		NTSB ID: LAX02FA281		Aircraft Registration Number: N357NT	
		Occurrence Date: 09/11/2002		Most Critical Injury: Minor	
		Occurrence Type: Accident		Investigated By: NTSB	
Location/Time					
Nearest City/Place Peach Springs		State AZ	Zip Code 86434	Local Time 1700	Time Zone MST
Airport Proximity: On Airport/Airstrip		Distance From Landing Facility:			
Aircraft Information Summary					
Aircraft Manufacturer Aerospatiale		Model/Series AS350BA		Type of Aircraft Helicopter	
Revenue Sightseeing Flight: Yes			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
HISTORY OF FLIGHT					
<p>On September 11, 2002, at 1700 mountain standard time, an Aerospatiale AS350BA, N357NT, experienced a hydraulic failure during cruise flight and landed hard while making a precautionary landing at the Grand Canyon West Airport (1G4), Peach Springs, Arizona. Heli-USA Airways, Inc., operated the helicopter under the provisions of 14 CFR Part 135 as a tour flight. The helicopter sustained substantial damage. The pilot and five passengers were not injured. A sixth passenger sustained minor injuries. Day visual meteorological conditions prevailed for the tour flight over the Grand Canyon, and a company visual flight rules (VFR) flight plan had been filed. The flight departed the McCarran International Airport (LAS), Las Vegas, Nevada, about 1600. The flight was returning to LAS when the hydraulic failure occurred.</p>					
<p>According to the operator, the flight was returning to LAS when the helicopter had a "complete" hydraulic failure. The pilot was in the vicinity of Peach Springs Airport, and made the decision to make a precautionary landing. The helicopter landed hard, the main rotor blades flexed down and cut off the tail boom.</p>					
<p>According to the pilot's written statement, the flight to the Grand Canyon was uneventful. He made a radio call indicating that he was crossing the Grand Wash Cliffs area heading towards the Bat Towers. Five miles before entering the canyon he heard an aural alarm and saw that the hydraulic light was illuminated on the caution panel indicating a hydraulic failure. The airspeed was at 100 knots so he slowed the helicopter down between 40 to 60 knots per the recommended procedures, and turned off the caution horn using the button on the systems control console.</p>					
<p>After turning the helicopter towards the Peach Springs Airport, he depressed the hydraulic cutoff button on the collective control. During the approach he reported making his radio calls to the airport traffic, as well as coordinating with a sister ship to transport his passengers back to the operator's facility after landing.</p>					
<p>The pilot informed his passengers of the mechanical problems and noted no additional issues with the flight to the airport. He indicated that the hydraulic off indications were "felt" in the flight controls, and intended to do a run on landing in the new concrete landing/parking ramp area on the field. He reported that everything was normal until the helicopter was about 25 feet short of the ramp area. As he continued the approach, the flight controls increased in stiffness. He noted the airspeed was now 30 knots, and about 10 feet before the ramp at an altitude of 15 to 25 feet above ground level (agl). The nose pitched down, and the helicopter started to rotate. He pulled back on the cyclic enough to get the nose back up, which slowed the helicopter more but increased the rotation speed. The pilot thought they made two complete rotations, and reported that the flight controls were not responding. In order to slow or stop the rotation of the helicopter, he "cut off" the engine. The rotation slowed, and the helicopter started to settle to</p>					
FACTUAL REPORT - AVIATION					
Page 1					

National Transportation Safety Board

## FACTUAL REPORT

AVIATION

NTSB ID: LAX02FA281

Occurrence Date: 09/11/2002

Occurrence Type: Accident

## Narrative (Continued)

the ground. The pilot attempted to keep the helicopter in a level attitude, and it impacted in a near vertical descent from about 10 to 20 feet agl. The helicopter came to rest facing 180 degrees from its original direction of travel.

The pilot reported that one of the passenger's feet had become trapped under the helicopter during the accident sequence. Airport personnel and pilot's from other companies assisted with pushing the helicopter up in order to remove the passenger's foot; there were no other injuries.

In an interview with the National Transportation Safety Board investigator-in-charge (IIC), the pilot reported that the flight was about 3 minutes from the airport when he heard the aural caution horn and saw the hydraulic light illuminate. He also recalled that the passenger seated behind him was over 6 feet tall. The passenger's foot had been extended all of the way forward, resting by the pilot's side door, and had become trapped during the accident sequence. The pilot reported that the helicopter made two full revolutions to the right, and he had in full left pedal. He also reported that he had landed with a 4-knot tailwind.

