Log 2515

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 21, 1994

In reply refer to: A-94-143 through -145

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D. C. 20591

On June 8, 1994, about 1139 local time, a Robinson R22 helicopter, registered in England as G-PUDD and operated by Bizzi-B Helicopters, broke apart during an instructional flight about 1,500 feet above ground level, near Martin, England. A witness about 1 1/4 mile from the accident site reported that he saw the helicopter flying normally and then heard a loud noise and observed the helicopter falling vertically to the ground with the main rotor assembly separated from the helicopter. The instructor pilot and student were fatally injured and the helicopter was destroyed. The instructor had accumulated 8,400 pilot flight hours, of which 5,200 hours were in the R22. The helicopter student held an airline transport pilot certificate (airplane) with approximately 4,000 hours of total flight time, including 22 hours in the R22. The investigation established that the helicopter was cruising at about 80 knots (nautical miles per hour) before the accident. The main wreckage (cockpit, skid assembly, and engine) came to rest inverted on level ground. The tailboom had separated from the fuselage and pieces were located 300 feet south of the main wreckage. The main rotor mast and rotor assembly had separated at the top of the transmission and were located about 100 feet from the main wreckage. The Safety Board and the Federal Aviation Administration (FAA) participated in the U. K. Air Accidents Investigation Board's investigation of the accident.

Examination of the wreckage revealed that the fourth tailboom bay aft of its fuselage attachment point was struck twice by the main rotor blades. One of the main rotor blades exhibited red paint transfer 10 inches from its tip that matched the red "DANGER" sign where the tailboom was struck. The blade was fractured 22 inches from the blade horn and was bowed approximately 8 inches downward. The other main rotor blade exhibited severe bending and twisting, and was fractured 14 inches from the blade tip. Examination of the tail rotor drive assembly showed no indications of preimpact failure.

The main rotor gear box (transmission), main rotor mast, and main rotor assembly were examined but no evidence of an initiating failure was found. The transmission upper cap and lower mast exhibited multiple overload fractures indicative of the mast rocking in flight. The

mating main rotor shaft exhibited an overload bending failure, and the upper portion of the shaft contained a 4° bend directly below the main rotor hub. Physical evidence indicates that the bending of the upper main rotor shaft occurred before the fracture of the transmission cap, and secondary to the main rotor blades traveling beyond their normal flapping range. One side of the upper swashplate was fractured at the outer arm and the corresponding pitch change link was also fractured. Examination of the recovered pieces indicated overload failures, with the arm of one main rotor blade horn striking the failed pitch change link. An instability of the main rotor, rocking of the mast, and extreme pitch divergence of the main rotor blades appeared to precede all of the fractures of the main rotor flight control system. The reason for the main rotor pitch divergence has not been determined and the investigation of the accident is continuing.

On August 10, 1993, about 1806 Hawaiian standard time, a Robinson R22 helicopter, N4017J, crashed into the Pacific Ocean about 8 miles southeast of Honolulu, Hawaii, during an intended pleasure flight. The airline transport pilot and his wife received fatal injuries. The pilot had logged 4,350 total flight hours and 140 hours of R22 flight time. An endorsement in his logbook indicated that the pilot had successfully completed the Robinson Helicopter Company Safety Course and biennial flight review in Torrance, California, on March 12, 1993. According to a certified flight instructor (CFI) who had instructed him, the pilot was proficient with emergency procedures in the R22. A witness kayaking in the ocean approximately 1/4 mile offshore indicated that the helicopter "appeared to be operating properly when all of a sudden it went down into the water." Another witness located aboard a catamaran said he saw "the front rotor blades' shaft bend toward the right side of the helicopter" and hit the helicopter body. The helicopter crashed into the water 50 to 75 feet from the catamaran. The last recorded radar data showed N4017J at an altitude of 500 feet above the ocean, 1/4 mile off the southeast coast of Oahu, and the radar track indicated that it was cruising at about 90 knots just before radar contact was lost. Examination of the retrieved wreckage revealed that one main rotor blade was bent downward and had entered the left forward section of the cockpit. The main rotor hub exhibited deep gouges where the droop stop tusks contacted the hub; the droop stop tusks were sheared. The upper transmission and lower mast remained intact; however, the upper main rotor shaft was bent approximately 30°, consistent with an aerodynamically divergent blade striking the body of the helicopter during powered flight. The Safety Board was unable to establish the exact cause of the main rotor blade divergence.[1]

