



Aviation Investigation Final Report

Location:	Keller, Washington	Accident Number:	SEA03GA153
Date & Time:	July 25, 2003, 17:03 Local	Registration:	N314KA
Aircraft:	Kaman K-1200	Aircraft Damage:	Destroyed
Defining Event:		Injuries:	1 Fatal
Flight Conducted Under:	Public aircraft		

Analysis

The pilot was returning to pick up a load of water while engaged in firefighting operations. The helicopter was in cruise flight when the pilot radioed "I've got a problem" and "I'm going down." Witnesses observed rotor blades departing from the helicopter. On site examination revealed that all four main rotor blades had departed from their respective rotor hub/blade grip units coming to rest in a circumferential band within several hundred feet of the helicopter's ground impact point. Both main rotor hubs also departed the airframe and were located a short distance north and east of the ground impact site. Post crash examination revealed the presence of extensive corrosion fatigue cracking in the upper half of the blade grip plate associated with blade (s/n) 27B. The crack passed through the 7th blade retention bolt hole from the inboard section of the grip leaving the blade attached at the upper blade grip plate by one bolt inboard of the crack and 5 bolts outboard of the crack. The crack displayed corrosion fatigue striations through most of its surface. The number 7 blade retention bolt bushing was also found to have corrosion fatigue cracking in line with the grip crack. With a crack through the inboard section of the upper blade grip plate occurring, the rigidity of the associated blade (27B) would have been significantly weakened in the vertical axis and dynamic imbalance would have developed leading to successive separation of all four blades.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Corrosion fatigue within the blade retention bolt bushing(s) of the main rotor blade grip resulting in fatigue, cracking and ultimate separation of the upper grip plate. The separation of the upper blade grip plate led to a dynamic imbalance within the rotor system and the subsequent loss of all four rotor blades in flight.

Findings

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

Phase of Operation: CRUISE

Findings

1. (C) MISCELLANEOUS,BOLT/NUT/FASTENER/CLAMP/SPRING - FATIGUE
2. (C) ROTOR SYSTEM,MAIN ROTOR HUB GRIP(SLEEVE) - FATIGUE
3. (C) ROTOR SYSTEM,MAIN ROTOR HUB GRIP(SLEEVE) - CRACKED
4. (C) ROTOR SYSTEM,MAIN ROTOR - DYNAMIC IMBALANCE
5. (C) ROTOR SYSTEM,MAIN ROTOR BLADE - SEPARATION

Occurrence #2: LOSS OF CONTROL - IN FLIGHT

Phase of Operation: CRUISE

Findings

6. AIRCRAFT CONTROL - NOT POSSIBLE

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER

Phase of Operation: DESCENT - UNCONTROLLED

Findings

7. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On July 25, 2003, approximately 1703 Pacific daylight time, a Kaman K-1200 helicopter, N314KA, registered to Superior Leasing LLC, operated by the Department of Interior, and being flown by a commercial pilot, was destroyed following a loss of control in cruise and subsequent in flight collision with terrain within 1,000 feet of the Brush Creek fire line near Keller, Washington. The pilot sustained fatal injuries and a post crash fire consumed much of the helicopter. Visual meteorological conditions prevailed and an operational flight plan was in effect at the time. The flight, which was engaged in fire-fighting operations at the McGinnis Flats forest fire, was being conducted as a public use operation by the Bureau of Indian Affairs, Department of Interior.

The helicopter had departed the Mt. Tolman fueling site approximately one hour previous to the accident and was engaged in the fourth fire-fighting mission of the day. The fuel truck driver, whose vehicle was equipped with an FM radio, reported the pilot radioed him about an hour into the fourth flight and spoke with the mechanic briefly. Several minutes after this transmission the fuel truck driver heard a radio transmission on FM of "...I've got a problem..." followed several seconds later by "...I'm going down..." (refer to Attachment S-I, Support Personnel).

Several witnesses located in the vicinity of the accident site observed the helicopter immediately prior to the crash and reported seeing several rotor blades departing the helicopter. One witness reported hearing something "weird" which attracted his attention to the helicopter. He noted that it was "wobbling" and that the pilot was following his route of flight a bit more slowly than expected. He also reported hearing the rotors spinning "louder and louder" as the helicopter descended (refer to Attachment S-I, witnesses).

