Aviation Investigation Final Report

Location:	SABINE PASS, Texas	**Accident Number:**	FTW96FA265
Date & Time:	June 21, 1996, 07:50 Local	**Registration:**	N2906T
Aircraft:	Mbb BO-105	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	4 Fatal
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

The twin engine helicopter was en route to an oil platform located 90 miles south of Sabine Pass, Texas, in the Gulf of Mexico. The pilot called company dispatch and reported off Sabine at 0711 with 2.5 hours of fuel on board. The company's flight following radio log shows that the pilot made a normal position report at 0729 and reported that he was 67 miles from destination. The pilot transmitted another normal position report at 0744 and reported that he was 38 miles from destination. No other radio transmissions were received from the aircraft. According to the chief pilot, the altitude at which the helicopter would have been cruising at would most likely have been between 500 and 1,000 feet AGL. No abnormalities were discovered with the engines during detailed examinations. Tear down of the main transmission revealed that the sun gear had failed, thus resulting in the main rotor system not being driven. Structural deformations of the airframe revealed that the helicopter impacted the water vertically in a high rate of descent.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of the sun gear within the main transmission resulting in the main rotor system not being driven.

Findings

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

Findings
1. (C) ROTOR DRIVE SYSTEM,MAIN GEARBOX/TRANSMISSION - FAILURE,TOTAL
2. AIRCRAFT CONTROL - NOT POSSIBLE - PILOT IN COMMAND

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
3. TERRAIN CONDITION - WATER

Factual Information

HISTORY OF FLIGHT

On June 21, 1996, approximately 0750 central daylight time, a Eurocopter Mbb BO-105 CBS-4, N2906T, was destroyed after impacting water approximately 70 nautical miles south of Sabine Pass, Texas, in the Gulf of Mexico. The twin engine helicopter, owned and operated by Air Logistics Inc. as a Title 14 CFR Part 135 air taxi passenger flight, was en route to an oil platform located 90 miles south of Sabine Pass. All 4 occupants, the airline transport rated pilot and 3 passengers, were fatally injured. A company flight plan was filed and visual meteorological conditions prevailed.

According to the company flight plan, the helicopter departed the Sabine Pass field base (95XS) at 0711 to transport 3 oil workers to High Island platform A-555. Company employees at the base reported that, the scheduled flight departed on time and nothing out of the ordinary was observed prior to and during departure. The pilot called company dispatch and reported off Sabine at 0711 with 2.5 hours of fuel on board (according to the chief pilot, 2.5 hours of fuel is "topped off" with approximately 1,020 lbs. of fuel). The company's flight following radio log shows that the pilot made a normal position report at 0729 and reported that he was 67 miles from destination. The pilot transmitted another normal position report at 0744 and reported that he was 38 miles from destination. No other radio transmissions were received from the aircraft. The company's published flight following procedures requires each aircraft to transmit position reports every 15 minutes after departure. The next position report was due from the accident aircraft at 0759. The pilots of 5 other aircraft which were monitoring the same company frequency at the time of the accident, reported that they did not hear any emergency transmissions or any unusual radio traffic. Although unlikely, it is feasible that a radio transmission from the accident aircraft between 0744 and 0759 could have been masked by other transmissions on that frequency.

According to the chief pilot, the altitude at which the helicopter would have been cruising at would most likely have been between 500 and 1,000 feet AGL. No radar data was available to verify position or altitude (out of range for ATC coverage).

PERSONNEL INFORMATION

The pilot held a rotorcraft-helicopter Airline Transport Pilot Certificate with a VFR Commercial Pilot Type Rating in Cessna Citation 500, Airplane Single and Multi Engine -Instrument, CFI Rotorcraft-Helicopter, and an A& P Certificate. His current FAA medical certificate was second class with no limitations or waivers, and was dated June 6, 1996. He had been employed by Air Logistics as a helicopter pilot since August 15, 1983. His total flight time was approximately 20,459 hours, 18,692 of which were in helicopters. He had no history of

previous accidents, incidents, or flight violations and his total experience in Gulf helicopter operations was 16 years (approximately 12,000 flight hours).

