Aviation Investigation Final Report

Location:	Rancho P.Verdes, California	**Accident Number:**	LAX03FA232
Date & Time:	July 12, 2003, 10:28 Local	**Registration:**	N15AH
Aircraft:	Sikorsky S-58ET	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	1 Serious
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The helicopter experienced a loss of tail rotor drive while maneuvering during a Federal Aviation Administration authorized low altitude external long line host operation, and collided with the ground in the subsequent descent. At the time, the operation was being performed in an area of the height-velocity curve that did not allow for a successful autorotative landing. Witnesses reported that minutes prior to the accident the pilot had made a precautionary landing due to illumination of the intermediate gearbox (IGB) chip light. The pilot removed, inspected, and cleaned the chip plug that contained metallic-like particles. During this action, the pilot was overheard to express concern to a ground crewmember by stating "this can be a problem." The pilot elected to continue flight operations. About 13 minutes later, within 200 feet above ground level while lifting an air conditioner (AC) unit from a school building, the pinion gear (part number S1635-64114-101) going into the drive side of the helicopter's intermediate gearbox (IGB) failed. This resulted in a total loss of antitorque control, and the helicopter yawed and spun in a clockwise direction while descending, and the helicopter impacted the unoccupied schoolyard. The pinion gear for the intermediate gearbox was examined. The laboratory reported that the initiating failure event had resulted from a fatigued gear tooth. The failure occurred about 175 hours prior to the part reaching its 2,000-hour life limit. The external long line was still connected to the cargo hook. Examination of the cockpit disclosed that the electrical cargo release switch was not armed. Post accident tests established that both the electrical release and manual backup cargo release mechanisms functioned.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A total loss of antitorque control, due to the fatigue-induced failure of a gear within the drive shaft's intermediate gear box (IGB). Contributing factors were the pilot's improper on-ground decision to continue flight operations following discovery of material on the IGB's chip plug, and his failure to immediately jettison the external load.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: MANEUVERING

Findings
1. WARNING SYSTEM(OTHER) - ACTIVATED
2. (F) OPERATION WITH KNOWN DEFICIENCIES IN EQUIPMENT - CONTINUED - PILOT IN COMMAND
3. (C) ROTOR DRIVE SYSTEM,INTERMEDIATE GEARBOX(42 DEG) - FATIGUE
4. (C) ROTOR DRIVE SYSTEM,INTERMEDIATE GEARBOX(42 DEG) - FAILURE,TOTAL
5. TAIL ROTOR/ANTI-TORQUE CONTROL - UNAVAILABLE - PILOT IN COMMAND

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

Findings
6. (F) DIRECTIONAL CONTROL - NOT POSSIBLE - PILOT IN COMMAND
7. (F) LOAD JETTISON - NOT PERFORMED - PILOT IN COMMAND
8. (F) HEIGHT/VELOCITY CURVE - EXCEEDED - PILOT IN COMMAND

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

Findings
9. TERRAIN CONDITION - CONGESTED/CONFINED AREA

Factual Information

HISTORY OF FLIGHT

On July 12, 2003, about 1028 Pacific daylight time, a Sikorsky S-58ET, N15AH, experienced a loss of control while maneuvering over the Miraleste Intermediate School, Rancho Palos Verdes, California. The pilot made a forced landing, and during the descent the helicopter impacted school bungalows and touched down hard. The helicopter came to rest in a basketball court adjacent to the bungalows, both unoccupied. Aris Helicopters, Ltd., San Jose, California, owned and operated the helicopter. The external load operation was performed under the provisions of 14 CFR Part 133. The helicopter was destroyed, and the commercial certificated pilot was seriously injured. Visual meteorological conditions prevailed at the time. The flight originated from the school property about 1015.

On June 9, 2003, Aris provided the contractor with its bid for the helicopter external load operation that involved removing and replacing several dozen air conditioner (AC) units located on top of various school buildings. In the bid, the maximum weight of an individual AC unit was indicated at 2,000 pounds. The following day, the contractor advised Aris that the maximum AC unit weight was 3,500 pounds.