PERSONNEL INFORMATION

According to records maintained by the Federal Aviation Administration (FAA) the pilot held a commercial pilot certificate with a helicopter rating. Additionally, he held private privileges in airplane single-engine land and airplane instrument ratings. He held type ratings in both the Boeing-Vertol BV-107 and Sikorsky SK-61 helicopters. He also held a flight instructor's certificate for helicopters with an expiration of 04/30/1991. His most recent FAA medical examination was conducted on 08/13/2002, at which time he was issued a second class medical with no restrictions.

According to the Operator the pilot had accrued a total of 12,200 hours of flight experience of

which 400 hours were fixed wing (single engine) and the remaining 11,800 hours were in helicopters. The pilot also had 11,292 hours of pilot-in-command time and 5,100 hours of that total was logged in the K-1200 helicopter. The pilot was reported to have logged 72.9, 21.1 and 5.7 hours in the previous 90, 30 and 1-day periods prior to the accident, and the helicopter manager reported that the pilot had "plenty of rest" and breaks during his flying periods.

AIRCRAFT INFORMATION

The K-1200 "K-Max" helicopter was manufactured by Kaman Aerospace in 1996, and was issued serial number A94-0015. The helicopter was equipped with a single Honeywell (formerly Lycoming) 1,500-shaft horsepower model T5317A-1 turboshaft engine, serial number LE81015. The helicopter's maximum external gross weight load was 12,000 pounds. The engine was connected to a transmission assembly that split the engine output equally between the two side-by-side, intermeshing, counter-rotating rotors. Each rotor consisted of two wood/composite rotor blades each equipped with a servo flap for rotor blade control. The helicopter was equipped with a single vertical stabilizer and controllable rudder panel as well as a variable pitch horizontal stabilizer (refer to Attachment PWD-I). At the time of the accident the helicopter was utilizing a 350-gallon "bambi" bucket on a 100-foot long line for water dispersal during the fire-fighting operations (refer to Attachment S-I, Helicopter Manager).

According to the Operator, the helicopter was being maintained in accordance with the Manufacturer's progressive inspection program and the most recent (Zone 2) inspection was part of a continuous airworthiness inspection conducted on July 24, 2003 (refer to Attachment PI-I). The total airframe time at the conclusion of that inspection was 4577.5 hours and the helicopter was reported to have logged an additional 5.7 hours between that inspection and the accident. The log entry for the Zone 2 inspection showed that a Zone 3 inspection was due at 4602.3 hours.

According to the K-1200 Maintenance Manual an examination and inspection of the left and right rotor hub assemblies including both left and right (upper & lower) blade grips was delineated in the Zone 1 inspection procedures (refer to Attachment PI-II). The last Zone 1 inspection was accomplished at 4552.3 hours on 07/10/03, and the helicopter was reported to have been found in an airworthy condition (refer to Attachment MI-I).

The individual rotor blades were manufactured and installed in sets of two blades with their associated blade grips completing a set. The rotor blades installed on N314KA at the left pylon station were serialized as 27A and 27B. These two blades were manufactured in April of 1994, and first installed at zero time on 09/11/94, helicopter K-1200 serial number A94-0006. Over the next eight years the blade set was successively installed on ships 0008, 0015, 0017, 0016, 0010, 0016, 0021, 0010 and finally, on 03/02/02, back to 0015. The blade set logged a total of 1555.5 hours when returned to N314KA on 03/02/02 (refer to Attachment ASC-I). The total time on both blades (27A/B) and their associated grips at the time of the accident was

2493.8 hours. According to Kaman the blade grips remain with their respective rotor blades until such time as the grips pass through an overhaul procedure. The blade grips associated with blade serial numbers 27A/27B had not reached the mandatory overhaul time and as such were the original grips installed with the original blades.