On June 29, 1992, at 1242 Pacific daylight time, a Robinson R22 helicopter, N83858, operated by the Sierra Academy of Aeronautics, Inc., experienced an in-flight breakup during an instructional flight near Richmond, California. Witnesses reported observing the tailboom and main rotor separate from the helicopter in flight. A CFI was providing a primary flight lesson to his student, who was recording the lesson (cockpit interphone and radio communications) with a microcassette tape recorder. The recording revealed no operational difficulties during the engine start, ground checks, takeoff, or the 17-minute flight en route to a practice area. The low rotor revolutions per minute (rpm) warning horn was checked and

[1]For more detailed information, read Brief of Accident File #1420 (attached).

operated normally on the ground. While en route, the CFI instructed the student to perform a left turn. According to the recording, the student completed the turn using a shallow bank. While cruising southbound at about 2,000 feet, the CFI began talking, but in mid-word, with no prior indication of an anomaly, an undetermined event interrupted the CFI's speech and culminated in the breakup of the helicopter. A wind-like background noise then became evident on the tape and muffled the student's exclamation, "Help." The helicopter rapidly descended and crashed into San Pablo Bay, 3 miles northwest of Richmond, California. The CFI, who had accumulated about 2,000 hours of R22 flight time, and the student pilot were fatally injured.

The record of the flight provided by the audiotape showed that neither pilot voiced any concern with the operation of the helicopter before the breakup. The low rotor warning horn did not activate before or during the breakup sequence. The Safety Board's analysis of the audiotape revealed that during most of the flight the main rotor sound signature was measured between 17.5 Hz and 18 Hz, equivalent to a main rotor speed of 525 to 540 rpm.[2] No unusual rotor system noises were heard before the event that resulted in the in-flight breakup. The Safety Board's sound spectrum analysis of the audiotape indicated that the main rotor rpm did not decay before the breakup. Analysis of the recorded primary and secondary air traffic control (ATC) radar data supported an in-flight breakup scenario with the initial breakup occurring at 2,000 feet mean sea level (msl). The helicopter's indicated airspeed (IAS) was calculated from available radar data to have been about 85 knots in level, cruise flight when the main rotor blades suddenly departed from their normal rotational plane and impacted the tailboom.

After recovery from San Pablo Bay, the wreckage was examined for evidence of possible preimpact control system or airframe failures that might have initiated the breakup, but none were found. No evidence was found of control interference, and the swashplate, spindle bearings, and engine exhibited no signs of preimpact damage. The main rotor mast assembly, with the main rotor blades attached, was recovered about 970 feet north of the main wreckage. The assembly had separated from the upper portion of the helicopter's transmission housing. One main rotor blade was found curled 39° upward and both main rotor blades exhibited multiple red paint smears that appeared to match the tailboom paint. The aft portion of the tailboom (aft of the first bay area) was not recovered. However, a main rotor blade had left its impression in the crushed left side of the tailboom's first bay area. Both pitch change links exhibited bending overload failures and the tusks were fractured from each spindle, consistent with damage resulting from the divergence of the main rotor blades from their normal plane of rotation. This accident was unique among other R22 in-flight loss of main rotor control accidents in that the audio recording documented the event, and analysis of the audiotape showed that the failure occurred with main rotor rpm in the normal R22-powered operating range. The Safety Board could find no evidence of the specific event that caused or allowed the main rotor blades to diverge from their normal flightpath plane and strike the airframe.[3]

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[2]Normal R22 main rotor speed for powered flight is 495 to 530 rpm.

