Aviation Investigation Final Report

Location:	Jordan, Minnesota	**Accident Number:**	CHI02LA163
Date & Time:	June 11, 2002, 13:30 Local	**Registration:**	N8542D
Aircraft:	Bell 47G-2A-1	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	1 Minor
Flight Conducted Under:	Part 137: Agricultural		

Analysis

The helicopter was substantially damaged during a forced landing to a swamp after a total loss of engine power. The purpose of the flight was to spray for mosquito control. Inspection of the engine revealed that the compressor coupling shaft to the spur adapter gear shaft had damaged splines on the turbine driven end of the coupling shaft. Examination of the turbine end of the exhaust collector revealed that the circumferential weld joining the mounting flange to the bifurcated duct was non-uniform, discontinuous, and displayed a heat tint on both sides. Closer examination revealed places where the duct material; adjacent to the weld was slightly buckled and displayed indications of being impacted. The exhaust collector was dimensionally checked on a co-ordinate measuring machine (CMM). The CMM indicated that the flatness of the attaching flange for the pilot diameter displayed localized variation. As the print specifies that the centerline of the collector is established from the turbine pilot diameter and its attaching flange surface, their discrepancies resulted in a run out error on the gearbox pilot diameter.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The loss of engine power due to improper maintenance by unknown maintenance personnel which led to a misalignment of the gearbox casing.

Findings

Occurrence #1: LOSS OF ENGINE POWER
Phase of Operation: MANEUVERING - AERIAL APPLICATION

Findings
1. (C) TURBOSHAFT ENGINE,GAS GENERATOR TURBINE SHAFT
2. (C) MAINTENANCE,ALIGNMENT - IMPROPER - UNKNOWN

Occurrence #2: FORCED LANDING
Phase of Operation: DESCENT - EMERGENCY

Occurrence #3: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: EMERGENCY LANDING

Findings
3. TERRAIN CONDITION - SWAMPY

Factual Information

On June 11, 2002, at 1330 central daylight time, a Bell 47G-2A-1, N8542D, operated by Scott's Helicopter Services Inc., was substantially damaged during a forced landing on a swamp approximately two miles south of Jordan, Minnesota. The helicopter experienced a total loss of engine power during a spray run for mosquito control. Visual meteorological conditions prevailed at the time of the accident. The 14 CFR Part 137 aerial application flight was not operating on a flight plan. The commercial pilot reported minor injuries. The flight departed from Jordan, Minnesota, about 1320.

The pilot stated in a written statement that he completed two swaths in applying mosquito larvicide when the engine lost power during a turn and entry to the third swath at 50 feet above the ground. The pilot performed an autorotation into a swamp area with tall grass. The pilot then exited the helicopter with back pain.

The helicopter was originally powered by a reciprocating engine. A supplemental type certificate (STC) SH657NW permits the installation of Rolls Royce Allison engine models: 250-C18A, -C18C, -C20, and -C20B gas turbine engines. The engine transfer record for the accident engine, model number 250-C18, serial number CAE 800951B, indicated that it was shipped to Davis/Monthan Air Force Base in November 1984 with a total time of 7,250.1 hours; the equipment operating log entry for November 1985 indicated a total time of 6,773.1 hours. The last entry in the equipment operating log was dated November 1985 and indicated a total time of 7,250.1 hours. In February 2001, the accident engine, with the same total time of 7,250.1 hours, was installed onto the accident helicopter. On the day of the accident, the total engine time was reported as 7,470.6 hours.

Field inspection of the engine by the Federal Aviation Administration (FAA) and Rolls-Royce Allison revealed that the turbine to compressor coupling shaft to the spur adapter gear shaft had damaged splines on the turbine driven end of the coupling shaft. The adapter and coupling was sent to the National Transportation Safety Board's Materials Laboratory for further examination.