According to a company check airman, the pilot demonstrated power recovery auto-rotations in a BO-105 helicopter during his most recent annual re-qualification on November 17, 1995. Full touchdown practice auto-rotations in the BO-105 were not practiced. Company records showed that the pilot completed re-qualification training in Bell BHT-206 helicopter on August 8, 1995. During this training the pilot accomplished two straight-in, and two 180 degree turn auto-rotations (full touch down). Additionally, company training policy requires pilots to demonstrate full touchdown practice auto-rotations to the water in Bell 206 helicopters. According to FAA regulations, there is no requirement to demonstrate full touchdown practice auto-rotations.

According to company records, the pilot worked normal duty hours from June 13 through June 21. Personnel based at Sabine observed that the pilot seem to have had regular sleep cycles for work days prior to the accident. They stated that he usually was in bed (quarters located at the base) by 2300 each night.

AIRCRAFT INFORMATION

The MBB BO-105 CBS-4 (originally a CBS-2 model), serial number S-573 was manufactured in March, 1982, and the current Standard Airworthiness Certificate was issued on March 29, 1991. The helicopter was acquired by Air Logistics in November, 1995. Airframe total time at the time of the accident was 10,596.3 hours.

The aircraft was being maintained in accordance with the Air Logistics Approved Aircraft Inspection Program (AAIP). The program contains a Daily Service Check (DSC), a 50 hour Preventative Maintenance Inspection (PMI), a series of 5 separate phase inspections conducted 150 hours apart, a 2,500 hour major airframe inspection, and "additional" maintenance items that are stand-alone inspections. The description and details of the inspection program are contained in the Air Logistics Maintenance Manual and is FAA approved.

A detailed review of the aircraft maintenance records indicated that all of the inspections required by the AAIP had been complied with. A Daily Service check had been performed on June 20, 1996, the night before the accident. The last 50 hour PMI was performed on June 17, 1996, 20.2 flight hours prior to the accident. The last phase inspection (Phase 5) was conducted on June 16, 1996, 26.4 flight hours prior to the accident. Additionally, 300 hour swashplate, and 6 month float assembly inspections were conducted on June 15, 1996.

Recent significant maintenance performed on the helicopter included the installation of the main transmission (S/N 1165) and main rotor assembly. Interviews of company maintenance personnel at the Sabine Pass, Texas, Air Logistics base, where the maintenance was performed, revealed that the main transmission and rotor assemblies were installed as a

complete unit, (i.e. rotor system installed on the transmission). The tail rotor intermediate gearbox and tail rotor pitch change links were also replaced at the same time. The above maintenance was performed on June 15, 1996, and the aircraft flew 27 hours after the installations prior to the accident.

Airworthiness Directive (AD) compliance was verified using the maintenance records and were visually inspected on the aircraft (during wreckage examination) for compliance. The non-applicable AD's were verified to be "non-applicable". All pertinent AD's were complied with and verified. A detailed review of the airframe maintenance records revealed no uncorrected defects or anomalies.

The helicopter was powered by two Allison 250-C20B turbo shaft engines. Engine #1 (left side), serial number CAE-832097, had a total operating time of 11,861.0 hours. It was installed on the airframe on August 20, 1993. Engine #2 (right side), serial number CAE-830480, had a total operating time of 12,802.6 hours. It was installed on the airframe on August 15, 1990. A review of both engines' maintenance records revealed that all overhauls and inspections of the accessory, gearbox, compressor, and turbine sections were properly complied with, and no anomalies or uncorrected defects were found.

Note: A detailed list of the last 90 days of verified maintenance history of the aircraft and a list of significant maintenance events for transmission, S/N 1165, are attached to this report.

METEOROLOGICAL INFORMATION

High Island weather station H08, located on platform HI 264, reported the following observation at 0730: 5000 scattered, 20 miles visibility, temperature 83 degrees, dew point 74 degrees, winds from 100 degrees at 10 knots, altimeter 29.92. Sea state reports ranged from 1 to 3 foot swells in the area of the accident.

COMMUNICATIONS

No distress calls were reported from the aircraft.