[3]For more detailed information, read Brief of Accident File #1003 (attached).

In the three accidents described above, the in-flight breakups occurred while the helicopters were being operated at cruise speeds well within the aircraft's defined operating envelope. In all cases the pilots were experienced and the investigation indicates that they had been adequately trained in the R22. The Safety Board has found no evidence that the pilots were improperly operating the helicopters. In addition to these three accidents, the Safety Board has investigated 18 others that have occurred since 1981 involving an in-flight breakup of an R22 helicopter. In all of these, the breakup occurred when the main rotor blades diverged from their normal plane of rotation and struck the airframe.

The R22 main rotor system is unique. The two-bladed, semi-rigid main rotor system includes rotor blades that are connected to the main rotor hub through coning (flapping) hinges.[4] The main rotor hub is connected to the main rotor shaft (mast) through an additional hinge so that the hub teeters with influence from main rotor blade movement. In other two-bladed, semi-rigid systems, the advancing blade flaps up, causing the retreating blade to flap down; however, each R22 main rotor blade flaps independently of the other blade's vertical movement. The chord and diameter of the main rotor blades measure 7 inches and 25 feet, 2 inches, respectively, and each blade weighs approximately 26 pounds. The main rotor rpm is much higher, and the rotor inertia is very low by comparison to other two-bladed rotor systems.

When in forward flight, the dynamic speed of the air over the rotor blade is the rotational speed of the blade algebraically added to airspeed. Thus, the airflow over the advancing blade is greater than the airflow over the retreating blade, and at a given pitch the rotor would create asymmetrical lift. To compensate, the lift generated by the advancing blade results in movement of the teetering hinge and tilting of the main rotor hub, such that the angle-of-attack (AOA) of the advancing main rotor blade is reduced and the AOA of the retreating blade is increased to balance the lift in the rotational plane. Thus, as the helicopter's forward airspeed increases, the advancing blade's AOA decreases as the retreating blade's AOA increases. However, if the AOA on the retreating blade exceeds the critical AOA, the blade will stall (retreating blade stall). The combination of large changes in the AOA of the main rotor blades, high forward airspeed, and high gross weight (high gross weight requires more lift, which increases the AOA of the main rotor blades) creates instabilities in the main rotor system as the retreating blade becomes stalled. The Safety Board is concerned that these instabilities are a potential contributing cause of blade divergence. Other aerodynamic characteristics (Mach tuck, drag divergence, pitch moment oscillations, and negative blade damping) also could have devastating effects on a low-inertia, high rpm rotor system. Therefore, the Safety Board is concerned that adequate testing may not have been accomplished to resolve any potential adverse aerodynamic characteristics of the rotor system.

The Safety Board is aware of other potential blade characteristics that this design would be likely to encounter. The construction of the R22 main rotor blade is unlike most other

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[4]Coning is the upward bending of the blades caused by the resultant forces of lift and centrifugal force. Flapping is the vertical movement of the blade as a result of aerodynamic forces.

helicopter blades in that there is no mid-chord shear web. The main rotor blade is constructed with a leading edge stainless steel D-shaped bar (spar), which is also designed to be the load-carrying structure. The honeycomb and blade skin is adhesively attached to the leading edge spar. The Safety Board is not aware of any wind tunnel testing using this blade design. The R22 main rotor blade was modified shortly after certification with weights in each main rotor blade tip. The weight was designed to improve the low inertia problem and aid in autorotational landings.

The R22 main rotor rpm will rapidly decay following a loss of power. The Robinson Helicopter Company has reported to Safety Board staff that it attributes most R22 loss of main rotor control accidents to pilot-induced low rotor rpm, or low-G maneuvering. The following physical evidence refutes these theories: In all three of the above accidents, there was physical evidence of main rotor blade strikes to the tailboom or cockpit under substantial operating power; the overload fractures of the spindles, pitch change links, transmission cap, and bending of the upper main rotor shaft all indicate that significant force was required to cause this damage; and the location and angle at which the strikes occurred revealed that the blade was not at its normal plane of rotation at the time of the strike to the helicopter body.