A witness to the accident (a company helicopter tour pilot) submitted a written statement to the Federal Aviation Administration (FAA). He reported that he was at 1G4 refueling his helicopter when he heard the accident pilot radio and that he had experienced a complete hydraulic failure. The witness asked where the accident pilot intended to land the helicopter, to which the pilot replied that he was headed for the large parking apron located on the northeast side of the runway.

The witness reported that the helicopter was heading in a southerly direction. He observed the helicopter approach the landing area and said it was a little fast, between 40-55 knots. As the helicopter made its final approach to the parking apron, it was still a little bit high. The helicopter started to pitch up with a slow roll to the left. The witness reported that the helicopter's nose pitched down, all the while doing a complete 360-degree turn to the left. He estimated the helicopter's altitude between 30-50 feet. The witness began yelling on the radio for the accident pilot to get the nose of the helicopter up and not let it strike the ground in a nose down attitude. After completing the 360-degree turn, the witness reported that the helicopter had lost altitude in the left turn, the nose was slowly starting to pitch back to level flight, and the main rotor blades were starting to slow down. He reported that he could see the main rotor blades starting to cone in an upward direction, an indication to him that the main rotor blades were starting to slow down.

The helicopter impacted the ground in a level attitude, and was covered by a large dust cloud. The witness could not see anything for about 10-15 seconds. He shut down the engine of his helicopter and ran towards the accident helicopter. When he was able to see the helicopter again, he noted that the tailboom had separated and was lying near the right side of the fuselage. He then assisted with the welfare of the passengers on the accident helicopter.

## PERSONNEL INFORMATION

A review of the FAA airman records revealed that the pilot held a commercial pilot certificate with helicopter and instrument helicopter ratings. The pilot also held a mechanic certificate with ratings for airframe and powerplant.

The pilot held a second-class medical certificate issued on August 28, 2002. It had no limitations or waivers.

The pilot reported his total flight time as 4,025 hours, with 1,785 hours in the accident make and model. He had logged 134 hours in the last 90 days, and 21.6 hours in the last 30 days. According to personnel records obtained from the operator, the pilot had flown 2.3 hours on the day of the accident.

National Transportation Safety Board

## FACTUAL REPORT

AVIATION

NTSB ID: LAX02FA281

Occurrence Date: 09/11/2002

Occurrence Type: Accident

## Narrative (Continued)

The operator had employed the pilot since 2000. At the time of the accident he was the Assistant Director of Operations, as well as a company flight instructor and mechanic.

## AIRCRAFT INFORMATION

The helicopter, serial number 1549, was originally issued a standard airworthiness certificate in 1987, as an Aerospatiale AS350B, but was converted to a BA and issued a standard airworthiness certificate on May 9, 2000. A review of the helicopter's daily flight logbook revealed a total airframe time of 8,387.7 hours at the last 100-hour inspection, completed on August 28, 2002. The airframe total time at the time of the accident was 8,451.7 hours.

A Turbomeca Arriel 1B engine, serial number 4474, was installed on the helicopter. The engine total time was 8,824.5 hours at the last 100-hour inspection dated August 28, 2002. The engine had accrued 2,830.7 hours since overhaul, and 74.6 hours since the last 100-hour inspection.

A review of the operator's maintenance work order for the helicopter (number 08270215491, dated August 28, 2002, revealed that under the Discrepancy heading, the hydraulic pump bearing was due for replacement. The operator's corrective action by maintenance personnel indicated, "replaced hyd[raulic] pump assembly TSN 0, 28Aug02." The serviceable tag issued for the hydraulic pump assembly, serial number 10318827, contained the following information, "inspected, cleaned filter, new O rings installed on connections, inspected coupling, new pump assembled."

According to the operator, the helicopter had 88.44 gallons (62 percent) of Jet-A fuel on board prior to departure from LAS. Examination of the maintenance and flight department records revealed no unresolved maintenance discrepancies against the helicopter prior to departure.

For a hydraulics failure, the operator's FAA approved AS350 flight manual states in part, "calmly reduce collective pitch and adjust the airspeed to between 40 and 60 knots (74 to 111 km/hr) in level flight. Cut off the hydraulic pressure, using collective lever pushbutton. Make a flat approach over a clear landing area and land with slight forward speed."

## AIRPORT INFORMATION

The Airport/ Facility Directory, Southwest U. S., indicated Grand Canyon West Airport (1G4) runway 17/35 was 5,058 feet long and 60 feet wide. The runway surface is composed of asphalt.


