Aviation Investigation Final Report

Location:	Tahoma, California	**Accident Number:**	WPR14FA324
Date & Time:	August 1, 2014, 13:00 Local	**Registration:**	N3597T
Aircraft:	S.N.I.A.S. AS350B	**Aircraft Damage:**	Substantial
Defining Event:	Settling with power/vortex ring state	**Injuries:**	2 Serious, 2 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The helicopter was being used to transport passengers and equipment for an off-road automobile event in a remote mountainous area. The airline transport pilot picked up two passengers, and the subsequent 3-minute-long inbound flight and landing into the wind at the helispot were uneventful. The pilot reported that, after a third passenger boarded, he initiated a vertical climb to clear trees. He reported that he expected and felt a "bump" as the helicopter encountered a headwind above the trees, and he then began to initiate a left turn for a downwind departure. As the turn progressed, the helicopter rapidly descended back to the ground, and, unable to maintain altitude, the pilot attempted to ditch the helicopter into trees and down-sloping terrain. The helicopter struck a rock slab and rolled onto its side, during which time both the pilot and a passenger sustained serious injuries. Postaccident examination did not reveal any anomalies with the airframe or engine that would have precluded normal operation, and both the pilot and operator reported that there were no mechanical malfunctions or failures.

The pilot attributed the loss of lift to a wind gust; however, the closest weather reporting station, about 14 miles away, reported light wind. Further, a weather simulation was performed to estimate wind and turbulence conditions in the area of the accident. The results revealed a low potential for turbulence with wind, which closely matched the conditions reported by the weather station, at the time and location of the accident.

The fuel load could not be definitely established; however, given the helicopter's estimated gross weight, it was likely operating very close to or slightly above its hovering ceiling. Therefore, it is likely that the pilot attempted to hover the helicopter out of ground effect at an altitude above its hovering ceiling, which resulted in it settling with power.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot's loss of helicopter control due to settling with power while maneuvering for takeoff.

Findings

Personnel issues	Aircraft control - Pilot
Environmental issues	High density altitude - Effect on equipment
Aircraft	Climb capability - Capability exceeded

Factual Information

History of Flight

Takeoff	Settling with power/vortex ring state (Defining event)
Takeoff	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On August 1, 2014, about 1300 Pacific daylight time (PDT), an SNIAS (Airbus Helicopters) AS350B, N3597T, collided with terrain on the shoreline of Buck Island Lake, near Tahoma, California. The helicopter was registered to, and operated by, Heli-Flite Inc. (dba Aris Helicopters), under the provisions of 14 Code of Federal Regulations Part 135. The airline transport pilot and one passenger sustained serious injuries; the remaining two passengers were not injured. The helicopter sustained substantial damage during the accident sequence. The local flight departed from a helispot at Loon Lake, California, about 1255, with a planned destination of Buck Island Lake. Visual meteorological conditions prevailed, and a company flight plan had been filed.

The helicopter was being utilized for transportation of both supplies and passengers (event organizers) for the Jeep and Jeepers Jamboree off-road events. The events took place along the Rubicon Trail during two adjoining weekends. The helicopter, pilot, and a fuel truck were provided by Heli-Flite, and were all utilized at the discretion of the event organizers. The accident helicopter had been flown by the pilot for the event the prior weekend. During that period, multiple uneventful missions were completed transporting crew, as well as equipment and supplies under external load utilizing the helicopter's long-line.

On the morning of the accident, the pilot departed from the helicopter's temporary base in Placerville, California, and performed multiple crew repositioning flights to the Buck Island Lake area, as well as transporting external loads from Loon Lake to Rubicon Springs. Prior to the accident flight, he departed from Loon Lake with two passengers onboard, having just serviced the helicopter with fuel. The pilot's intention was to pick up a third occupant at Buck Island Lake, about 3 miles to the east. The inbound flight lasted about 3 minutes and was uneventful. The passenger being picked up observed the helicopter approach the landing spot over the lake from the south. The helicopter landed, and he boarded. Once secure he gave the pilot the signal to depart, and the helicopter lifted into a hover about 20-30 feet off the ground. The passengers all recounted similar observations, stating that having attained a hover, the helicopter began a 180-degree turn to the south, and then proceeded to move forward. Rather than climb, the helicopter descended while still maintaining forward movement, crashing into trees and rocks south of the takeoff point.

