbine controls for both the No. 1 and No. 2 power sections were continuous and intact. The chip detectors and filters for both power sections were clean with the exception of the combining gearbox oil filter, the combining gearbox chip detector, and the No. 2 power section chip detector, which were bridged by ferrous debris.

1.16.2 No. 1 Power Section

1.16.2.1 Compressor Section

The first, second, and third stage discs and blades showed circumferential rubbing, with material smearing. Some of the first stage blade tips and leading edges were deformed and fractured opposite the direction of rotation. The centrifugal impeller showed circumferential rubbing. According to the manufacturer, the circumferential rubbing and material smearing of the first, second, and third stage discs, as well as the centrifugal impeller, was due to contact with their respective shrouds.

1.16.2.2 Turbine Section

1.16.2.2.1 Compressor

The compressor turbine guide vane ring trailing edge airfoils displayed nicks, gouges, and cracks. The vane ring inner drum was axially cracked. The outer drum downstream lip fractured. The technicians felt that damage to the vane ring was due to separated compressor turbine blade debris.

The compressor turbine blades were numbered from 1-58 in a clockwise direction in relation to the disc master spline. Sections 24-26 were not recovered. The disc firtree serrations adjacent to the No. 24 and No. 25 positions fractured above the blade retaining rivet hole. The blade airfoils at Nos. 27 through 29 fractured at the blade roots. The remaining blades showed fractures from the tip to trailing edges, as well as minor burning.

One blade tip was found in the gas generator case. Blade Number's 52 through 18 of the disc upstream side blade platforms were circumferentially rubbed and scored, which the technicians said are characteristics of axial contact with the compressor turbine guide vane ring inner drum. The disc downstream side blade platforms displayed the same damage, but at the blades numbered 27 through 53.

Pratt and Whitney conducted a metallurgical examination of the compressor turbine, and the

Safety Board Materials Laboratory reviewed the report. The report indicated that the compressor turbine disc failure was a result of cyclic stress rupture. Three of the turbine blades were liberated as a result of the firtree failures. Cracking and necking of a dozen firtree sections upstream of the Nos. 24 and 25 firtree sections was noted on the upstream face. They took dimensional measurements. They noted growth and deformation in the area of the fractures. According to a metallurgist for Pratt and Whitney, the compressor turbine blades fractured by tensile overload promoted by overheating. According to the senior metallurgist for the Transport Safety Board of Canada, the compressor turbine disc failed due to stress rupture brought about by "sustained operation near or above acceptable limits." He further indicated that there were no material or design deficiencies identified with the component.

1.16.2.2.2 Turbine

The metallurgist reported that the power turbine housing was deformed, cracked, and torn radially along the seam line aft of the power turbine containment ring. The power turbine guide vane ring airfoils were nicked, and gouged from contact with separated compressor turbine blades. The inner drum upstream side was circumferentially deformed after axial contact with the compressor turbine disc. The power turbine shroud displayed gouging and scoring due to separated power turbine blade debris contact. The power turbine blade airfoils were fractured, with the leading edges nicked and gouged from contact with upstream debris. A macroscopic examination of the fractures showed features characteristic of overload. The power turbine shaft was manually rotated with no binding present.

1.16.2.3 Accessory Gearbox

The accessory gearbox was manually rotated via the input shaft. Continuous operation of the accessory drives was observed.

1.16.3 No. 2 Power Section

1.16.3.1 Compressor Section

There were no discrepancies noted with the compressor section.

1.16.3.2 Turbine Section

1.16.3.2.1 Turbine

The metallurgist noted that the turbine section was coated in oil, soot, and ash. There was circumferential scoring on the compressor turbine shroud. He observed circumferential scoring and heat discoloration on the compressor turbine blade airfoils, characteristic of axial contact with the power turbine guide vane ring and interstage baffle.

The power turbine guide vane ring and interstage baffle showed vane airfoil trailing edges were

nicked and gouged due to contact with separated power turbine blades. The power turbine blade airfoils were fractured at varying heights. A macroscopic inspection revealed overload characteristics of the fractured surfaces.

The power turbine shaft housing was displaced aft. The power turbine shaft was loose, but was manually rotated. The oil scavenge tube housing retaining bolts were loose. With the exception of the lower retaining bolt, which was inside the combining gearbox, all of the retaining bolts remained with the component.

1.16.4 Combining Gearbox

1.16.4.1 No. 1 Input Section Reduction Gear Train

The metallurgist noted no discrepancies with the left-hand input section reduction gear train.

1.16.4.2 No. 2 Input Section Reduction Gear Train

The first stage gear input shaft splines were smeared and showed evidence of fretting. The upper three retaining bolts for the No. 5 bearing cover were inside the combining gearbox. One of the bolt shanks sheared at the bolt head and was deformed, which corresponded to deformation on one of the clutch gear teeth, and on one of the second stage idler gear teeth. The No. 5 bearing rotated freely without binding.

The clutch gear assembly inner race exhibited circumferential rubbing, material smearing, and brinelling that corresponded to damage to the sprag clutch element. The sprag clutch element was heat discolored and exhibited material smearing.