On June 26, 2003, Aris provided the Federal Aviation Administration (FAA) with the requisite "Congested Area Lift Plan" for the work project. In the plan, Aris informed the FAA that the maximum AC unit weight was 2,500 pounds, and the operational altitude during the lifts was within 200 feet above ground level. On June 30, the FAA approved the plan.

One of the Aris ground crewmembers reported to the National Transportation Safety Board investigator that the first portion of the July 12, 2003, external load operation was performed without incident. However, after a number of AC units were relocated, the pilot made a precautionary landing in an open field on school grounds. The landing was performed after the pilot observed the illumination of a tail rotor gearbox chip light.

The pilot landed and shut down the helicopter. Thereafter, the pilot removed the chip plug from the tail rotor drive shaft's intermediate gearbox (IGB) and examined it.

The ground crewmember, who reported that he was near the pilot, further indicated to the Safety Board investigator that the pilot stated he looked at the chip plug and did not observe any metal on it, but he did observe "lots of black carbon." After the pilot completed his examination, the chip plug was reinserted into its orifice.

Another of the operator's ground crewmembers, who reported that he was standing next to the pilot during the examination, provided the Safety Board investigator with the following

(summarized) statement regarding the event:

I accompanied the pilot to the tail area of the helicopter where I observed him open an access door. The pilot removed an object that he indicated was, I think, the chip plug. It was connected to the helicopter with a wire. When the plug was removed, between 1 and 2 ounces of fluid dripped out of this area of the helicopter. I saw the pilot wipe off the plug. I went into the helicopter and obtained a piece of masking tape onto which 2 or 3 little chips were placed. The chips looked like metal objects. I do not know if the pilot actually touched the chips; I did. We both thought it might be metal. The chips had a dark color and definitely had some sort of rigidity to them. They were not sludge-like in feel. The pilot stated something like "this can be a problem."

The pilot did not make any entry into the helicopter's maintenance records regarding his observations of the chip light having illuminated. He did not make any entry into the records of having removed, cleaned, or reinserted the chip plug.

Witnesses reported that the pilot then resumed the external load operation. About five additional lifts were performed before the accident occurred.

The pilot reported to the Safety Board investigator that during flight, seconds before the accident, he had detected a high frequency vibration and the helicopter lost tail rotor thrust. His ground crewmembers reported that while the pilot was repositioning one of the larger sized AC units using the 100-foot-long line, the helicopter suddenly began rotating in a clockwise direction and descending.

During the Safety Board's on scene examination of the wreckage, the input portion of the tail rotor's drive shaft into the IGB was found disconnected from the corresponding output shaft. Metal particles were observed on the gearbox's chip plug, which was found dangling from an electrical connection wire in the tail boom housing adjacent to the IGB.

PERSONNEL INFORMATION:

The pilot held the following FAA airman certificates: airline transport pilot, rotorcraft-helicopters. He had commercial privileges for airplane single engine land and sea, and instrument airplane. The pilot also held a certified flight instructor certificate for rotorcraft-helicopters. The pilot held the following type ratings: BH-14ST, BH-206, and SK-58.

The pilot was hired by Aris Helicopters in 1995, and thereafter, was appointed to the position of chief pilot and check airman. In 2001, his employment with the company ceased, and the pilot acquired employment flying for a municipality. In January 2003, the pilot reacquired employment with Aris, on a part-time basis, and he performed flights under FAR Part 91 and 133.

The pilot reported that his total aircraft and rotorcraft flight times were approximately 14,500

and 13,600 hours, respectively. His total flight time in the accident model of helicopter was 1,500 hours, and he had flown the helicopter 50, 20, and 1.5 hours during the preceding 90-day, 30-day, and 24-hour period.

AIRCRAFT INFORMATION

Ownership and Model Change History.