The pilot reported that after boarding the passenger, he raised the helicopter to the tops of the trees which bordered the area to the north and northwest. He anticipated a headwind "bump" as he climbed over the trees while on a north heading. The bump occurred, and he began a slow left turn into the wind with the intention of assessing whether to perform a direct headwind departure, or perform a left downwind departure back over the lake and towards the direction he had arrived. He stated that he had accomplished this maneuver in similar conditions multiple times before, and decided to continue the

turn for a downwind departure. He reported that during the initial stages of the turn, the helicopter was suddenly "shoved" back down. He decided that he would not be able to recover, and continued the turn, aiming for a spot between rocks and the trees ahead. He attributed the rapid descent to an unexpected downdraft, rather than a problem with the helicopter.

Pilot Information

Certificate:	Airline transport; Commercial; Military	**Age:**	55,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	May 8, 2014
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	June 11, 2014
Flight Time:	8000 hours (Total, all aircraft), 3000 hours (Total, this make and model), 7500 hours (Pilot In Command, all aircraft), 30 hours (Last 90 days, all aircraft), 15 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

The pilot held an airline transport certificate with ratings for helicopter, airplane single-engine land, airplane multiengine land, and instrument helicopter and airplane. He reported a total flight time of 8,000 hours in all aircraft, with 3,000 in the accident make and model. He held a USDA/USDI Interagency Helicopter Pilot Card, and reported flight experience in flight test, firefighting, and air medical operations.

He took and passed a recurrent pilot test in accordance with Federal Aviation Air Regulations 135.293, on June 11, 2014. This test was accomplished in the accident helicopter, with an FAA inspector.

He stated that he had flown in the same capacity at the event for the last twelve years, and had utilized the accident helispot hundreds of times over that period. This was the first year he had flown for the event in an AS350B, and for the prior years he had utilized a Bell UH1, or the Bell 206 Jet and Long Rangers.

Aircraft and Owner/Operator Information

Aircraft Make:	S.N.I.A.S.	**Registration:**	N3597T
Model/Series:	AS350B	**Aircraft Category:**	Helicopter
Year of Manufacture:	1979	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1126
Landing Gear Type:	Skid	**Seats:**	5
Date/Type of Last Inspection:	June 30, 2014 Continuous airworthiness	**Certified Max Gross Wt.:**	4300 lbs
Time Since Last Inspection:	18 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	8541.3 Hrs at time of accident	**Engine Manufacturer:**	Turbomeca
ELT:	C91A installed, activated, did not aid in locating accident	**Engine Model/Series:**	Arriel 1B
Registered Owner:	HELI-FLITE INC	**Rated Power:**	590 Horsepower
Operator:	HELI-FLITE INC	**Operating Certificate(s) Held:**	Rotorcraft external load (133), On-demand air taxi (135)
Operator Does Business As:	ARIS HELICOPTERS LTD	**Operator Designator Code:**	CAXA

The helicopter was originally manufactured as an AS350D by SNIAS in 1979. In 1989 it was converted to an AS350B model by removing the Honeywell (formerly Lycoming) LTS101-600A2 engine, and installing a Turbomeca 1B engine.

The helicopter was configured with single pilot controls on the right side, and a belly-mounted cargo hook system. Both forward doors had been removed for flight operations.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KTVL,6314 ft msl	**Distance from Accident Site:**	14 Nautical Miles
Observation Time:	12:53 Local	**Direction from Accident Site:**	118°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	Broken / 8500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	6 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	30°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.26 inches Hg	**Temperature/Dew Point:**	28°C / 7°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Tahoma, CA (N/A)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Tahoma, CA (N/A)	**Type of Clearance:**	None
Departure Time:	13:00 Local	**Type of Airspace:**	Class E

The closest aviation weather observation station was located at Lake Tahoe Airport, which was about 14 miles southeast of the accident site, at a similar elevation. An aviation routine weather report (METAR) was recorded at 1253 PDT. It reported: wind from 030 degrees at 6 knots; visibility 10 miles; broken clouds at 8,500 ft; temperature 28 degrees C; dew point 7 degrees C; altimeter 30.26 inches of mercury.