WRECKAGE AND IMPACT INFORMATION

At the request of the NTSB IIC, the wreckage recovery portion of the investigation was delegated to Air Logistics, party to the investigation. Recovery events were documented with under water video and still photography once the wreckage was brought to the surface. This documentation was valuable to the investigation team as it was used as a means of distinguishing recovery damage from impact damage.

After 3 days of searching, a sonar contact was made at coordinates; North 28 degrees 27 minutes 84 seconds, West 94 degrees 15 minutes 24 seconds. At 1628 June 24, 1996, a diver confirmed contact with Air Logistics BO-105, N2906T. The location of the wreckage was

oriented on line with a straight course from Sabine base to the intended destination (High Island platform A-555). The following information is submitted as the aircraft was found in-situ on the ocean floor:

The divers found the helicopter laying on its left side with the skid mounted floats not deployed. The right float bag was torn away from the aircraft and the float bottle was exposed. The tail boom was found structurally separated from the fuselage and was only attached by wiring. The rotor head was attached to the mast and gear box, and all four blades were attached to the blade grips. Three of the blades were full length and appeared relatively undamaged. The fourth blade was found fractured approximately eight feet outboard. The under carriage was severely crushed upward and the fuel bladders were found exposed.

After the extraction of the occupants, the aircraft was pulled to the surface. The rotor blades were cut off and marked to facilitate raising the wreckage to the surface. About twenty feet off the bottom, the main transmission began to separate from the fuselage. When the aircraft broke the surface, it had completely come apart. It was held together by the transmission mounting point on the right side of the transmission deck. At the conclusion of recovery operation, the aircraft had been submerged for approximately 157 hours. The recovery effort was completed in water temperatures of approximately 67 degrees and a water depth of 130 feet.

All major components of the helicopter to include the main rotor blades, hub assembly, fuselage, tailboom, tail rotor drive shaft, flight controls, powerplants, skids, and hydraulic pack were found at the same location on the sea bottom. Aircraft parts found floating on the surface during the initial search included; 2 clam shell doors, the right side of the fairing that houses the tail rotor drive shaft from the intermediate gearbox to the 90 degree gearbox, the radio compartment door from the baggage compartment, a portion of the left engine air intake cowl, and a 6 inch by 36 inch piece of MRB skin.

After recovery, the airframe and powerplant components were examined by the investigation team, under the direction of the NTSB investigator-in-charge. Deformation signatures throughout the structure and dynamic components showed evidence that the aircraft impacted the water with a high rate of descent, level pitch attitude, slightly left skid down, with minimal forward momentum. The following facts are presented as they were discovered by the investigation team during examination of the helicopter wreckage at a secure hangar facility:

The cabin floor, which was found severely crushed upward, exhibited fractures across the span in the following locations: just aft of the pilots radio console; just aft of the forward cross tube; just forward of the main fuel tank; and just forward of the main tank fuel quantity probe. The bottom left side of the fuselage structure was crushed upward just inboard of the landing gear cross tube mount. The skid assembly was found intact and attached to the fuselage with the exception of 28 inches of the left front skid, which was found separated during the recovery. Cross tube support structure exhibited minimal deformation.

The cabin roof was crushed downward and the main transmission mounts were found fractured in compression. Together with the turbine deck, the main transmission, rotor mast, and rotor head were displaced downward, forward and to the left. The 2 power levers on the overhead panel were found in the flight (full power) position; however, both levers may have been pulled to that position during the impact by the throttle control cables extending to the engine deck. Two indentations/slap marks were found on the throttle control quadrant adjacent to the throttle closed position. The indentations correlate to the width and movement of the power levers within the control quadrant. The mast moment indicator needle was found in the "yellow" range. The master caution panel was found intact on the instrument console. The panel was removed and a light bulb analysis was performed.