## TESTS AND RESEARCH

Investigators from the FAA and American Eurocopter examined the wreckage at Lone Mountain Aviation, Inc., North Las Vegas, on September 19, 2002, under the supervision of the Safety Board IIC.

Examination of the hydraulic pump assembly revealed a rust color surrounding the interior of the pump to include the coupling sleeve (S40 coupling). The visible splines of the coupling sleeve were worn down beyond serviceable limits, and investigators noted a lack of lubrication (grease) inside the coupling, as well as bluing inside the pump. The Safety Board IIC retained the hydraulic pump and coupling for further examination by the Safety Board's Materials Laboratory in Washington, DC.

The Safety Board's Materials Laboratory examined the hydraulic pump drive, and a specialist prepared a factual report. The following paragraphs summarize pertinent parts of the report.

Section 1-17 of the maintenance manual described servicing recommendations for the main hydraulic section. It specified that the hydraulic pump drive shaft and bearing be checked and greased at 500-hour intervals. An illustration in the manual indicates that the lubrication is accomplished

 <p>National Transportation Safety Board <b>FACTUAL REPORT</b> AVIATION</p>	NTSB ID: LAX02FA281
	Occurrence Date: 09/11/2002
	Occurrence Type: Accident

## Narrative (Continued)

by packing the hub with abundant grease before the coupling sleeve is installed.

Examination of the coupling flange revealed a tan colored deposit on its inner surface. Examination of the elastic coupling revealed a similar tan deposit, a raised letter "U," and raised characters "PB 72". The cylindrical bearing support located on the mounting plate was permanently riveted to it and displayed no indications of looseness. The hydraulic pump was also bolted to the mounting plate.

Examination of the hydraulic pump revealed that material had been worn from the splines of the driving gear, which protruded outside of the front body to connect with the internal splines on the coupling sleeve. There was a red powdery deposit on the splines and the adjacent components, consisting of the retaining ring, the O-ring, and the bearing. The O-ring provided a seal between the driving shaft and the end of the coupling sleeve to prevent the escape of the grease applied to the splines.

The Materials Laboratory specialist extracted several components from the pumping assembly. He observed a hard black circumferential deposit on the shaft portion of the driving gear that corresponded with the location of the bearing seal, and he measured it at 0.0015-inch thick. He removed a piece of the splined portion of the driving gear, cut it perpendicular to the axis of the shaft portion of the driving gear, mounted it and polished it for metallurgical examination. He chemically etched the polished metallurgical mount to reveal a uniform microstructure with a darker-etching surface layer that was consistent with a case hardening process.

The specialist performed micro-hardness testing at various depths from the surface of a spline root. He recorded the hardness in the Knoop scale with a 500-gram load (HK/500) and converted it to Rockwell C-scale (HRC) for comparison with the engineering requirements. The hardness measurements indicated that the case hardened layer was not deep enough, and was slightly below the specified value throughout its thickness.

Examination of the cross section through the pump splines revealed that each spline was missing a uniform amount of material, and that the remaining material had been deformed in the direction of rotation. One spline displayed a crack that was continuous through the spline, and inclined approximately 10 degrees outwards. The crack had propagated along the grain boundaries. The microstructure displayed the needle-like features consistent with a predominantly martensitic structure.

Separation and examination of the pumping assembly revealed surface smearing on opposing inner faces of the front and rear bearings.

Compensation seals and anti-extrusion seals were located in grooves at the front and rear ends of the pumping assembly. These seals isolate the low-pressure side (intake) of the pumping assembly from the high-pressure (output) side.

The specialist measured the dimensions of the assembled pumping body for comparison with the corresponding dimension on the central body. The measurements suggested that the seals were fully compressed within their grooves in their respective bearing and that the front and rear bodies were also in contact with the bearing.

The examination revealed that all surfaces of the front body displayed a black finish.

The surfaces of the rear body, with the exception of the inner surface, displayed a similar black finish. The inner surface of the rear body displayed bare metal with what appeared to be machining marks on the upper portion. The areas containing the machining marks also contained a black deposit, possibly remains of the black finish. The machining marks consisted of concentric curving arcs, which were present on the surface inside and outside of the O-ring. The O-ring itself did

National Transportation Safety Board

## FACTUAL REPORT

AVIATION

NTSB ID: LAX02FA281

Occurrence Date: 09/11/2002

Occurrence Type: Accident

## Narrative (Continued)

not display any downwardly curving marks or surface disturbance. The inner surface, adjacent to the O-ring groove, displayed an imprint left by the central body. The imprint was not on the top of the rear body, but there was an indication of the continuation of the shape of the central body in this area. There was an indication of an imprint of the rear bearing. Measurement of the machining lines using an OGP Smartscope indicated that a cutting tool of approximately 3.8-inches diameter produced them. The measurements also revealed that the front body was 0.710-inch thick and the rear body was 0.705-inch thick.

