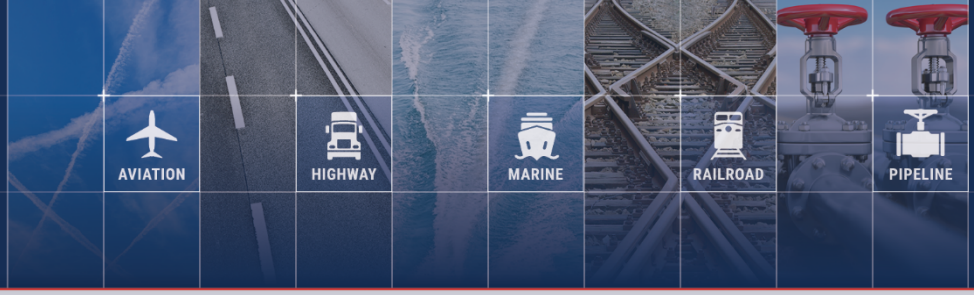

Aviation Investigation Final Report

Location:	Lihue, Hawaii	**Accident Number:**	LAX01LA083
Date & Time:	February 1, 2001, 09:18 Local	**Registration:**	N985SA
Aircraft:	Eurocopter AS-350-B2	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Minor
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Sightseeing		

Analysis

The commercial pilot was performing a hydraulic accumulator test during the before takeoff check when the helicopter inadvertently lifted off. The hydraulic pressure had been bled off during the test, and the pilot could not regain control of the helicopter prior to it impacting the ground tail rotor first. The collective was locked down during the accumulator test; however, it became unlocked when the pilot was repositioning his hands to restore hydraulic power after the accumulator test. FAA inspectors indicated that the collective lock design allowed for the release of the collective when the cyclic was moved during the test with the hydraulic pressure depleted.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The manufacturer's inadequate collective lock design, which resulted in the collective unlocking during a preflight check and subsequent unintentional liftoff and loss of helicopter control. The pilot's loss of control was due in part to the unavailability of the hydraulic system.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: STANDING - ENGINE(S) OPERATING

Findings
1. CHECKLIST - PERFORMED - PILOT IN COMMAND
2. (C) ROTORCRAFT FLIGHT CONTROL,COLLECTIVE CONTROL - UNLOCKED
3. HYDRAULIC SYSTEM - NOT AVAILABLE
4. (C) ACFT/EQUIP,INADEQUATE DESIGN - MANUFACTURER

Occurrence #2: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: OTHER

Findings
5. LIFT-OFF - INADVERTENT
6. AIRCRAFT CONTROL - NOT POSSIBLE - PILOT IN COMMAND

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
7. TERRAIN CONDITION - GROUND

Factual Information

On February 1, 2001, at 0918 Hawaiian standard time, a Eurocopter AS-350-B2 single engine helicopter, N985SA, impacted terrain and rolled over after an unintentional liftoff during a before takeoff check at Lihue, Hawaii. The helicopter sustained substantial damage; however, the pilot, who was the sole occupant, received only minor injuries. The helicopter was registered to and operated by Safari Helicopters Inc., of Lihue, as an on-demand, sightseeing, air-taxi flight under 14 CFR Part 135. The pilot was performing a before takeoff run-up on the Lihue Airport helipad, in preparation for flight's boarding and departure, when the accident occurred. Visual meteorological conditions prevailed at the time of the accident and a company visual flight rules flight plan was filed.

According to the pilot, he was in the process of conducting the hydraulic accumulator test during the before takeoff checklist when the accident occurred. According to the Eurocopter training manual, the helicopter can be maneuvered without hydraulic assists, "but this requires the pilot to apply non-negligible forces that are difficult to gauge." The training manual also states, "in case of loss of hydraulic pressure, accumulators in the main rotor servo actuators provide a small energy reserve, giving the pilot time to reconfigure in the safety configuration.

The helicopter's before takeoff checklist calls for a hydraulic accumulator test to be accomplished with the fuel flow control in the "flight" power setting. The test dictates that the collective pitch be locked down prior to testing the accumulators. The pilot is then instructed to cut off hydraulic pressure by actuating the hydraulic test push-button (located on the center consol). The hydraulic warning light will illuminate and the hydraulic warning horn will sound. The pilot is then instructed to "move the cyclic 2 or 3 times along both axes separately on 10 percent of total travel, check for hydraulic assistance by absence of control load." Once this is accomplished, the pilot is to press the hydraulic test pushbutton (on the center console) to restore hydraulic pressure.

At the time of the accident, the pilot was seated in the left cockpit seat. From the left seat, the collective is positioned to the left of the seat, the cyclic is centered in front of the seat between the pilot's legs, and the hydraulic test pushbutton is to the right of the seat on the center console. During the hydraulic accumulator test, while positioned in the left seat, the pilot has to remove his left hand from the collective control and place it on the cyclic control, then he has to remove his right hand from the cyclic and depress the hydraulic test pushbutton. The pilot then repositions his hands to their normal position (left hand on collective and right hand on cyclic). Once the test is complete, the pilot has to remove his left hand again from the collective and place it on the cyclic and remove his right hand from the cyclic and depress the pushbutton to restore hydraulic pressure.