The Safety Board is aware that the R22 has demonstrated compliance with the certification requirements and that previous certification reviews have not uncovered evidence of noncompliance with certification standards or of a deficiency that would explain accidents such as those discussed above. However, because of the violent nature of the accidents and the evidence of possible main rotor involvement, the Safety Board believes that the FAA should, in conjunction with the National Aeronautics and Space Administration (NASA) and Robinson Helicopter Company, conduct further testing to evaluate the R22 main rotor and control system. The testing should include wind tunnel and computer modeling to evaluate the main rotor design, main rotor performance in cruise flight, rotor stability and other possible areas in which main rotor divergence or instabilities may have occurred on accident flights. The Safety Board is concerned that the unique design of the R22 may result in flight characteristics that are not adequately addressed by Title 14 Code of Federal Regulations (CFR) Part 27 standards. The Safety Board is concerned that the R22 main rotor control system may allow flight characteristics that were not flight or ground-tested under 14 CFR Part 27 standards, allowing anomalies in the main rotor system to go undetected during the original certification process.

Because the Richmond, California, accident occurred abruptly and with no apparent warning to the flightcrew, it was of particular concern to the Safety Board. That accident and the 20 other similar R22 in-flight breakup accidents examined by the Safety Board indicated that there may be undesireable aerodynamic characteristics of R22 main rotor blades that can result in one or both blades diverging from their normal plane of rotation (see Appendix A for the list of accidents). The Safety Board is concerned that the stability of the R22 main rotor blades is compromised by an inherent rotor system design deficiency that may allow loss of control of the rotor system when operating the helicopter within the currently defined flight envelope and in a manner that would seem normal in other light helicopters. The Safety Board is aware of the

importance of the R22 as a training and light utility helicopter. However, until the cause of the accidents, like those cited above, is determined, the flight envelope should be restricted.

In each of the in-flight breakups described above, the helicopter was being operated at a speed close to that recommended for cruise. The R22 flight manual indicates 83 knots as maximum range airspeed, and the Robinson Helicopter Training Manual specifies 75 knots as the recommended cruise speed. The FAA-approved never exceed airspeed (V_{ne}) is 102 knots. The Safety Board believes that, as an interim measure, while the cause of the in-flight breakup accidents is being determined, the maximum R22 operating speed should be reduced to a speed lower than the cruise speeds at which the accidents have occurred in the past.

The Safety Board has paid particular attention to the R22 main rotor blades and the rotor head because its special investigation has revealed that the in-flight breakup accidents were more likely caused by failures that initiated at the main rotor, rather than in the transmission, its mounts, or the main rotor control system. Because of its investigative findings, the Safety Board requested Material Review Records (MRRs) for the main rotor blades involved in the accidents but has not yet received those records. The Safety Board's review of an MRR of rotor blades not involved in an accident caused the Board to become concerned with the disposition and subsequent approval of blades containing defects, as illustrated by that MRR. The MRR examined showed that the Designated Engineering Representative (DER) employed by the Robinson Helicopter Company approved the use of main rotor blades for use on new helicopters when those blades did not pass design inspection requirements. The proper design, manufacture, testing, and approval of main rotor blades are crucial to the airworthiness of a helicopter. Defects in main rotor blades should be carefully examined and any blade not meeting the original design limits should be rejected. The Safety Board does not know the circumstances under which the approval was granted by the DER but is concerned about the appearance of the action.