The low-pressure connection and the high-pressure connection remained attached to the central body of the hydraulic pump. The low-pressure connection incorporated a magnetic plug intended to attract and hold any magnetic material in the hydraulic fluid passing across it. The specialist removed the magnetic plug and noted no contamination. Examination of the central body revealed that both end faces displayed surface patterns similar to the patterns on the mating surfaces of the front and rear bodies. Two of the assembly bolt holes displayed bare metal surfaces, and two holes displayed the "gold" surface similar to that on the exterior surface of the central body. The "gold" color extended across the rear face of the central body from one of the colored holes and the adjacent exterior surface of the central body. Examination of the inside chamber of the central body revealed shallow grooves on the chamber walls, adjacent to the low pressure and high-pressure fluid holes. The width of the grooves was similar to the thickness of the pumping gears.

## Coupling sleeve

The coupling sleeve connects the belt driven pulley (via the coupling flange and the elastic coupling) to the splines on the pump driving gear shaft. Examination of the sleeve revealed light tan colored deposits on its exterior surface on the mating face with the elastic coupling and the surface of the installed plug. A majority of the internal splines were missing. The specialist observed a small amount of a grease-like lubricant on the inner surfaces, most of which was adjacent to the internal edge of the remaining splines. The small amount of lubricant would not satisfy the "abundant grease" requirement specified in the maintenance manual.

The specialist cut the coupling sleeve perpendicular to its longitudinal axis to produce a profile section of the splines. The section was metallurgically mounted, polished, and etched to reveal a uniform microstructure with a darker layer at the remaining edges of the splines. The specification indicated that the splined surface in the coupling is nitrided (a case hardening process) to a specific depth and a specific hardness within that depth. He performed micro-hardness testing at various depths from the surface of a spline root (an undamaged area). He recorded the hardness in the Knopp scale with a 500-gram load (HK/500), and converted it to Vickers, with a 10-kilogram load, (HV10) for comparison with the specified requirements. The hardness measurements indicated satisfaction with the specified depth, but the hardness, within the depth, was low.


## ADDITIONAL INFORMATION

The Safety Board's metallurgist conducted comparative tests on two other hydraulic pumps and coupling sleeves, one that had currently been in use, and the other was a brand new hydraulic pump.

The results of the comparison testing revealed similar characteristics to the accident hydraulic pump for failure mode, hardness testing, and torque tests. The complete metallurgical report is appended to this report.

According to American Eurocopter, the hydraulic pump body and the coupling sleeve (S40 coupling) are sold as separate units.

The manufacturer of the hydraulic pump, Hydroperfect International (HPI), reported in a meeting with Safety Board investigators that they do not authorize the overhaul of the hydraulic pump, and


 <p>National Transportation Safety Board <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: LAX02FA281
	Occurrence Date: 09/11/2002
	Occurrence Type: Accident


Narrative (Continued)

HPI does not publish an overhaul maintenance manual for the hydraulic pump. The operator reported that in the past they had purchased overhauled hydraulic pumps; however, they had purchased only brand new hydraulic pumps for the past year and a half.

As a result of this accident, Eurocopter issued Service Bulletin No. 29.00.04, titled Hydraulic Power - Lubrication of the splines on the Hydraulic Pump Drive Shaft dated January 27, 2004. The Service Bulletin reduced the lubrication interval from 550 flying hours or every 2 years, whichever occurs sooner, to 110 flying hours or every 6 months, whichever occurs sooner.

The IIC released the wreckage to the owner's representative.