The helicopter was manufactured in 1962, and it bore serial number 58-1563. The helicopter was sold to the German Army as a model H-34A. The German Army operated the helicopter until about 1975, when it was converted to an S-58ET and operated by the German Government, Geological Society.

Following an inspection by a team from Sikorsky Aircraft and maintenance, the helicopter was found to conform to FAA type certificate requirements. The FAA issued the helicopter a Standard Airworthiness Certificate after Aris purchased it in 1986.

On March 25, 1987, the FAA issued the helicopter (N15AH) an airworthiness certificate indicating that the helicopter, serial number 58-1563, was a model "S-58ET (H34A)." The following day, the FAA issued another airworthiness certificate indicating that the helicopter was a model "S-58JT."

By the accident date, the FAA's aircraft registry had classified the helicopter as being in the Standard Normal category, and as being a model S-58ET.

Authorized Operations and Maintenance.

In November 2002, the FAA authorized Aris to operate the helicopter for external load purposes under Part 133.

During this accident investigation, FAA flight standards personnel reviewed the helicopter's maintenance records. According to the FAA, no discrepancies were noted with airworthiness compliance, time life components, and required inspection intervals.

During external load operations, the helicopter's operating limitations indicated that its maximum sling load was either 4,000 or 5,000 pounds, depending upon the sling in use.

Aris management reported to the Safety Board investigator that it maintained the helicopter in accordance with Sikorsky's "S-58T Equalized Inspection and Maintenance Program, SA 4047-20." According to this program, the IGB chip detector and/or magnetic plug must be checked for metal every 500 hours.

According to the helicopter's aircraft maintenance logbook, as of the start of flight operations on July 12, 2003, the helicopter's total flight time was 7,878.1 hours, and the collective Hobbs

meter registered 1,420.5 hours. Post crash, the collective Hobbs meter registered 1,421.5 hours.

A review of the logbook pages from the date of the last 100-hour inspection did not reveal any evidence of maintenance or inspection/removal of the IGB chip plug, or of illumination of the associated chip light.

Cargo Jettisoning and Helicopter Equipment.

To jettison cargo suspended from the attachment hook on the host line, the helicopter was equipped with an electric switch activated release system and an independent manual release pedal system. The "Operating Procedures" section of the Aris "Load Combination Flight Manual" states that the electric release and the manual release should be checked on the ground before flight. The manual further states that in the event of an electrical failure, the pilot should use the manual system to release the cargo load. If difficulties arise during the flight and an emergency landing is necessary, the pilot should be prepared to release the load immediately.

Autorotation Performance Data.

Sikorsky Aircraft provides operating parameter information in the helicopter's rotorcraft flight manual. In pertinent part, the manual's height-velocity curve indicates that an autorotative descent from, for example, 300 feet above ground level at 10 knots airspeed is not authorized. A successful outcome under this condition is not possible.

Aris personnel opined that during the accident host operation, the pilot was operating the helicopter at or less than 200 feet above the ground. The helicopter's airspeed was at or less than 10 knots.

METEOROLOGICAL INFORMATION:

The closest aviation weather facility to the accident site was at the Torrance Municipal Airport, about 3 miles from the accident site. During the approximate 20-minute period before and after the accident, Torrance reported a variable surface wind between 5 and 8 knots, visibility between 4 and 7 miles, and temperature between 23 and 24 degrees Celsius.

COMMUNICATION

None of the operator's employees reported hearing any radio transmission from the accident pilot during the mishap sequence.

WRECKAGE AND IMPACT INFORMATION

The helicopter was examined at the Miraleste Intermediate School accident site, 3801 Via La

Selva, Palos Verdes Estates, California. The site elevation was approximately 900 feet mean sea level. The entire helicopter was found at the site, on an approximate magnetic heading of 070 degrees.

The helicopter was in an upright attitude and on its main wheels. The left main landing gear wheel rim was found fractured; the right side wheel rim was intact. The tail wheel was broken off. Fuel was leaking from the fuel tank. There was no fire.