Examination of the flight controls revealed the following:

According to the manufacturer, the helicopter was originally equipped with dual controls; however, it was modified to facilitate a passenger in the left front crew seat. The left side pedals, cyclic, and collective were removed and properly covered. The pilot's control stick was bent in compression and the collective grip was fractured. All control rods in the nose section lower front fuselage were fractured in several locations due to overload. The control rods connecting to the tandem hydraulic unit were found fractured in compression overload. The tandem hydraulic unit was found basically undamaged with the exception of one hydraulic line, which was broken off. Examination of the 2-system hydraulic unit revealed that the helicopter was operating on the #1 system (i.e., the normal operating system). The connecting link between system #1 and system #2 was measured without removal and found to be 25mm. The specified value is 25.1mm. Both #1 and #2 system reservoirs exhibited normal filling and both filters were clean, and the buttons were not popped. The unit was free to move in all three axis. The boost control rods, "Lateral" & "Collective", were fractured in compressive overload and the "Longitudinal" rod was bent. The "Lateral" mixing lever exhibited bending rearwards. The swashplate, including input controls, were without visible damage. All rotating pitch links were attached and found to be properly fitted to the blade control levers. The blue pitch link rod was bent inward on its lower section. All main rotor blade controls were movable.

In summary, no pre-existing problems were found in the flight control system.

The tailboom was found intact and was connected to the main structure by lines and cables. The lower right portion of the boom exhibited compression damage upward along its length. The upper mounting rivets were found sheared toward the rear and the lower forward portion of the boom was buckled upward. The vertical fin was separated at the intermediate gearbox area. The failure appeared to be aft and to the right. The horizontal stabilizer was intact with the exception of the left vertical end plate lower end cap, which was missing. The stabilizer, outboard of the right end plate, was bent inboard toward the boom. The tail skid tube was bent slightly to the left.

The tail rotor drive shaft was intact from just aft of the main transmission rearward to the intermediate gearbox. All couplings were found intact with the exception of the transmission gear box to short drive shaft, and the coupling connecting the tail rotor 90 degree gear box. All three drive shaft sections exhibited some degree of bending. The forward coupling (adjacent to the transmission gear box) showed evidence of tension with some torsion. The coupling to the 90 degree gear box exhibited evidence of tension. The #2, #3, and #4 bearing supports showed evidence of shifting aft from the impact forces.

The intermediate gear box was found attached to the vertical fin. The couplings on the input and output sides of the box were found slightly distorted but intact. The gear box case was intact, but rotation by hand could not be accomplished; however, examination of the internal gears did not reveal evidence of sudden stoppage or oil starvation.

The chip detector was dry and clean. No fluid was visible in the sight gauge. The 90 degree gear box was found connected to the upper vertical fin. It was intact and rotated by hand on both input and output. The chip detector was moist with water and oil and had 1 small chip.

The tail rotor head and pitch links were intact and connected. One tail rotor blade was separated just outboard of the blade grip and was not recovered. The other blade was mostly intact and exhibited no leading edge damage.

Examination and tear down of engine #1, mounted on the left side of the aircraft, revealed the following:

The engine mounts were broken, and the engine was resting on the compartment deck. The fuel control lever was found in the "off" position when examined in the hangar. It is unknown what position the lever was in before the recovery effort. The cable to the fuel control was broken between the fuel control and the power lever. The N1 and N2 rotor systems were locked up. The upper and lower chip plugs were clean of any metal chips. They were coated with a white gray pasty mixture of oil, sea water, and magnesium corrosion by-products.

The compressor inlet was covered with by-products of the magnesium corrosion. There were no signs of FOD on the inlet guide vanes. The compressor rotor, vanes, and blades exhibited severe corrosive effects from the salt water immersion. The compressor case lining was intact and showed normal wear. All blades and vanes were present and there was no signs of FOD. Both #1 and #2 bearings spun freely, and were oil wetted. The impeller shroud exhibited about a 35 degree segment of scraping near the impeller exit.

The outer combustion case was dented on the under side adjacent to the fractured engine mounts. There were no signs of over-temperature operation, or streaking within the combustion liner.

There were no holes or bulges in the turbine case. Examination of the turbine section revealed contact rub marks between the second stage turbine wheel and the corresponding shroud. The

first stage exhibited rub between the blade tips and the shroud, on a 35 degree segment. Minor rub marks on the shroud corresponded to the position of the third stage wheel. The shroud exhibited severe rub marks on a 40 degree segment adjacent to the fourth stage wheel. N1 and N2 couplings were basically intact and all bearings in the turbine were oil wetted and spun freely. There were no missing, bent, or cracked turbine blades on any of the stages and no evidence of over-temperature operation was found.