 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>		NTSB ID: LAX02FA281			
		Occurrence Date: 09/11/2002			
		Occurrence Type: Accident			
<b>Landing Facility/Approach Information</b>					
Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
Grand Canyon West Airport	1G4	4825 Ft. MSL	17	5058	60
Runway Surface Type: Asphalt					
Runway Surface Condition: Dry					
Approach/Arrival Flown: NONE					
VFR Approach/Landing: Precautionary Landing					
<b>Aircraft Information</b>					
Aircraft Manufacturer		Model/Series		Serial Number	
Aerospatiale		AS350BA		1549	
Airworthiness Certificate(s): Normal					
Landing Gear Type: Skid					
Amateur Built Acft? No	Number of Seats: 7	Certified Max Gross Wt.	4630 LBS	Number of Engines: 1	
Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:		
Turbo Shaft	Turbomeca	Arriel 1B	647 HP		
- Aircraft Inspection Information					
Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time		
100 Hour	08/2002	74.6 Hours	8387.7 Hours		
- Emergency Locator Transmitter (ELT) Information					
ELT Installed?/Type Yes /	ELT Operated? No	ELT Aided in Locating Accident Site? No			
<b>Owner/Operator Information</b>					
Registered Aircraft Owner		Street Address			
Heli-USA Airways, Inc.		245 E. Tropicana Ave. Suite 120			
		City	State	Zip Code	
		Las Vegas	NV	89109	
Operator of Aircraft		Street Address			
Heli-USA Airways, Inc.		245 E. Tropicana Ave. Suite 120			
		City	State	Zip Code	
		Las Vegas	NV	89109	
Operator Does Business As:			Operator Designator Code: S9HA		
- Type of U.S. Certificate(s) Held:					
Air Carrier Operating Certificate(s): On-demand Air Taxi					
Operating Certificate:			Operator Certificate:		
Regulation Flight Conducted Under: Part 135: Air Taxi & Commuter					
Type of Flight Operation Conducted: Non-scheduled; Domestic; Passenger Only					

 <p><b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b></p>	NTSB ID: LAX02FA281
	Occurrence Date: 09/11/2002
	Occurrence Type: Accident

**First Pilot Information**

Name On File	City On File	State On File	Date of Birth On File	Age 42
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Sex: M	Seat Occupied: Right	Occupational Pilot?	Certificate Number: On File
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Certificate(s): Commercial

Airplane Rating(s): None

Rotorcraft/Glider/LTA: Helicopter

Instrument Rating(s): Helicopter

Instructor Rating(s): None

Current Biennial Flight Review? 05/2002

Medical Cert.: Class 2	Medical Cert. Status:	Date of Last Medical Exam: 08/2002
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time	4025	1785			386	64	300	4025		
Pilot In Command(PIC)	2928	1780								
Instructor										
Instruction Received										
Last 90 Days	134									
Last 30 Days	22									
Last 24 Hours										

Seatbelt Used? Yes	Shoulder Harness Used? Yes	Toxicology Performed? No	Second Pilot? No
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**Flight Plan/Itinerary**

Type of Flight Plan Filed: Company VFR

Departure Point Las Vegas	State NV	Airport Identifier LAS	Departure Time 1700	Time Zone PDT
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Destination Local Flight	State NV	Airport Identifier LAS	
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Type of Clearance: None

Type of Airspace:

**Weather Information**

Source of Wx Information:

Unknown

 <b>National Transportation Safety Board</b> <b>FACTUAL REPORT</b> <b>AVIATION</b>	NTSB ID: LAX02FA281
	Occurrence Date: 09/11/2002
	Occurrence Type: Accident

**Weather Information**

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
LAS	1756	MST	2181 Ft. MSL	65 NM	275 Deg. Mag.

Sky/Lowest Cloud Condition: Few	4000 Ft. AGL	Condition of Light: Day
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Lowest Ceiling: Broken	15000 Ft. AGL	Visibility: 7 SM	Altimeter: 29.90 "Hg
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Temperature: 24 °C	Dew Point: 15 °C	Weather Conditions at Accident Site: Visual Conditions
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Wind Direction: 290	Wind Speed: 9	Wind Gusts:
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Visibility (RVR): Ft.	Visibility (RVV) SM
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Precip and/or Obscuration:  
 No Obscuration; No Precipitation

**Accident Information**

Aircraft Damage: Substantial	Aircraft Fire: Ground	Aircraft Explosion: None
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- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot					
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew					
Passengers			1	5	6
- TOTAL ABOARD -			1	6	7
Other Ground					
- GRAND TOTAL -			1	6	7

National Transportation Safety Board

**FACTUAL REPORT**

**AVIATION**



NTSB ID: LAX02FA281

Occurrence Date: 09/11/2002

Occurrence Type: Accident

Administrative Information

Investigator-In-Charge (IIC)

Tealeye C. Cornejo

Additional Persons Participating in This Accident/Incident Investigation:

Frank Vavra  
Federal Aviation Administration  
Las Vegas, NV