A photograph of the accident site taken from a California Highway Patrol helicopter about 90 minutes after the accident revealed that the containment boom protecting the dam was curved towards the southeast. The curvature was consistent with a wind direction generally out of the northwest.

Weather Research and Forecasting Model (WRF) simulations were performed to estimate wind and turbulence conditions in the area of the accident at 1300 PDT. Advanced Research WRF version 3.2.1.5 was run with 3 domains with horizontal grid spacing of 8 kilometers (km), 1.6 km, and 320 meters over the accident site. Results from this model run estimated 10-meter wind magnitudes were approximately 4 meters-per-second (~8 knots), with vertical air motion near the surface identified as being less than 30 feet-per-minute (in a downward direction). Richardson Number, which is used as a proxy for estimating potential for aircraft-scale turbulence, was greater than 1.0 above the surface near the accident site. Richardson Numbers greater than 1.0 generally indicate a low potential for turbulence. Although grid spacing of this model run was high (small distances), the model was not able to resolve fine terrain features or vegetation such as tall trees.

Airport Information

Airport:	Lakeshore NONE	**Runway Surface Type:**	
Airport Elevation:	6445 ft msl	**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Serious, 2 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Serious, 2 None	**Latitude, Longitude:**	39.004722,-120.255554

The wreckage was examined at the accident site by the NTSB investigator-in-charge (IIC).

The accident site was located on the northwest shore of the lake, at an elevation of 6,445 ft mean sea level (msl) within a geographic bowl inside the confines of the Eldorado National Forest, 8 miles southwest of Tahoma. The primary wreckage consisted of the fuselage and tailboom, and was located on the lakeshore adjacent to the intersection of two concrete dam walls. Fragments of the main rotor blades were strewn around the site and into the adjoining lake. The farthest located component was a main rotor blade tip, which came to rest about 350 feet northeast. The remaining two blade tips were located in the immediate vicinity of the fuselage. All primary airframe components were accounted for at the accident site.

The takeoff point was on a flat rock slab in between the two dam walls. Thirty- to forty-feet-tall trees surrounded the area 60 ft to the north and northwest. The primary wreckage was located about 170 feet south, and 10 feet below the takeoff point. A series of cut trees were in line with the departure path, and all were cut at a height approximately level with the takeoff point.

The main cabin came to rest on its right side on a heading of 090 degrees magnetic at the base of a north-south oriented slab of rock. The rock exhibited multiple blue and silver paint transfer marks and scratches oriented on a heading of 140 degrees. The main landing gear had become fragmented and pushed aft, with crush damage and longitudinal scrape marks present on the lower left side of the nosecone, and the lower forward right section of the belly.

The windshield was shattered, with fragments of Plexiglas and window gasket material strewn around the immediate vicinity. The mast fairing exhibited rotational score marks, and the ground around the hub had been excavated, in a manner consistent with the hub and mast continuing to spin while the airframe was on its side.

The tailboom had separated at the junction frame with the main cabin, and was oriented on a north-south heading, about 8 feet to the north. A 12-inch-thick tree, severed about 4 feet from the ground, was located between the tailboom and the cabin. The tailboom was positioned just below a set of three trees, which were severed at the 8-foot-level. Five more trees were severed at the same level, 15 feet to the north.

The engine remained attached to the airframe, and encased within the cowling. The air inlet screen was free of debris and obstruction. The gravel below the exhaust pipe exhibited dark discoloration and sooting emanating in a fan-shaped plume about 5 feet beyond the outlet, consistent with continued engine operation after the accident.

Tests and Research

The helicopter was recovered from the accident site, and examined by the IIC along with representatives from Turbomeca and Airbus Helicopters.

Examination did not reveal any anomalies with the airframe or engine that would have precluded normal operation, and both the pilot and operator reported that there were no mechanical malfunctions or failures. The engine's axial compressor blades exhibited leading edge damage consistent with the engine producing power at the time of impact and ingesting debris as the helicopter came to rest on its side. Rotational damage was noted to components within the main and tailrotor transmission system, consistent with operation of the transmission components at the time of impact.