According to the pilot, it was when he repositioned his hands to restore hydraulic pressure

when the helicopter became airborne in a nose low attitude. The pilot quickly repositioned his left hand to the collective and his right hand to the cyclic. He attempted to pull aft on the cyclic, turn the aircraft into wind, and takeoff in order to gain a controllable airspeed. The aircraft immediately pulled back to the right and entered a back and forth oscillation. The aircraft "entered a figure '8' type of oscillation with a nose high then nose low position in extreme almost wing over attitudes." The helicopter descended like a "falling leaf" and struck the ground tail rotor first on the right side. The pilot heard a series of grinding sounds and observed the main rotor blades disintegrate upon ground impact. The helicopter came to rest on the right side, and the pilot shutdown the engine and exited the helicopter.

There are two types of collective locks utilized in the AS-350-BA and B2 helicopters. One lock (located on right seat collective) incorporated a steel plate, which slides over a stud mounted on the forward side of the collective head. The other lock (located on the bottom side of the left seat collective) utilizes a clip that is attached to and hangs below the collective arm, curving up at the end forming a c-shaped clip. The c-shaped clip wraps around a pin, which is mounted on the cockpit floor oriented along the longitudinal axis of the helicopter. The left seat collective lock utilizes a locking plate, which the pilot depresses while he pushes the collective lever down. When the locking plate is depressed, the clip is aligned with the locking pin and the clip automatically engages around the pin when the collective is lowered. When the locking plate is not depressed, the clip is offset from the pin preventing it from unintentionally engaging in flight.

The employment of either lock depends on an upward spring load incorporated in the collective control handle. In either case, the spring loading must be physically overcome in order to apply the locks, as well as to ensure that the control handle remains in the full down or flat pitch position. When physical pressure on the collective is released, the spring loading helps keep both locks in the locked position, while preventing the upward movement of the control handle.

Federal Aviation Administration (FAA) inspectors from the Honolulu Flight Standards District Office responded to the accident site, and, as part of the investigation, performed the hydraulic system check in a company helicopter identical to the accident helicopter. The inspector noted that once the hydraulic system check is performed and the pressure is bled from the accumulators, the airframe experiences transient 1:1 vibratory loads. This loading excites the collective control, and it reacts by bouncing up and down against the lock. The lock sometimes reacts by releasing the collective. The positive spring loading causes the collective, upon release, to suddenly pop up, putting some degree of pitch in the main rotor blades. This scenario was played out by the FAA inspectors and it was noted that feedback from the cyclic motion with hydraulic pressure off, coupled with the collective lock design, would result in the collective lock releasing the collective. In the accident sequence, the pilot's hands were transitioning and were not in position to offset the instantaneous and unexpected positive collective load.

According to the Pilot/Operator Aircraft Accident Report (NTSB Form 6120.1/2), the pilot had

accumulated a total of 14,438 flight hours, of which 7,632 hours were in the same make and model as the accident helicopter.

Pilot Information

Certificate:	Commercial	**Age:**	56,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	May 22, 2000
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 30, 2000
Flight Time:	14438 hours (Total, all aircraft), 7632 hours (Total, this make and model), 11747 hours (Pilot In Command, all aircraft), 21 hours (Last 90 days, all aircraft), 15 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N985SA
Model/Series:	AS-350-B2	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3111
Landing Gear Type:	Skid	**Seats:**	7
Date/Type of Last Inspection:	January 3, 2001 100 hour	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	3093.1 Hrs as of last inspection	**Engine Manufacturer:**	Turbomeca
ELT:	Installed, not activated	**Engine Model/Series:**	1D1
Registered Owner:	SAF, LTC	**Rated Power:**	475 Horsepower
Operator:	Safari Helicopter, Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Safari Helicopter Tours	**Operator Designator Code:**	XSFA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	LIH,153 ft msl	**Distance from Accident Site:**	
Observation Time:	08:53 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	3 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	250°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.12 inches Hg	**Temperature/Dew Point:**	24°C / 18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	HI (LIH)	**Type of Flight Plan Filed:**	Company VFR
Destination:		**Type of Clearance:**	None
Departure Time:	09:18 Local	**Type of Airspace:**	Class D

Airport Information

Airport:	Lihue LIH	**Runway Surface Type:**	Asphalt
Airport Elevation:		**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	1 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Minor	**Latitude, Longitude:**	21.966667,-159.333328

Administrative Information

Investigator In Charge (IIC):	Crispin, Robert
Additional Participating Persons:	Jeff T Weller; Federal Aviation Administration; Honolulu, HI Andrew Colvin; Federal Aviation Administration; Honolulu, HI
Original Publish Date:	April 15, 2003
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=51429