A DER is the quality assurance link between the FAA and the manufacturer. The Safety Board believes that to ensure product integrity and safety during the design and development of an aircraft, the FAA must closely monitor the manufacturing process. The DER has the authority, granted by the FAA, to approve deviations during the manufacturing of a component that will be installed on an aircraft. The Safety Board was concerned to learn that the only FAA-designated DER currently at the Robinson Helicopter Company was also the president of the company. (A previously assigned DER left the company on September 3, 1993, and has not been replaced.) The Safety Board is concerned that the potential exists for any senior company officer, especially its president, to have a conflict of interest that could influence the performance of his or her duties as a DER. The president of any company has a financial interest in the success of the company and has other duties that could conflict with his or her responsibilities as a DER. Therefore, the Safety Board believes that it is essential that the FAA promptly review the appointment of any DER who is both a senior company officer and a DER.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Issue an immediate airworthiness directive to reduce the Robinson R22 helicopter "never exceed airspeed" (V_{ne}) to an airspeed that would provide an adequate margin of operating safety below the airspeeds at which loss of main rotor control accidents have occurred, until the reason for in-flight main rotor blade divergent behavior is established and design changes are approved and implemented, as necessary. (Class I, Urgent Action)(A-94-143)

In conjunction with the National Aeronautics and Space Administration and Robinson Helicopter Company, conduct wind tunnel and modeling tests to examine flight parameters of the R22 helicopter to determine the helicopter's design characteristics that are related to main rotor divergent behavior; and if any abnormal rotor system performance characteristics are found, take the necessary actions to assure proper dissemination of the information and to modify the R22 design. (Class I, Urgent Action)(A-94-144)

Examine the appropriateness of the Designated Engineering Representative (DER) assignment at the Robinson Helicopter Company and at other small manufacturers where senior executives are assigned DER responsibilities, and take necessary actions to eliminate any conflict of interest with DER responsibilities. (Class II, Priority Action)(A-94-145)

Acting Chairman HALL, and Members LAUBER, HAMMERSCHMIDT, and VOGT concurred in these recommendations.

By Jim Hall
Acting Chairman

Appendix A, R22 Loss of Main Rotor Control Accidents

APPENDIX A

R22 Loss of Main Rotor Control Accidents

Date	Location	Registration No.	Robinson Serial No.	NTSB Accident No.
11-11-81	Livermore, CA	N9073Q	0227	LAX82FA012
09-25-82	Nashville, TN	N9072V	0212	ATL82FA285
10-06-82	Santa Ana, CA	N8358B	0302	LAX83FUA01
12-25-84	Huntsville, AL	N8475K	0391	ATL85FA067
05-05-85	San Angelo, TX	N83745	0320	FTW85FA207
03-22-86	Memphis, TN	N9069S	0181	ATL86FA097
05-10-86	E. Fishkill, NY	N8511Z	0415	NYC86FA127
03-16-87	Scottsdale, AZ	N2256M	0498	LAX87FA147
06-03-87	S. Windsor, CT	N2287L	0512M	NYC87FA160
11-03-87	Moraga, CA	N8475A	0389	LAX88FA032
11-23-90	Simi Valley, CA	N80783	1319	LAX91FA037
07-05-91	Phoenix, AZ	N23039	1846	LAX91FA288
09-23-91	Point Judith, RI	N950CW	1637	NYC91FA254
01-30-92	Malabar, FL	N2313G	2015	MIA92FA072
03-04-92	Maricopa, AZ	N8413Q	0354	LAX92FA137
05-06-92	Mt. Pleasant, TN	N191KC	1818	ATL92FA096
05-08-92	Anaheim, CA	N8064E	1264	LAX92FA206
06-29-92	Richmond, CA	N83858	0337	LAX92FA267
09-30-92	Martinez, CA	N8069X	1364	LAX92FA410
08-10-93	Honolulu, HI	N4017J	1443	LAX93FA318
06-08-94	Martin, England	G-PUDD	0863	DCA94RA060