The fuselage exhibited downward crush signatures, principally in a vertical direction. Transmission supports were observed buckled in a downward direction. No ground scar was evident except directly beneath the wreckage. The vertical distance from the ground to the top of the helicopter's mast was about 8 feet. In an undamaged helicopter, the distance is about 14 feet.

All the main rotor blades were found attached to the swash plate assembly. One of the helicopter's main rotor blades was observed partially resting on top of a school bungalow. The blades exhibited damage signatures consistent with impact marks from structures at the accident site.

The tail rotor blades exhibited either no apparent impact damage, or were crushed in a spanwise direction commencing from the blade tip. No leading edge deformation was apparent. A 1.5-inch-deep ground scar depression in the asphalt-covered ground, a few feet from one of the tail rotor blades, matched the size and orientation of a tail rotor blade's spanwise crushed tip. No deformation signature consistent with blade rotation was observed. All of the tail rotor blades were found attached to the tail rotor drive assembly. All couplings to the tail rotor drive shaft were found intact.

When the input shaft to the IGB was rotated by hand, the output shaft did not rotate. The IGB's case housing was observed cracked. The IGB's chip plug was found outside the gearbox receptacle. The chip plug was found inside the tail boom and was hanging by a connecting wire next to the IGB.

The 100-foot-long cargo host line was found strung out between the impact damaged (dropped) AC unit, which was reportedly being lifted at the time of the mishap, and the main wreckage (see photographs).

The helicopter was equipped with two independent mechanisms to release cargo, an electric switch and a manually operated foot pedal. The cockpit-arming switch for the sling release was found in the SAFE position. Aris personnel opined that the switch should have been set to the Cargo Sling position, which would have permitted the electric switch (button) on the cyclic control to operate. The electrically activated release button on the cyclic control was impact damaged.

The manual sling release pedal mechanism connected to the cargo line hook was functionally

tested. It was found operational.

TESTS AND RESEARCH

Under the direction of the Safety Board investigator, and with the on-scene supervision of FAA personnel, the helicopter's IGB assembly, segments of the input and output drive shafts with attached flex couplings, and the associated chip detector were examined by the Sikorsky Aircraft Company. Sikorsky's Material Laboratory issued a metallurgical examination report, number MER-6813d-Rev. 1. (On December 1, 2005, Sikorsky's Chief, Aircraft Safety Investigation, advised the Safety Board investigator that its examination report could be released as a public document.) As indicated in the report, the component examination revealed the following:

A lack of drive continuity was found to be due to a large segment of the input [pinion] gear, comprising approximately seven gear teeth, having fractured in the intermediate gearbox. Considerable damage to other components in the assembly was also observed; all of it was considered to have been secondary to the fracture of the input gear.

Regarding the nature of the fractured input gear, Sikorsky reported that "the fracture had a fatigue appearance, with the origin in a gear tooth root, at the drive side fillet radius, approximately 3/16" from the heel end face, in a noncontact area. There were no discontinuities optically visible at the origin, and the teeth flanks and roots had a uniform shot peened appearance. The initial propagation mode was fatigue in nature, transitioning to apparent cyclic overload in the web region, with many crack arrest markings visible along the extent of the fracture surface. A final overload zone where fracture once again intersected the teeth eventually allowed release of the entire segment." Evidence was found indicating that the IGB had previously been overhauled.

The data plate on the IGB bore the following marks:

MFRS ASSY DWG. S1635-64100-041
MFRS S/N S1-58-1420
Order No. W.O. 1195

The input (pinion) gear that was found fractured bore the following marks:

Stamped (etched) marks: 16*35-64114-G FZ B/L 007
Hand written (etched marks: FZ21 TS-20*01 S/N AH-713
[* Represents best estimate of number/letter]

Intermediate Gearbox Installation and Pinion Gear Component History.