All fuel lines were tight and fuel was present in all lines from the fuel pump to the fuel nozzle. The low and high pressure fuel filters were clean, and the fuel in all lines was clean with no water. The only exception was in the low pressure fuel filter, the fuel in the bowl contained some water, about half fuel and half sea water. The shafts of the fuel control and the governor were free to turn.

The gearbox was severely corroded from the salt water immersion. It contained several holes from the corrosive effects of the salt water (internal components were visible through the holes). Tear down of the gearbox revealed no missing gears and all the gears were oil wetted. The interior of the case was filled with a pasty mixture of magnesium corrosion by-products, oil, and salt water.

Examination and tear down of engine #2, mounted on the right side of the aircraft, revealed the following:

The engine mounts were broken, and the engine was resting on the turbine deck. The turbine top mount bolt was found pulled out of the gearbox case. The fuel control lever was found in the full "on" position when examined in the hangar. It is unknown what position the lever was in before the recovery effort. The cable to the fuel control was broken between the fuel control and the power lever. The N1 and N2 rotor systems were locked up.

The compressor inlet was covered with by-products of the magnesium corrosion. There were no signs of FOD on the inlet guide vanes. The compressor rotor, vanes, and blades exhibited sever corrosion effects from the salt water immersion. The compressor case lining was intact and showed normal wear. All blades and vanes were present there was no signs of FOD. Both #1 and #2 bearings spun freely, and were oil wetted. The impeller shroud exhibited about a 40 degree segment of scraping near the impeller exit.

The outer combustion case was dented on the under side due to impact, and the engine mount fractured. There were no signs of over-temperature operation, or streaking within the combustion liner.

There were no holes or bulges in the turbine case. There were no contact rub marks between the first and second stage turbine wheel and their corresponding shrouds. Minor rubs were found on the shroud adjacent to the third stage wheel. The shroud exhibited severe rub marks on a 40 degree segment adjacent to the fourth stage wheel. The turbine to compressor coupling and the N2 coupling were corroded due to the salt water environment. The N2

coupling was fractured just aft of the forward ring groove and the shaft was bulged out just aft of the fracture. It was also bulged out between the forward ring groove and the forward spline. All bearings in the turbine spun freely and were oil wetted. There were no missing, bent, or cracked turbine blades on any of the stages and no signs of over-temperature operation.

All fuel lines were tight and fuel was present in all lines from the fuel pump to the fuel nozzle. The low pressure and high pressure fuel filters were clean and the fuel in all lines was clean with no water. The only exception was in the low pressure fuel filter, the fuel in the bowl contained some water, about half fuel and half sea water. The main fitting for the fuel inlet exhibited impact damage and the fitting was dislodged from the pump housing. The shafts of the fuel control and the governor were corroded but free to turn.

The gearbox was severely corroded from the salt water immersion. It contained several holes from the corrosive effects of the salt water where you could see the interior of the gearbox. Tear down of the gearbox revealed no missing gears and all the gears and bearings were oil wetted. The interior of the case was filled with a pasty mixture of magnesium corrosion by-products, oil and salt water. The upper and lower chip plugs were clean of any metal chips. They were coated with a white gray pasty mixture of oil, sea water, and magnesium corrosion by-products.

In summary, no evidence of failure or over speed was found during the engine examinations.

All four main rotor blades (MRB) were found attached to the rotor head assembly. The blade mounting grips were intact and not damaged. All 4 rotating pitch links were intact and free to move when rotated by hand. All pitch levers were found intact and the scissors (drive link) assembly was attached undamaged. Collective and longitudinal mixing levers were not damaged and the lateral mixing lever exhibited slight bending downward. The bearing support for the collective mixing lever fork was found offset from center and the lateral and collective control rods were fractured due to compression loads. The longitudinal control rod exhibited bending at the rod ends. The rotor star and inner sleeve assembly, including the blade grips and attaching hardware (nuts, bolts, pins), were not damaged.