According to Kaman the mandatory overhaul time on the blade grips was set at an artificially low number of hours due to the newness of the helicopter. As operational experience was gained the time between overhaul (TBO) was increased. Accordingly, the initial TBO was 1200 hours until 11/27/1996, at which time it increased to 1800 hours. The TBO was again increased to 2750 hours on 04/06/2001, and to 3750 hours on 01/27/2003.

METEOROLOGICAL INFORMATION

The aviation surface weather observation taken at Spokane International airport (Geiger Field) located 56 nautical miles east at 1656 on the afternoon of the accident reported the following conditions:

Few clouds at 15,000 feet, broken clouds at 20,000, visibility 10 statute miles, temperature/dew point 31/04 degrees Celsius respectively, winds from 170 magnetic at 8 knots (variable 120 to 190), and altimeter 29.88 inches of mercury.

A number of Bureau of Land Management weather reporting points were located around the accident site. The reports nearest the time of the accident were all consistent (refer to Chart I).

WRECKAGE AND IMPACT INFORMATION

The helicopter crashed in moderately wooded terrain approximately three and one-half nautical miles west northwest of Keller, Washington, and approximately one-half nautical mile southeast of the water dip site being utilized for fire fighting. The accident site (fuselage ground impact) coordinates were determined using a hand held GPS unit and were found to be 48 degrees 07.350 minutes north latitude and 118 degrees 44.933 minutes west longitude. The elevation of the accident site was approximately 3,135 feet MSL (refer to CHART II). The crash site was one-half nautical mile north-northwest and 900 feet upslope of the Brush Creek fire line at the McGinnis Flats forest fire. The terrain slope at the ground impact site was measured to be approximately +10 degrees toward the northeast. A post-crash fire, which was knocked down, consumed a substantial portion of the forward airframe at the fuselage ground impact site.

The main fuselage, exclusive of all four rotor blades and their associated control flaps, both rotor pylons and the bambi bucket, was observed in an inverted attitude (refer to graphic images 1 through 5). The fire damage was minimal to non-existent starting at the trailing edge

of the rudder panel and progressing through the vertical stabilizer and along the fuselage until reaching the horizontal stabilizers where the fire damage rapidly transitioned to destructive levels. The post-crash fire consumed all the main cockpit area, engine compartment, landing gear and forward empennage. The engine was observed lying on the ground and its magnesium compressor casing had ignited and burned away. The right horizontal stabilizer and its associated vertical stabilizer were separated from the empennage and lying within the ground fire pattern area a short distance southwest of the ground impact site. The left horizontal stabilizer and its associated vertical stabilizer remained attached to the empennage. Damage to horizontal limbs of conifer trees at the impact site was confined to the immediate area of the fuselage and the damage was oriented along a primarily near vertical axis.

On site examination revealed that all four rotor blades had separated near their respective hub assemblies, and all four blades, as well as their associated flap control surfaces, were located circumferentially within a band 340 to 540 feet wide around the fuselage ground impact site (refer to graphic images 6 through 10). The bambi bucket was located bearing approximately 150 degrees magnetic and 500 feet short of the ground impact site of the fuselage (refer to graphic image 11). The blades displayed little to no leading edge damage and all four blade flaps, although broken apart, were found in the general area of the accident site. Both main rotor hubs were found north and northeast of the fuselage ground impact site (refer to graphic images 12 and 13), and all eight wood blade fracture surfaces were identified and recovered (refer to Diagram I).

The wreckage was recovered from the site on July 31, 2003, and moved to a storage and reconstruction facility in Bend, Oregon, where a more detailed examination was conducted. The rotor blades, including their associated flap control surfaces, were reconstructed and both main rotor pylons and their supporting structure were examined.

All four rotor blades had separated just outboard of their associated blade grips. Blades 52A and 27B displayed characteristics of downward bending at their respective separation areas (stations 44-54 and 47-55). Blade 52B also displayed tearing separations consistent with leading edge compression and trailing edge tension at its separation area (stations 27-30). Blade 27A also displayed tearing separations consistent with leading edge tension and trailing edge compression at its separation area (stations 27-30). Additionally, three of the four blades displayed separations well outboard (in the vicinity of their respective control flaps). Blades 52B and 27B displayed characteristics of downward bending at their respective separation areas (stations 243 and 223). Blade 52A displayed characteristics of a combination of both downward bending and leading edge tension/trailing edge compression at its separation area (station 237). Refer to Attachment K-I and Diagram II for further details.