According to the manufacturer, the intermediate drive shaft fractured in counterclockwise torsion at the oil vent hole. They noted no discrepancies with the third stage helical gear or the torque meter assembly. A functional test of the torque control unit revealed that the torque equalizer was not venting No. 2 power section Pg control pneumatic pressure. They located unidentified debris in the pneumatic orifice. The component was cleaned and successfully completed a functional test with no further discrepancies noted.

According to a metallurgist from Pratt and Whitney, the damage to the clutch drive shaft and the sprag clutch assembly was due to a sudden seizure. The transverse fracture of the coupling shaft that engages inside the clutch shaft was due to torsional overload and was a secondary event. There were no metallurgical abnormalities observed with the sprag clutch assembly.

According to the senior metallurgist for Transport Safety Board of Canada, the clutch drive shaft bearing surface exhibited discoloration and adhesive wear from contact with mating surfaces, which he attributed to a sudden load spike, rather than a gradual wear building up to the seizure. The coupling shaft sheared off in torsion due to a peak load "well above the

calculated design loads." He observed no metallurgical abnormalities with the clutch drive shaft or the coupling shaft.

1.16.5 Master Caution Warning Lights

The IIC found the master caution breaker, on the overhead circuit breaker panel, in the open (protruding, popped) position. Immediately adjacent to the master caution breaker is the cargo hook release breaker. The stem of the cargo hook release breaker was retracted. Also, the circuit breakers on the above row were damaged, with the stems in the retracted position.

According to the manufacturer, if there were repeated Nr droops, which activates the low rotor audio, and lights, and if the master caution breaker was pulled, the pilot would not necessarily have the benefit of the remainder of the caution/warning system to alert him of a potential problem. That situation could delay the pilot's timely recognition of, and corrective action of an engine failure.

1.18 ADDITIONAL INFORMATION

1.18.1 Release of Aircraft Wreckage and Personal Effects

The Safety Board released the helicopter, along with the pilots' personal effects, to U.S. Aviation of San Francisco, California, on March 5, 2001. The helicopter logbooks were released to Era Aviation on August 31, 2000.

1.18.2 Department of Interior (DOI) Aircraft Rental Agreement

The accident helicopter was operated as a Call When Needed (CWN) contract. General requirements for the DOI aircraft rental agreement say in part, under C.4 (2) that aircraft used under this agreement will be operated and maintained under the provisions of 14 CFR Part 121 or Part 135.

1.18.2.1 United States Department of Agriculture (USDA) Forest Service Operations and Safety Procedures Guide for Helicopter Pilots

The USDA Forest Service Operations and Safety Procedures Guide stated that a Power Trend Check be conducted every 10 hours and the results would be recorded and made available for the helicopter manager. According to OAS form OAS-87, Helicopter Power Check Turbine Engine, the accident pilot completed a helicopter power check on August 13, 2000.

Pilot Information

Certificate:	Airline transport	Age:	52, Male
Airplane Rating(s):	None	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	Helicopter	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	Yes
Medical Certification:	Class 1 Valid Medical-w/ waivers/lim	Last FAA Medical Exam:	March 29, 2000
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	March 30, 2000
Flight Time:	15406 hours (Total, all aircraft), 4306 hours (Total, this make and model), 14806 hours (Pilot In Command, all aircraft), 150 hours (Last 90 days, all aircraft), 111 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	Registration:	N174EH
Model/Series:	412 412	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Transport	Serial Number:	33085
Landing Gear Type:	Skid	Seats:	15
Date/Type of Last Inspection:	August 7, 2000 Continuous airworthiness	Certified Max Gross Wt.:	11900 lbs
Time Since Last Inspection:	32 Hrs	Engines:	2 Turbo shaft
Airframe Total Time:	7683 Hrs as of last inspection	Engine Manufacturer:	Pratt & Whitney Canada
ELT:	Installed, not activated	Engine Model/Series:	PT6T-3B
Registered Owner:	ERA AVIATION	Rated Power:	1025 Horsepower
Operator:	US Department of Interior	Operating Certificate(s) Held:	On-demand air taxi (135)
Operator Does Business As:		Operator Designator Code:	ERAA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	NFL,4412 ft msl	Distance from Accident Site:	60 Nautical Miles
Observation Time:	16:56 Local	Direction from Accident Site:	270°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	12 knots / None	Turbulence Type Forecast/Actual:	/
Wind Direction:	290°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30 inches Hg	Temperature/Dew Point:	33°C / -3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Cold Springs, NV	Type of Flight Plan Filed:	Company VFR
Destination:		Type of Clearance:	None
Departure Time:	16:05 Local	Type of Airspace:	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:		Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Fatal	Latitude, Longitude:	39.566665,-117.815551

Administrative Information

Investigator In Charge (IIC):	Cornejo, Tealeye
Additional Participating Persons:	Ken R Kelley; Federal Aviation Administration; Reno, NV Steve Rauch; Office of Aircraft Services/Dept. of the Interior; Boise, ID Cliff Mitchell; Era Aviation; Lake Charles, LA Joseph Syslo; Bell Helicopter; Fort Worth, TX Thomas Berthe; Pratt & Whitney Canada Aircraft Services Inc.; South Burlington, VT
Original Publish Date:	June 8, 2005
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=49975

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](#).