National Transportation Safety Board
Washington, D.C. 20594

Brief of Accident

File No. - 1420 8/10/93 HONOLULU,HI A/C Reg. No. N4017J Time (Lcl) - 1806 HST

----Basic Information----
Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -PERSONAL
Flight Conducted Under -14 CFR 91
Accident Occurred During -CRUISE

Aircraft Damage
DESTROYED
Fire
NONE

	Injuries			
	Fatal	Serious	Minor	None
Crew	1	0	0	0
Pass	1	0	0	0

----Aircraft Information----
Make/Model - ROBINSON R-22 BETA
Landing Gear - SKID
Max Gross Wt - 1370
No. of Seats - 2

Eng Make/Model - LYCOMING O-320-B2C
Number Engines - 1
Engine Type - RECIPROCATING-CARBURETOR
Rated Power - 160 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----
Weather Data
Wx Briefing - UNK/NR
Method - UNK/NR
Completeness - UNK/NR
Basic Weather - VMC
Wind Dir/Speed- 080/016 KTS
Visibility - 20.0 SM
Lowest Sky/Clouds - UNK/NR SCATTERED
Lowest Ceiling - NONE
Obstructions to Vision- NONE
Precipitation - NONE
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
LANAI,HI
Destination
SAME AS ACC/INC

ATC/Airspace
Type of Flight Plan - VFR
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----
Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,ATP
SE LAND,ME LAND
HELICOPTER

Age - UNK/NR
Biennial Flight Review
Current - YES
Months Since - 5
Aircraft Type - R-22

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT
Flight Time (Hours)
Total - 4350
Make/Model- UNK/NR
Instrument- UNK/NR
Multi-Eng - UNK/NR
Last 24 Hrs - UNK/NR
Last 30 Days- UNK/NR
Last 90 Days- UNK/NR
Rotorcraft - 140

Instrument Rating(s) - AIRPLANE

----Narrative----
ABOUT 10 MI FROM THE DESTINATION, THE PILOT RADIOED APPROACH CONTROL TO ENTER THE TCA. HE WAS GIVEN A TRANSPONDER CODE BY THE CONTROLLER, BUT DID NOT ACKNOWLEDGE THE TRANSMISSION. WITNESSES NEAR THE ACCIDENT SITE REPORTED HEARING A LOUD "EXPLOSION", OR A METAL TO METAL SOUND, AND THEN OBSERVED THE HELICOPTER IN AN UNCONTROLLED DESCENT. ONE WITNESSES SAID THE ROTOR DISK TILTED AND STRUCK THE AIRFRAME. POST-CRASH EXAMINATION REVEALED THAT ONE MAIN ROTOR BLADE HAD ENTERED THE FORWARD LEFT SIDE OF THE CABIN.

File No. - 1420 8/10/93 HONOLULU,HI A/C Reg. No. N4017J Time (Lcl) - 1806 HST

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

Finding(s)
1. ROTOR SYSTEM - UNDETERMINED

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

Finding(s)
2. TERRAIN CONDITION - WATER

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident was:
A DIVERGENCE OF THE MAIN ROTOR FROM ITS NORMAL PLANE OF ROTATION FOR AN UNDETERMINED REASON(S) WHICH RESULTED IN ROTOR CONTACT WITH THE AIRFRAME.

National Transport Safety Board
Washington, .. 20594

Brief of Accident

File No. - 1003 6/29/92 RICHMOND,CA A/C Reg. No. N83858 Time (Lcl) - 1242 PDT

----Basic Information----
Type Operating Certificate-NONE (GENERAL AVIATION)
Type of Operation -INSTRUCTIONAL
Flight Conducted Under -14 CFR 91
Accident Occurred During -CRUISE

Aircraft Damage
DESTROYED
Fire
NONE

Injuries	Fatal	Serious	Minor	None
Crew	2	0	0	0
Pass	0	0	0	0

----Aircraft Information----
Make/Model - ROBINSON R22
Landing Gear - SKID
Max Gross Wt - 1370
No. of Seats - 2