All four rotor blade grips were examined and the following significant observations were noted. The bottom of the grip for blade 27A displayed severe bending deformation and strike evidence. The blade grip for blade 52A displayed paint scrapes and possible strike damage. The leading edge of the grip for blade 52B displayed severe bending deformation. The blade grip for blade 27B displayed a chordwise fracture on its upper surface completely crossing the

grip from leading to trailing edge and passing through the most inboard forward bolt hole (station 19.9). The bolt and its associated bushing remained captured within the outboard section of the separated upper blade grip. The lower grip displayed fractures at both the leading and trailing edges. These fractures were not complete and the section of retained blade inboard of the blade separation previously described remained attached to the grip (refer to Attachment K-I).

All eight inboard blade separation surfaces and both rotor head assemblies (two sets of blade grips each) as well as some pylon support structure were shipped to Kaman Aerospace, Bloomfield, Connecticut, for further visual and metallurgical examination. The engine was shipped to Honeywell, Phoenix, Arizona for disassembly and examination.

MEDICAL AND PATHOLOGICAL INFORMATION

Post-mortem examination of the pilot was conducted by Deputy Medical Examiner (Spokane County) Marco A. Ross, M.D., at the facilities of the Forensic Institute, Holy Family Hospital, Spokane, Washington, on July 28, 2003, (case number 03-75-FA).

The FAA's Toxicology Accident and Research Laboratory, Oklahoma City, Oklahoma conducted toxicological evaluations of samples from the pilot. Testing for Carbon Monoxide and Cyanide were not performed. Tests results for ethanol and drugs were both negative (refer to attached Toxicology report).

TESTS AND RESEARCH

Fuel samples from the fuel truck which serviced the helicopter on the day of the accident were evaluated by the Department of the Air Force, Headquarters 92nd Air Refueling Wing at Fairchild Air Force Base, Spokane, Washington. All fuel test results were found to be within Air Force standards (refer to Attachment FT-1).

Several heavily fire damaged cockpit instruments were shipped to the manufacturer (Howell Instruments). Examination of the instruments determined that the non-volatile memories were too badly damaged by fire to extract any useable information.

The T5317A-1 turboshaft engine, serial number LE81015 was shipped to the facilities of Honeywell where a disassembly and examination was conducted on September 3-4, 2003. The disassembly and inspection revealed no evidence of any pre-impact engine malfunction (refer to Attachment H-I).

A number of pieces of wreckage were identified and selected for further examination, including metallurgical examination, by the investigative team. These components were shipped to the facilities of Kaman Aerospace Corporation, Bloomfield, Connecticut, for further examination

under the oversight of FAA personnel local to the manufacturer. The majority of components examined revealed separation surfaces indicative of shear, tension or static overload. Several components, however, displayed fatigue signatures as described below.

The left blade grip assembly (part number K-911045, serial number B3-3599) associated with blade serial number 27B was observed to have a through and through fracture along the upper surface of the grip passing from the leading edge, through retaining bolt hole number 7 and continuing through to the trailing edge. Outboard of this fracture the remainder of the upper blade grip plate remained attached by means of the blade retaining bolts in holes 1, 2, 3, 5 and 6. Inboard of this fracture only one blade retaining bolt remained attached at hole 4. The blade grip, when viewed looking into the chordline of the blade is a "U" shaped fitting. The butt end of the rotor blade is seated between the upper and lower grip plates. The blade is retained by bolts 1 through 7 which are inserted through the 7 bolt holes in the upper plate, through the blade butt and finally through the 7 bolt holes in the lower plate. The retaining nuts are screwed on to the bolts at the underside of the bottom grip plate. Each bolt hole in both the upper and lower blade grip plate has a fitted bushing through which the respective bolt passes.