All 4 main rotor blades were cut just outboard of the pendulum absorbers (vibration dampers) to facilitate recovery from the sea bottom. Each MRB end was marked by divers with saw cuts to identify positions after salvage. The following MRB damage was documented:

Blade #1; No saw cuts, and structurally intact. The blade face exhibited minor scrapes and abrasions associated with recovery damage. The trim tab was bent and there was no leading edge damage.

Blade #2; One saw cut, and structurally intact. Minor scrapes and abrasions associated with recovery. Dent on the underside near the blade tip. No leading edge damage.

Blade #3; Two saw cuts, and the bottom skin at the inboard trailing edge just outboard of the

pendulum absorbers was found separated in a section measuring approximately 36 inches spanwise and 5 inches chordwise. The leading edge protection strip, approximately 3 feet outboard of the pendulum absorber was separated. The blade root was partially fractured at the blade root just outboard of the grip (not separated). Minor scrapes and abrasions and no leading edge damage.

Blade #4; Three saw cuts, and fractured approximately 5 feet outboard of the pendulum absorbers. Three standard repairs were noted on the leading edge which was not damaged and the blade face had minor scrapes and abrasions.

The rotor brake piston was found in the open position. No malfunction was evident.

Examination and disassembly of the main transmission, S/N 1165, revealed the following:

The magnesium case housing was basically intact but severely corroded due to salt water immersion. Several holes (caused by corrosion) in the lower part of the case allowed viewing of some of the some of the internal components. The transmission chip detector plug contained two small metal chips, and was found coated with white powdery deposits of magnesium corrosion.

After removal of the upper housing assembly, the sun gear, serial number 839f, was found severely damaged with all of the gear teeth missing down to their roots on the shaft. The 5 planetary gears had no missing teeth, but all the teeth were found heavily scalloped along the length of the gear teeth. There were signs of high metal temperatures and the scalloped deformation corresponded to the width of the ring gear. The ring gear was found basically intact and exhibited some heat discoloration. Metal debris was found smeared into the grooves of the ring gear teeth. The remaining parts from the planetary system (i.e. bearings, thrust washers, etc.) exhibited normal wear. All the magnesium housings were excessively corroded due to salt water immersion. Many parts inside the transmission were coated with a milky white powder of magnesium corrosion by-products. There were dark deposits found on the inside top of the case housing.

The rotor mast was free to rotate after the transmission case was separated. The tail rotor drive gear, fan drive gear, and accessory drive gear exhibited normal wear. The oil nozzle ring (lubrication system for the sun gear area) had its 18 holes blocked by the white powdery deposit of corroding magnesium. The oil channel (the horizontal channel which feeds the nozzle ring) was blocked by white deposits. Other than the white deposits, no other debris was found within the sun gear oiling system. The collector gear assembly was not damaged and the following gear meshes in the lower section were found undamaged: collector stage, input stages (left and right). The collector assembly was found sagging due to no support from the corroded housing. The oil pump was found clean, and without any debris or marks inside the pump. The airframe mounted oil filter appeared normal and the oil in the filter bowl was found contaminated by sea water.

In summary, examination of the main transmission components and sub components revealed no pre-existing anamalies other than the sun gear (serial number 839f) gear teeth failures. According to the transmission manufacturer, the scalloped planet gears were resultant from the sun gear teeth failures. The manufacturer also stated that there was no evidence of assembly misalignment or improper maintenance prior to the failure.

MEDICAL AND PATHOLOGICAL INFORMATION

Results of pilot's autopsy indicated that the cause of death was blunt force trauma/massive internal injuries. Toxicology tests were not performed due to the lack of suitable specimens.

SURVIVAL FACTORS

The pilot and two of the three passengers were found within the wreckage One passenger was not recovered. The recovered bodies were found in their seats with seat belts locked. The empty seat, aft right side, was found to have its seat belt locked. There was no evidence of an egress and none of the onboard inflatable life jackets were deployed. Both pilot and co-pilot seat support structures were crushed downward approximately 7 inches and tilted forward and to the left. The 4 point seat belts and shoulder harnesses were intact and were reported to have been fastened during recovery.

Both left and right floats were not deployed. The gang bar in cockpit for arming and activation was found safety wired and not actuated. The left float pressure bottle was found charged and the right float pressure bottle was found discharged.