A complete examination report is included in the public docket for this accident.

Performance

The pilot reported that he had serviced the helicopter with 40 gallons of fuel from the fuel truck while at Loon Lake, just prior to the accident flight. He estimated that this addition would have provided him with about 1.5 hours flight time, based on the helicopter consuming about 45 gallons per hour.

Examination of the fueling records revealed that no entry had been made that day; however, the truck's fuel delivery meter indicated a metered amount of 81.1 gallons. The helicopter came to rest on its side following the accident, resulting in fuel leaking from the filler neck. Therefore and accurate assessment of the total amount of fuel onboard at the time of the accident could not be made.

According to the helicopters most recent weight and balance chart from May 2010, the basic empty weight was 2,686 pounds. Utilizing the weight of the occupants, along with baggage and both 40 and 81 gallons of fuel, the helicopters gross weight at the time of the accident would have been about 3,850 or 4,096 pounds respectively. The limitations section of the helicopter's flight manual indicated a maximum gross weight of 4,300 pounds.

Utilizing the flight manual located onboard the helicopter, the hover in ground effect (HIGE) and hover out of ground effect (HOGE) altitudes were calculated for both weights utilizing a temperature of 28 C.

HIGE at a gross weight of 3,850 pounds would have been possible up to 8,500 ft pressure altitude, and up to 6,700 ft at a weight of 4,096 pounds.

Likewise, HOGE at 3,850 pounds would have been possible up to 6,750 ft, and up to 4,800 ft at a weight of 4,096 pounds.

Fuel Gauge

An entry in the helicopters maintenance logbook indicated that 10 days prior to the accident the fuel gauge was replaced. The entry stated that the gauge was still inoperative following its replacement, and no other entry was located indicating the gauge was subsequently repaired. No inoperative placard was found in the helicopter following the accident, and the operator's technical representative stated that he could not confirm if the gauge was working at the time of the accident. The five subsequent entries in the logbook were signed by the accident pilot, and affirmed compliance with the pre-flight visual inspections of the main and tail rotor drive systems.

The pilot stated that the gauge was operating at the time of the accident (it had been sticking prior to the repair), and that since its replacement he also confirmed fuel load between flights utilizing the sight gauge in the aft of the helicopter as a precaution.

Additional Information

Vortex Ring State

According to the FAA Rotorcraft Flying Handbook, "vortex ring state" (or "settling with power") describes an aerodynamic condition where a helicopter may be in a vertical (with regard to the air mass) descent with up to maximum engine power applied, and little or no cyclic authority. The term "settling with power" comes from the fact that a helicopter keeps settling, even though full engine power is applied. However, when the helicopter begins to descend vertically, it settles into its own downwash, which greatly enlarges the main rotor blade tip vortices. In this vortex ring state, most of the power developed by the engine is wasted in accelerating the air in a doughnut pattern around the rotor.

A vortex ring state may be entered during any maneuver that places the main rotor in a condition of high upflow and low forward airspeed, including near-vertical descents of at least 300 feet per minute, and a horizontal velocity slower than that for effective translational lift. Vortex ring state susceptibility increases with increases in gross weight and density altitude.

The handbook also noted that "when recovering from a settling with power condition, the tendency on the part of the pilot is to first try to stop the descent by increasing collective pitch. However, this only results in increasing the stalled area of the rotor, thus increasing the rate of descent. Recovery is accomplished by increasing forward speed, and/or partially lowering collective pitch." With sufficient altitude, temporary entrance into an autorotation will also enable safe exit from the vortex ring state.

Administrative Information

Investigator In Charge (IIC):	Simpson, Eliott
Additional Participating Persons:	William C Kunder; Federal Aviation Administration FSDO; Reno, NV Arnaud Toupet; BEA (Bureau d'Enquêtes et d'Analyses); Paris Seth Buttner; Airbus Helicopters; Grand Prairie, TX Bryan Larimore; Turbomeca; Grand Prairie, TX Scott Donley; Heli-Flite Inc.; Riverside, CA
Original Publish Date:	August 10, 2016
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=89783