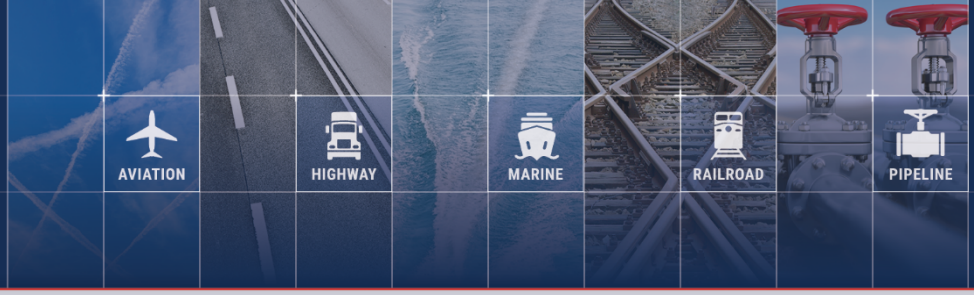

Aviation Investigation Factual Report

Location:	Kahului, Hawaii	**Incident Number:**	LAX07IA115
Date & Time:	March 28, 2007, 11:45 Local	**Registration:**	N4010K
Aircraft:	Eurocopter AS 350 BA	**Aircraft Damage:**	Minor
Defining Event:		**Injuries:**	7 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Sightseeing		

Factual Information

On March 28, 2007, at 1145 Hawaiian standard time, a Eurocopter AS 350 BA single engine helicopter, N4010K, experienced a loss of tail rotor control in cruise flight and sustained minor damage during a hard landing at Kahului Airport, Kahului, Hawaii. The helicopter was operated by Mauiscapes Helicopters, Inc., under the call sign HOWZIT3, as a tour flight under the provisions of 14 CFR Part 135. The commercial pilot and six passengers were not injured. Visual meteorological conditions prevailed for the local area tour flight, and a company visual flight rules (VFR) flight plan had been filed. The helicopter departed Kahului Airport at 1140.

The pilot reported the helicopter was in cruise flight at 2,800 feet mean sea level (msl) heading southwest toward the front entrance of the Iao Valley. Approximately 100 knots airspeed, the pilot felt a "sharp yaw of the nose to the left. The aircraft then yawed back straight." The pilot pressed each rotor pedal and "found they were not functioning." The pilot turned back to Kahului Airport and declared an emergency with the Maui air traffic control tower. The pilot attempted a run-on landing at Kahului Airport. During the landing, the helicopter "wanted to turn left as the airspeed slowed." Subsequently, the helicopter twice spun to the left and came to rest upright partially on the runway and adjacent grass.

A Federal Aviation Administration airworthiness inspector from the Honolulu Flight Standards District Office responded to the site. He reported that the tail rotor gearbox upper arm of the support yoke had fractured. The tail rotor gearbox assembly was removed and shipped to the National Transportation Safety Board Material Laboratory for further metallurgical examination.

Maintenance History

The tail rotor gearbox was a 15,000-hour total time component with overhauls every 3,000 hours plus 10 percent, and an inspection every 500 hours. The tail rotor gearbox log card indicated the gearbox was new in 1988, and had been overhauled in 1997, after 3,038.2 hours of operation, in 2000, after 3,287.9 hours of operation, and in 2005, after 3,293.8 hours of operation. The helicopter status sheet indicated that the gearbox had operated for 3,188.1 hours since last overhaul.

A review of the documentation received from the overhaul facility revealed that the gearbox had been received for the 2005 overhaul without a pitch control arm and a new one had been installed. A list of replaced parts was part of the documentation received and indicated that a new expansible pin had been purchased for that gearbox. No bushings were listed on the parts list.

A review of the master servicing recommendations revealed that the tail rotor gearbox was to

be inspected every 500 hours or 2 years in accordance with the maintenance manual (MET). The MET work card describes and requires the following during the inspection: installation of expansible pin be checked; installation and removal of the tail rotor transmission system; removal and installation of tail rotor hub; removal and installation of the pitch change spider; description of the installation of the various modification states of the expansible pins, which includes assembly of the expansible pin, torque loading and resealing.

A review of the maintenance records revealed the helicopter was scheduled for a 500-hour inspection at 15,605.7 hours; however, the 100/200/500-hour inspection was completed on February 22, 2007, at a total time of 15,657.3 hours. The helicopter underwent a 100-hour inspection on March 15, 2007, at a total time of 15,745.8 hours. The helicopter had accumulated approximately 15,795.2 hours at the time of the incident.

Tail Rotor System Description

The input flange is connected to, and driven by, the tail rotor drive shaft. The flange drives the gears inside the gearbox, which drive the shaft and the attached yoke. The tail rotor assembly is bolted to the yoke, and the tail rotor blades are connected to the clevis at the outer end of the rotating cylinder by pitch change links. The pitch change links drive the rotating cylinder, which contains self-lubricating bushings and is free to slide on the shaft. The tail rotor controls operated the input rod, which is located below the tail rotor drive shaft and connects to the forward end of the pitch control bellcrank. The aft end of the pitch control bellcrank is connected to a stationary cylinder. The pitch control bellcrank rotates about its fulcrum where it attaches to the support yoke upper and lower arms. When operated by the input rod pitch control bellcrank imparts linear motion to the stationary cylinder, which imparts linear motion to the rotating cylinder. Linear motion of the rotating cylinder changes the pitch of the tail rotor blades via the pitch change links, providing left and right yaw control of the aircraft.