TEST AND RESEARCH

Due to the discovered failure of the sun gear presented earlier in this report, research was done to examine the history of the main transmission, serial number 1165, and the individual sun gear, serial number 839f. According to records provided by Petroleum Helicopters Inc., Air Logistics, and the FAA, the following is an approximate chronological history of the sun gear and its relationship to the main transmission, serial number 1165:

1984: Sun gear, s/n 839f, installed in new main transmission, s/n 955. Main transmission, s/n 955, installed in new BO-105, s/n S-620, N2784E. Aircraft purchased, owned and operated by Evergreen Helicopters.

June 13, 1986: Helicopter, N2784E destroyed in an accident. NTSB report number FTW86FA116 concluded that a fatigue failure in one of the main rotor blades pitch change links resulted in the loss of control of the associated blade, leadind to an in-flight separation of the tail boom. The helicopter was uncontrollable and impacted the ground inverted from about 500 feet AGL. After the accident, Air Salvage of Dallas stored the wreckage for several years.

1991-1992: Rotorcraft of Broussard, Louisiana, purchased the wreckage from Air Salvage of

Dallas. Main transmission, s/n 955, sent to Petroleum Helicopters Inc. (PHI), Lafayette, Louisiana, for repair evaluation. After evaluation, PHI acquires the transmission and removes sun gear, s/n 839f.

December 4, 1992: PHI installs sun gear, s/n 839f, in transmission, s/n 1165, during an overhaul (PHI work order #923890)

December 12, 1992: Transmission, s/n 1165, case repaired due to a shipping accident. Transmission is then installed on BO-105, N54197.

October 28, 1993: Transmission, s/n 1165, removed from N54197 due to an oil leak.

November 15, 1993: Transmission, s/n 1165, repaired by PHI (work order #936173).

January 16, 1994: Transmission, s/n 1165, installed on BO-105, N1818X. Transmission total time was 6,218.8 hours. Time since overhaul was 897.5 hours.

November 1995: Air Logistics acquires N1818X from PHI. Transmission, s/n 1165, with sun gear, s/n 839f is still installed and has been operating with no reported problems.

December 20, 1995: Transmission chip detector light. Maintenance found 1/32 and 1/8 inch diameter chips on the detector plug. Total time was 6,486.3 hours. Time since overhaul was 1,165.0 hours.

January 2, 1996: Transmission chip detector light. Maintenance found a shorted wire. Total time was 6,542.7 hours. Time since overhaul was 1,221.4 hours.

January 4, 1996: Removed transmission, s/n 1165, from N1818X due to metal found in oil.

March 4, 1996: Air Logistics of Alaska repaired transmission due to metal in oil (work order #94272). Total time was 6,558.4 hours. Time since overhaul was 1,237.1 hours.

March 9, 1996: Transmission, s/n 1165, installed on BO-105, N352TT.

June 15, 1996: Transmission, s/n 1165, removed from N352TT and installed on N2906T. Total time was 6,885.5 hours. Time since overhaul was 1,564.2 hours.

June 21, 1996: BO-105, N2906T crashes in Gulf of Mexico. The helicopter had flown approximately 27 hours with transmission, s/n 1165, installed prior to the accident.

According to the above information, the sun gear, s/n 839f, was in service for approximately 1,593 hours since being installed in transmission, s/n 1165. Both PHI and Air Logistics operated helicopters with this transmission installed during that time period.

Transmission components from the accident helicopter were sent to the Materials Laboratory of the National Transportation Safety Board, Washington, D.C., for examination. The components examined were: the sun gear (attached to the bevel gear as a unit); 5 planetary gears (w/attaching axles, cage assemblies, and carrier housing); ring gear; center housing (w/collector ring and cover); upper housing assembly; and 2 bags of metal debris which was collected during the gear box disassembly. Also examined, was the triple temperature gauge, the triple oil pressure gauge, and a light bulb analysis was performed on the master caution light cluster.

According to the NTSB metallurgist, the cause of the disintegration of the gear teeth of the sun gear could not be determined because the fracture features were obliterated.