Aris provided historical records listing the helicopter's installed components by part number, serial number, and maintenance history. The subject pinion gear was identified in its records as follows:

P/N S1635-64114-101

S/N AH713/F721

Information about the subject input pinion gear was found listed on a "Serviceable" part tag, dated August 26, 1992. The tag bore the following statements:

P/N S1635-64114-101
S/N F721 (AH-713)
T.T. 0.0
T.S.O. 0.0

In addition, the following remarks were written on the tag: "C/W shotpeening NDT, inspected OK. O/H'd ASB 58B35-26A C/W.
Printed on the tag, in part, was the following statement: "The item identified above was inspected...and is approved for return to service...."

Sikorsky's Chief, Aircraft Safety Investigation, reported to the Safety Board investigator that after the input pinion is reworked pursuant to all the procedures indicated in Alert Service Bulletin No. 58B35-26, the component is to be marked with the following letters "TS-200-1." Input pinions marked with "TS-200-1" are assigned a life limit of 2,000 hours per the ASB.

According to a "Component Log Card," the input bevel gear, identified by serial number AH713 F721 TS-200-1 was installed in N15AH on June 3, 1994. At the time, the helicopter's time was listed as being 6,054.5 hours.

On a document bearing the name Sikorsky Aircraft, and referring to the major component named "Intermediate Gear Box," S/N 58-1420, the subject input bevel pinion gear was listed with the remarks "Retire in 2000 hours."

Based upon the subject pinion gear having zero time, a 2,000-hour life limit, and having been installed in the helicopter at 6,054.5 hours, the part's life would expire at 8,054.5 hours. The accident helicopter's total time at impact was 7,879.1 hours (7,878.1 hours at the start of the day's flight, plus 1.0 hour during the day's flight). The subject pinion gear broke about 175.4 hours prior to reaching its life limit (8,054.5 - 7,879.1 hours).

ADDITIONAL INFORMATION

The main helicopter wreckage was released to the owner's assigned insurance adjuster on July 14, 2003. No original records were retained.

Pilot Information

Certificate:	Airline transport	**Age:**	51,Male
Airplane Rating(s):	Single-engine land; Single-engine sea	**Seat Occupied:**	Right
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 With waivers/limitations	**Last FAA Medical Exam:**	December 1, 2002
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 1, 2002
Flight Time:	14500 hours (Total, all aircraft), 1500 hours (Total, this make and model), 14300 hours (Pilot In Command, all aircraft), 100 hours (Last 90 days, all aircraft), 40 hours (Last 30 days, all aircraft), 2 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Sikorsky	**Registration:**	N15AH
Model/Series:	S-58ET	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	58-1563
Landing Gear Type:	Tailwheel	**Seats:**	11
Date/Type of Last Inspection:	June 1, 2003 100 hour	**Certified Max Gross Wt.:**	13000 lbs
Time Since Last Inspection:	11 Hrs	**Engines:**	2 Turbo shaft
Airframe Total Time:	7879 Hrs at time of accident	**Engine Manufacturer:**	Pratt & Whitney
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	PT6T-6
Registered Owner:	ARIS Helicopters, Ltd.	**Rated Power:**	1875 Horsepower
Operator:		**Operating Certificate(s) Held:**	
Operator Does Business As:		**Operator Designator Code:**	CAXL

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TOA,103 ft msl	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	09:57 Local	**Direction from Accident Site:**	336°
Lowest Cloud Condition:	Few	**Visibility**	4 miles
Lowest Ceiling:	Broken / 15000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	23°C / 18°C
Precipitation and Obscuration:	N/A - None - Haze		
Departure Point:	Rancho P.Verdes, CA	**Type of Flight Plan Filed:**	None
Destination:	Rancho P.Verdes, CA	**Type of Clearance:**	None
Departure Time:	10:15 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious	**Latitude, Longitude:**	33.754444,-118.330001

Administrative Information

Investigator In Charge (IIC):	Pollack, Wayne
Additional Participating Persons:	Kenneth Brock; Federal Aviation Administration; Long Beach, CA
Original Publish Date:	March 28, 2006
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=57490