Gear Box Examination

The Safety Board Material Laboratory examination revealed that the upper arm of the support yoke was fractured and the lower arm was intact. The pitch control bellcrank was manipulated to reveal that movement was evident below the sealant that covered hardware on the underside of the lower arm. The sealant on the underside was removed to reveal hardware consistent with the installation of the expansion pin assembly illustrated as "mod 07-8525" in MET work card 65.20.00.401.

The radii between the support yoke arms and the reinforcing rib located between them had been smoothed, blended, and the surface resealed. This work was performed in 1991 in accordance with Service Bulletin 01.33.

Support Yoke Lower Arm Examination

Measurements of the expansion pin hole revealed that the diameters were larger than the

specified diameter of the hole. Examination of the surface in the hole revealed a dimpled surface consistent with fretting. Prior to removing the lower arm bushing for examination, the torque applied to the locking nut was determined. The torque required to loosen the nut was measured at 29.5 inch/pounds, and the torque required to tighten the nut to realign the scratched lines was measured at 27 inch/pounds. The MET work card specifies that the self locking nut is to be torque loaded to 88.5 to 141.6 inch/pounds.

Examination of the lower arm bushing revealed a non-uniform smear pattern on the surface normally in contact with the bellcrank bushing. The lower arm bushing also revealed fretting on the outer surface, which is normally press fit in the lower arm.

Examination of the expansion pin components revealed a dark lubricant smeared on the taper washers and the expansible rings. Mechanical manipulation revealed the taper washers and expansible rings could be compressed and returned to their original condition when the compressive force was removed. A functional test was performed on the expansive pin by reassembling it and measuring the diameter of the expansible rings at different torque loadings. The test revealed the expansion pin functioned correctly.

Support Yoke Upper Arm Examination

Examination of the upper arm bushing also revealed a non-uniform smear pattern on the surface normally in contact with the bellcrank bush. The bush was not located centrally in the forward end of the upper arm as indicated by the width of the surrounding material, but the minimum width of material did satisfy the minimum width specified in the manufacturer's wear criteria work card.

The upper arm bushing was pressed out of the upper arm for examination. The inner surface normally in contact with the expansible ring was found to be in a pristine condition. Document review revealed that the manufacturer drawing required that the bushings be insulated with Mastinox (used to prevent corrosion) prior to installation in the gearbox. Fourier Transform Infra-Red (FTIR) analysis spectra revealed that the deposits found on the lower and upper arm bushes were similar material, but dissimilar to Mastinox.

Examination of the fracture face revealed that it was relatively flat and mostly perpendicular to the inner surface, the exception being a concave area located almost in the center of the fracture face and adjacent to the inner surface. The surface on the forward portion of the fracture face was rougher than the surface on the rear portion and displayed a chevron pattern. The chevron pattern indicated that the fracture initiated in the rear portion of the fracture face. The rear portion of the fracture face displayed an undulating reflective surface, devoid of any fracture features, consistent with it being repeatedly impacted by the mating fracture face.

Higher magnification examination of the fracture face indicated fissures in the surface that were orientated parallel to each other. Each fissure was representative of an individual

location of high stress, consistent with a fatigue process. The orientation of the fissures and the other markings on the fracture face were consistent with the fatigue crack portion of the fracture initiating in the radius between the upper arm and the thicker portion where the bushing was installed.

Pitch Control Examination

A portion of the input rod was still attached to the pitch control bellcrank and displayed severe damage. The input rod portion revealed that it consisted of a tube with a shorter second tube inserted inside the end. Approximately 50 percent of the round portion of the input rod was missing and the remaining material had laterally orientated score lines on the exposed thickness of the outer and inner tubes.

The pitch control bellcrank bushes are normally in contact with upper and lower arm bushes. Examination of the bellcrank bushes revealed a non-uniform smear pattern similar to that observed on the lower and upper arm bushes.

Pilot Information

Certificate:	Commercial; Flight instructor; Private	**Age:**	50,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	April 1, 2006
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	12844 hours (Total, all aircraft), 5741 hours (Total, this make and model), 214 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N4010K
Model/Series:	AS 350 BA	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2841
Landing Gear Type:	Skid	**Seats:**	7
Date/Type of Last Inspection:	March 1, 2007 Continuous airworthiness	**Certified Max Gross Wt.:**	4630 lbs
Time Since Last Inspection:	49 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	15794 Hrs at time of accident	**Engine Manufacturer:**	Turbomeca
ELT:	Installed, not activated	**Engine Model/Series:**	Arriel 1B
Registered Owner:	Mauiscapes Helicopters, Inc.	**Rated Power:**	640 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	OGG,54 ft msl	**Distance from Accident Site:**	
Observation Time:	11:54 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Scattered / 5000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	350°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	28°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Kahalui, HI (OGG)	**Type of Flight Plan Filed:**	Company VFR
Destination:	(OGG)	**Type of Clearance:**	None
Departure Time:	10:45 Local	**Type of Airspace:**	

Airport Information

Airport:	KAHULUI OGG	**Runway Surface Type:**	Asphalt
Airport Elevation:	54 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	2	**IFR Approach:**	None
Runway Length/Width:	6995 ft / 150 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Minor
Passenger Injuries:	6 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	7 None	**Latitude, Longitude:**	

Administrative Information

Investigator In Charge (IIC):	Cornejo, Tealeye
Additional Participating Persons:	Herman L Rios; Federal Aviation Administration; Honolulu, HI Lindsay Cunningham; American Eurocopter; Grand Prairie, TX
Report Date:	June 4, 2008
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=65503