Log 2538

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: January 6, 1995

In reply refer to: A-95-1 through -8

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

On December 8, 1994, about 1405 local time, a Robinson R44 helicopter, registered in Germany as D-HPHS and operated by Luftfahrt-Geseltschaft-Mannheim, broke apart during an instructional flight about 2,000 feet above ground level, near Speyer, Germany. The flight was intended to be a continuation of the second pilot's R44 type-rating training.[1] Witnesses near the accident site reported that they heard a loud noise and observed the helicopter falling to the ground with parts of the helicopter separating from the structure as it fell. The instructor pilot and student were fatally injured, and the helicopter was destroyed. The instructor had accumulated 2,885 pilot flight hours in helicopters, 123 hours of which were in the R44. The R44 student held a commercial pilot certificate (airplane and helicopter) with flight time in the smaller, but similar, Robinson R22 and several hours in the R44. The National Transportation Safety Board and the Federal Aviation Administration (FAA) are participating in the German Flugenfalluntersuchungsstelle (FUS) Accidents Investigation Board's continuing investigation of the accident.

Radar data and the history of flight indicate that the helicopter was cruising 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 1,400 feet north of the main wreckage. The main rotor mast and rotor assembly remained attached to the transmission assembly. One main rotor blade had broken chordwise, approximately 2 feet from the root, and the outer portion of the blade was located about 1,200 feet south of the main wreckage.

Examination of the wreckage revealed that a main rotor blade had struck the front cockpit structure of the helicopter and that the other main rotor blade had struck the second tailboom bay causing the tailboom in the fourth tailboom bay aft of the fuselage to separate. One of the

[1]German regulations require that pilots obtain a minimum of 5 hours of flight time in the specific model before [illegible]-in-command.

main rotor blades exhibited scoring that matched the windshield attachment screws of the center support in the nose of the fuselage. The other main rotor blade exhibited scoring that matched a row of similarly scored rivets on the left side of the tailboom. One main rotor blade was fractured about 2 feet from the blade horn and was found 1,400 feet from where the fuselage came to rest. The other main rotor blade exhibited severe bending and twisting, and was fractured in several places. 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. The main rotor shaft exhibited evidence of mast bumping but no evidence of an initiating material failure was found. The evidence indicates that the mast bumping occurred secondary to the main rotor blades traveling beyond their normal flapping range. The transmission upper cap and entire mast assembly were integral to the transmission and helicopter structure. Both sides of the upper swashplate were fractured at the outer arms, and the corresponding pitch change links were also fractured. Examination of the recovered pieces of pitch change links indicated overload failures. The structural damage of the plexiglass and cockpit structure indicated low blade momentum during the in-flight strike. An instability of the main rotor, rocking of the mast, and extreme pitch divergence of at least one 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.

On April 2, 1994, about 1345 local time, another Robinson R44 helicopter, registered in Germany as D-HTOP, crashed about 8 miles east of Hanover, Germany, during an intended pleasure flight. The private pilot and his wife received fatal injuries. The pilot was qualified in fixed-wing airplanes and helicopters. His total flight experience was not known, but he had logged 110 hours of R22 flight time. This was the pilot's first unsupervised flight after receiving more than 5 hours of R44 instruction and his R44 type-rating checkout. The Safety Board and the FAA are participating in the continuing FUS investigation of the accident.

The investigation has revealed that the main rotor blades struck the cockpit area of the fuselage. The evidence indicates that the helicopter yawed sharply due to the blade strike, and the structure of the tailboom wrinkled and then failed, resulting in separation of the tailboom. The main rotor mast shows evidence of being bumped by the main rotor blades, and the main rotor system separated from the helicopter. No precipitating mechanical failure of the helicopter has been found. The investigation has not determined the reason for the main rotor blade divergence that resulted in the rotor striking the body of the helicopter during powered flight.[2]

On December 27, 1994, about 1440 local time, a Robinson R22 helicopter, registered in Switzerland as HB-XZW and operated by BB Helikopter AG, crashed onto the roof of an apartment house near Zurich, Switzerland, after a loss of control in flight. The flight's purpose was not reported, and the pilot's flight experience is not yet known. The weather was reported

[2]For more detailed information, refer to the German FUS Accident File 3x047-94.

to be good with gusting wind conditions. Witnesses saw the helicopter in cruise flight about 1,000 feet above the ground and heard the engine running normally before the accident. The witnesses then heard a loud bang and saw parts of the tailboom separate from the helicopter before the helicopter crashed onto the apartment house. Parts of the tailboom and tail rotor assembly were found about a quarter of a mile from the accident site, and there was evidence of paint transfer from the tailboom to one of the main rotor blades. The pilot and passenger received fatal injuries. The Swiss Aircraft Accident Investigation Bureau (AAIB) has requested the assistance of the Safety Board and the FAA in the continuing investigation. The cause of the main rotor divergence that led to the contact with the tailboom has not been determined.

On September 28, 1994, about 0947 local time, a Robinson R22 helicopter, registered in the United States as N83112, crashed near Knightdale, North Carolina, after an in-flight separation of the tailboom. The pilot was operating the helicopter for business purposes. The pilot had accumulated 790 total flight hours, with 373 of those hours in helicopters and 305 in the R22. A witness observed the helicopter about 200 feet above the ground when it appeared to fishtail and began to lose parts. He additionally said he heard a sputtering sound, which has not been identified. Radar data indicated that the helicopter was maneuvering at a moderate speed before the accident. The pilot was fatally injured, and the helicopter was destroyed.