Scanning electron microscopy (SEM) revealed fatigue striations with a count of striations yielding approximately 111,000 cycles. The origins of the fatigue crack were observed within bolt hole number seven and the fatigue fracture extending through the majority of the upper grip plate. Additional testing determined that the blade grip was manufactured with the proper hardness, displayed the proper microstructure for quenched and tempered 4340 steel, and was composed of 4340 steel, and no significant material defects were noted (refer to Attachment K-II).

Examination of the bushing for the upper blade grip plate bolt hole number 7, which remained attached to the bolt, revealed a crack at both the leading and trailing edges of the bushing geographically consistent with the fatigue crack origin within the inside of the grip bolt hole. SEM examination of the cracks revealed multiple fatigue origins on the chamfer and inside diameter of the bushing with fatigue originating at corrosion pits and propagating by corrosion fatigue. Hardness and microstructure of the bushing material was found to be within acceptable requirements.

Examination of the remaining bushing from all four blade grips revealed the following. Three additional bushings in blade grip 27B (upper), one additional bushing in blade grip 27A (upper), one additional bushing in blade grip 52B (upper), were all noted to have cracks and corrosion fretting (refer to Attachment K-II).

ADDITIONAL INFORMATION

On-site examination of the wreckage was conducted on July 26/27, 2003, after which the wreckage was conditionally released to Mr. James Stiger, PAC Northwest, for the purpose of recovery to a secure site. Further examination of the wreckage was conducted at the facilities

of Specialty Aircraft Co., Redmond, Oregon, on August 14/15, 2003, and the wreckage, exclusive of the items listed on NTSB Form 6120.15 was released to the insurance representative, Mr. Stiger. Written wreckage release covering all items retained was accomplished on June 28, 2004, and is documented on NTSB form 6120.15 (enclosed).

Pilot Information

Certificate:	Commercial; Flight instructor; Private	Age:	44, Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Front
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	Helicopter	Toxicology Performed:	Yes
Medical Certification:	Class 2 Valid Medical--no waivers/lim.	Last FAA Medical Exam:	August 13, 2002
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	August 25, 2002
Flight Time:	12200 hours (Total, all aircraft), 5100 hours (Total, this make and model), 11292 hours (Pilot In Command, all aircraft), 73 hours (Last 90 days, all aircraft), 21 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Kaman	Registration:	N314KA
Model/Series:	K-1200	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	A940015
Landing Gear Type:	Tricycle	Seats:	1
Date/Type of Last Inspection:	July 24, 2003 AAIP	Certified Max Gross Wt.:	12000 lbs
Time Since Last Inspection:	5.9 Hrs	Engines:	1 Turbo shaft
Airframe Total Time:	4583.4 Hrs at time of accident	Engine Manufacturer:	Honeywell (Lycoming)
ELT:	Installed	Engine Model/Series:	T5317A-1
Registered Owner:	Superior Leasing LLC.	Rated Power:	1500 Horsepower
Operator:	US Department of Interior (Bureau Indian Affairs)	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	GEG, 2372 ft msl	Distance from Accident Site:	56 Nautical Miles
Observation Time:	16:56 Local	Direction from Accident Site:	110°
Lowest Cloud Condition:	Few / 15000 ft AGL	Visibility	10 miles
Lowest Ceiling:	Broken / 20000 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	8 knots / None	Turbulence Type Forecast/Actual:	/
Wind Direction:	170°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.87 inches Hg	Temperature/Dew Point:	31°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Keller, WA	Type of Flight Plan Filed:	Company VFR
Destination:		Type of Clearance:	None
Departure Time:	15:50 Local	Type of Airspace:	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:		Aircraft Fire:	On-ground
Ground Injuries:	N/A	Aircraft Explosion:	On-ground
Total Injuries:	1 Fatal	Latitude, Longitude:	48.121944,-118.748886

Administrative Information

Investigator In Charge (IIC):	McCreary, Steven
Additional Participating Persons:	Donnie D Ware; FAA Spokane FSDO; Spokane, WA Robert Galloway; US Department of Interior; Boise, ID Tim Graham; Kaman Aerospace Corporation; Bloomfield, CT Mike Cummins; Honeywell; Phoenix, AZ
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Note:	
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