According to the NTSB's Materials Laboratory Factual Report, which is included in the public docket of this report, indicated that the spline adapter, part number "...784 (the last three digits were all that was discernible), serial number 39753, exhibited a blackened diameter from the compressor end with circumferential scoring. For approximately 0.15 inches after the blackened diameter, a chamfered face on the splines was similarly blacked, scored, and displayed a burr on its edges. The remaining portion of the splines displayed circumferential scoring and burred edges. Based upon design drawings, missing splines were present and the diameter of the remaining splines were within the drawing specifications.

Design drawings reflect the spline adapter minimum core hardness value as 30 Rockwell "C" scale (HRC). The spline adapter was section into three pieces which underwent HRC core hardness testing. The average harness at the turbine end was 40.2 HRC and the average hardness at the compressor end was 34.0 HRC.

The coupling, part number 6898977, serial number AE 41271, exhibited a rubbing pattern consisting of light circumferential scratches aligned along the coupling axis. A light gray band, about 0.45 inches in width, which consisted of faint stripes and oriented along the coupling axis, was present about 0.4-0.85 inches from the turbine end.

The splines at the turbine end exhibited damage, which consisted of lost material from the spline crowns contained in a band approximately 0.45 inches wide. These splines contained cracks at each of their roots. The crack surfaces contained ratchet marks, features consistent with fatigue.

The engine manufacturer's representitive indicated that splines are nitrided to a depth of 0.011-0.015 inches with a required minimum hardness of 90 HR15N (Hardness, Rockwell, 15 kg load, "N" indenter). The representative also indicated that the required core hardness for the coupling was 26-32 HRC. Measurements and microhardness testing on the mounted section revealed that the nitrided layer was 0.011 inches thick and the average of three hardness tests was 91 HR15N. The microhardness testing also revealed that the average of three hardness test in the core of the mounted section was 45 HRC. Hardness testing was also performed on a section removed from an unaffected portion of the coupling, approximately 1.3 inches from the turbine end, and revealed an average core hardness of 24 HRC.

Examination of the turbine end of the exhaust collector revealed that the circumferential weld joining the mounting flange to the bifurcated duct was non-uniform, discontinuous, and displayed a heat tint on both sides. Closer examination revealed places where the duct material; adjacent to the weld was slightly buckled and displayed indications of being impacted.

The exhaust collector was returned to the manufacturer for dimensional checking under FAA oversight on a co-ordinate measuring machine (CMM). The CMM indicated that the flatness of the attaching flange for the pilot diameter displayed localized variation. As the print specifies that the centerline of the collector is established from the turbine pilot diameter and its attaching flange surface, their discrepancies resulted in a runout error on the gearbox pilot diameter.

The Federal Aviation Administration, Scott’s Helicopter Services Inc., and Rolls-Royce Allison were parties to the investigation.

Pilot Information

Certificate:	Commercial; Private	**Age:**	38,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 2 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	March 18, 2002
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 29, 2001
Flight Time:	2678 hours (Total, all aircraft), 2575 hours (Total, this make and model), 2625 hours (Pilot In Command, all aircraft), 90 hours (Last 90 days, all aircraft), 30 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N8542D
Model/Series:	47G-2A-1	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3546
Landing Gear Type:	Skid	**Seats:**	2
Date/Type of Last Inspection:	December 27, 2001 Annual	**Certified Max Gross Wt.:**	2910 lbs
Time Since Last Inspection:	98 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	8472 Hrs	**Engine Manufacturer:**	Rolls-Royce
ELT:	Not installed	**Engine Model/Series:**	C-18B
Registered Owner:	Scott's Helicopter Services Inc.	**Rated Power:**	317 Horsepower
Operator:		**Operating Certificate(s) Held:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 2200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	2 knots / 0 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	180°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.88 inches Hg	**Temperature/Dew Point:**	27°C / 21°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Jordan, MN	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	13:20 Local	**Type of Airspace:**	Class G

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:**	44.660259,-93.629287(est)

Administrative Information

Investigator In Charge (IIC):	GALLO, MITCHELL
Additional Participating Persons:	Larry Landis; Federal Aviation Administration; Minneapolis, MN Michael D Conrad; Scott's Helicopter Service; Le Sueur, MN John J Swift; Rolls-Royce Allison; Indianapolis, IN
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Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=54941