Eng Make/Model - LYCOMING O-320-B2C
Number Engines - 1
Engine Type - RECIPROCATING-CARBURETOR
Rated Power - 160 HP

ELT Installed/Activated - NO -N/A
Stall Warning System - NO

----Environment/Operations Information----
Weather Data
Wx Briefing - NO RECORD OF BRIEFING
Method - N/A
Completeness - N/A
Basic Weather - VMC
Wind Dir/Speed- 180/011 KTS
Visibility - 15.0 SM
Lowest Sky/Clouds - 1800 FT SCATTERED
Lowest Ceiling - 12000 FT BROKEN
Obstructions to Vision- NONE
Precipitation - RAIN
Condition of Light - DAYLIGHT

Itinerary
Last Departure Point
OAKLAND,CA
Destination
LOCAL

ATC/Airspace
Type of Flight Plan - NONE
Type of Clearance - NONE
Type Apch/Lndg - NONE

Airport Proximity
OFF AIRPORT/STRIP

Airport Data
Runway Ident - N/A
Runway Lth/Wid - N/A
Runway Surface - N/A
Runway Status - N/A

----Personnel Information----
Pilot-In-Command
Certificate(s)/Rating(s)
COMMERCIAL,CFI
SE LAND
HELICOPTER

Age - 36
Biennial Flight Review
Current - YES
Months Since - UNK/NR
Aircraft Type - R22

Medical Certificate - VALID MEDICAL-WAIVERS/LIMIT

Flight Time (Hours)			
Total	- 2200	Last 24 Hrs	- 0
Make/Model	- 2000	Last 30 Days	- 14
Instrument	- UNK/NR	Last 90 Days	- 70
Multi-Eng	- UNK/NR	Rotorcraft	- 2000

Instrument Rating(s) - NONE

----Narrative----
THE STUDENT HAD RECORDED HER PRIMARY FLIGHT LESSON ON A TAPE RECORDER. AFTER REACHING THE PRACTICE AREA, THE CFI INSTRUCTED THE STUDENT TO TURN 180 DEG LEFT. THE STUDENT COMPLIED AND PERFORMED A SHALLOW BANK TURN. SECONDS LATER, WHILE CRUISING AT 2,200 FT, THE CFI BEGAN TALKING. IN MIDSENTENCE AN UNDETERMINED EVENT OCCURRED WHICH INTERRUPTED HIS SPEECH. A WIND-LIKE BACKGROUND NOISE STARTED, AND THE STUDENT EXCLAIMED "HELP." RADAR DATA CONFIRMED WITNESS REPORTS THAT THE TAIL BOOM AND M/R HAD SEPARATED IN LEVEL FLT. EXAM OF THE WRECKAGE INDICATED MAST BUMPING HAD OCCURRED, A M/R BLADE CRUSHED THE LEFT SIDE OF THE INBOARD TAIL CONE, AND THE ENTIRE MAST WITH ATTACHED M/R BLADES BROKE OUT OF THE TOP OF THE TRANSMISSION. THE OUTBOARD TAIL BOOM AND ROTOR ASSEMBLY HAVE NOT BEEN FOUND. EVIDENCE OF A MAIN ROTOR BLADE DIVERGENCE WAS FOUND. SPECTRUM ANALYSIS OF THE TAPE REVEALED NO ANOMALIES UNTIL THE CFI'S VOICE WAS TERMINATED. WITHIN 2 SECONDS THE ROTOR SPEED APPEARED TO SIGNIFICANTLY OSCILLATE AND ABRUPTLY END.

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

Finding(s)
1. ROTOR SYSTEM - UNDETERMINED

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

----Probable Cause----

The National Transportation Safety Board determines that the Probable Cause(s) of this accident was:
A DIVERGENCE OF THE MAIN ROTOR FROM ITS NORMAL PLANE OF ROTATION FOR AN UNDETERMINED REASON(S) WHICH RESULTED IN ROTOR CONTACT TO THE TAILBOOM.