The faces of the triple temperature and oil pressure gauges were examined with a stereo microscope illuminated by incandescent and ultra-violet light. No needle slap marks were found.

Light bulb analysis of the master caution cluster revealed that 1 of the 48 filaments examined was stretched. The stretched filament corresponded to the "RPM Low" caution light. The transmission oil temperature bulbs were found not to be stretched.

Detailed reports of the above examinations are attached to this report.

According to the FAA Principal Operations Inspector (POI) of Air Logistics, the sudden catastrophic failure of the sun gear would be represented on cockpit instruments as engine over speeds and rotor RPM over speed. The pilot's reaction to this condition would most likely be the reduction of engine power and/or the addition of collective pitch to control the over speed conditions. The reason that the rotor RPM would indicate an over speed condition is due to the fact that the main rotor RPM transmitting device is located on the transmission beneath where the sun gear failed. Thus, the lower portion of the transmission was still driven by the engines with no associated loads from the main rotor system.

A fuel sample taken from the source was tested by an independent lab (Macro Oil, Lafayette, Louisiana) on July 3, 1996. The analysis was performed in accordance with ASTM, UOP, or GPA guidelines for quality assurance. No sediment or water was found in the sample. Additionally, 5 other Air Logistics helicopters refueled from the same source on the morning of the accident. According to Sabine Pass base manager, the accident aircraft refueled between 0530 and 0630 on the morning of the accident.

The original weight & balance (W&B) was not recovered from the aircraft. A reconstructed W&B was calculated using all available data collected during the course of the investigation. Pilot, passenger, and baggage weights were extracted from company manifest records. Fuel weight was estimated at maximum. According to the reconstructed W&B, the accident aircraft was 347 lbs. below max gross and within CG limits.

Aircraft Basic Weight 3394 Pilot Weight 226 Pax 1
160 Pax 2 170 Pax 3 150 Baggage
145 Fuel (maximum) 1020 Total Weight @ Takeoff 5265
A/C Max Gross 5512

ADDITIONAL INFORMATION

The wreckage and all components that were tested were released to the owner.

Pilot Information

Certificate:	Airline transport	**Age:**	48,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**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 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	June 6, 1996
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	20459 hours (Total, all aircraft), 664 hours (Total, this make and model), 18692 hours (Pilot In Command, all aircraft), 296 hours (Last 90 days, all aircraft), 95 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Mbb	**Registration:**	N2906T
Model/Series:	BO-105 BO-105	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	S-573
Landing Gear Type:	Skid	**Seats:**	5
Date/Type of Last Inspection:	June 16, 1996 AAIP	**Certified Max Gross Wt.:**	5512 lbs
Time Since Last Inspection:	26 Hrs	**Engines:**	2 Turbo shaft
Airframe Total Time:	10596 Hrs	**Engine Manufacturer:**	Allison
ELT:	Installed	**Engine Model/Series:**	250-C20B
Registered Owner:	OFFSHORE LOGISTICS	**Rated Power:**	420 Horsepower
Operator:	AIR LOGISTICS INC.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	AIR LOGISTICS	**Operator Designator Code:**	ALGA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	H08	**Distance from Accident Site:**	10 Nautical Miles
Observation Time:	07:30 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Scattered / 5000 ft AGL	**Visibility**	20 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	100°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29 inches Hg	**Temperature/Dew Point:**	83°C / 74°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	, TX (95XS)	**Type of Flight Plan Filed:**	Company VFR
Destination:	HIGH ISLAND 553, GM (NONE)	**Type of Clearance:**	None
Departure Time:	07:11 Local	**Type of Airspace:**	Class G

Airport Information

Airport:		**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	3 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	4 Fatal	**Latitude, Longitude:**	29.959457,-93.889541(est)

Administrative Information

Investigator In Charge (IIC):	Lemishko, Alexander
Additional Participating Persons:	SCOTT S SCHEURICH; INDIANAPOLIS , IN B.SCHWARZE & D. LIVINGSTON; GERMANY / USA W. FRY & C. BROWN; NEW IBERIA , LA E. METZ & H. BODENMILLER; GERMANY
Original Publish Date:	March 31, 1998
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=19649