Following the on-site investigation, pieces from the main rotor blades, transmission, tailboom, and main rotor head were sent to the Safety Board's materials laboratory for examination; however, no evidence was found to indicate a precipitating mechanical or material failure of any helicopter system. The engine did not exhibit any evidence that would indicate a loss of power before the tailboom separation and loss of control. The investigation is continuing and no determination has been made as to the cause of the accident.

In the four recent R44 and R22 accidents described above, the in-flight breakups are believed to have occurred while the helicopters were being operated at speeds well within the aircraft's defined operating envelope. In these cases, the pilots-in-command were experienced, and the investigations indicate that they had been adequately trained in the R44 and R22. The pilots assumed to be manipulating the flight controls of the R44s had low R44 experience; however, the investigations found no evidence that the pilots were improperly operating the helicopters. In addition to these accidents, the Safety Board is investigating other Robinson helicopter accidents involving over 20 in-flight breakups of the R22 helicopter. In all of these accidents, the breakups occurred when the main rotor blades diverged from their normal plane of rotation and struck the airframe in flight. The known circumstances of the above R44 accidents are very similar to the R22 accidents that have concerned the Safety Board since 1982.[3]

On September 30, 1982, a Robinson R22 was involved in an in-flight breakup accident near Paige, Texas. The investigation determined that the tailboom of the helicopter was struck in flight after the pilot maneuvered near power lines, possibly in an evasive maneuver.

[3]For more information refer to the Safety Board's safety recommendation letters to the FAA dated October 27, 1982, and July 21, 1994.

Following this accident, the Safety Board issued Safety Recommendations A-82-143 and -144 to the FAA on October 27, 1982, which stated:

> Suspend the Airworthiness Certificate of the Robinson R22 model helicopter until (1) The main rotor system stability/stall characteristics and the main rotor rpm [revolutions per minute] decay rates are determined to provide adequate margins of safety and to be compatible with normal pilot reaction times, and (2) the R22 main rotor system is determined to be in compliance with 14 CFR [Code of Federal Regulations] 27.661.[4] (A-82-143)
>
> Conduct a study to verify that adequate engine torque is available to the Robinson R22 model helicopter main rotor system to recover rpm should a rapid decay of rpm occur during flight. (A-82-144)

On December 29, 1982, the FAA responded that it had completed a supplementary flight test program and a critical design review of the R22 main rotor system in conjunction with the Robinson Helicopter Company. The results reportedly indicated that the main rotor system complied with 14 CFR Part 27 and that no unusual flight characteristics existed when the R22 helicopter was operated within its Flight Manual Limitations. The FAA also stated that the rpm decay rates and helicopter recovery characteristics were evaluated during supplementary flight tests. The tests indicated that adequate engine power is available to recover rpm should a rapid decay occur. In addition, the FAA issued a telegraphic airworthiness directive (AD) T82-23-51 on October 29, 1982, which required that the low rotor warning indication be increased from 91%+1% to 95%+1% rpm. The AD required installation of a low rotor speed warning light adjacent to the rpm indicator.

The FAA also prepared an operations bulletin to emphasize R22 flight instructor responsibilities in student training. Also, additional analytical and simulation studies considered relevant to the evaluation of the R22 rotor system were conducted by the National Aeronautics and Space Administration (NASA) Ames facility, at the FAA's request. The NASA studies reportedly did not disclose any adverse or divergent characteristics associated with the lightweight, low inertia rotor system of the R22. There was no NASA report of the study. On April 7, 1983, the Safety Board classified Safety Recommendations A-82-143 and -144 "Closed--Acceptable Action" and "Closed--Acceptable Alternate Action" respectively.

The Safety Board is aware of 339 R22 accidents that have occurred in the United States. According to the FAA, there are 855 currently registered R22s in the United States.[5] The Safety

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[4]14 CFR Part 27.661 provides for the minimum acceptable standards for certification of helicopters by specifying the minimum clearance between the main rotor blades and the structure of the helicopter during any operation.

[5]According to the FAA there are three currently registered R44 helicopters in the United States. There are approximately 142 R44s operating worldwide.

Board has found that R22 mechanical reliability problems have not contributed significantly to the accident rate compared to other light utility helicopters, but the R22 has had an unusually high number of accidents attributed to pilot performance or undetermined causes (including in-flight rotor instability and breakup accidents) compared to other helicopters. The R22 is the smallest helicopter of those compared. Its small size and relatively low operating cost result in its use as a training and light utility aircraft and operation by a significant population of relatively inexperienced helicopter pilots.

The R44 main rotor system has design features that are very similar to the R22. The two-bladed, semi-rigid R44 and R22 main rotor systems include rotor blades that are connected to the main rotor hub through coning (flapping) hinges.[6] 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 R44 and R22 main rotor blade flaps independently of the other blade's vertical movement. The flapping blade causes a change in the main rotor hub (teeter), which causes an appropriate change in the opposite blade. In each of the R44 and R22 in-flight breakup accidents described above, the evidence relative to the sequence of breakup was similar to that found by the Safety Board in other R22 accident investigations.

The main rotor rpm of both the R44 and the R22 is much higher, and the rotor inertia is very low by comparison to other light utility two-bladed main rotor systems manufactured in the United States. Such systems are affected to a much greater extent by abrupt control inputs, external perturbations, and other factors causing rpm to droop. The Safety Board believes that changes in rpm occur at a significantly higher rate in the R44 and R22 than in other helicopter rotor systems.

The Robinson Helicopter Company has theorized that low main rotor rpm is contributing to the stall and divergence of the main rotor blades in some of the R22 in-flight breakup accidents in the United States, including those involving experienced instructor pilots. However, none of the participants in the Safety Board's investigations have adequately defined a sequence of events leading to a critically low rotor rpm (and follow-on instabilities of the main rotor system) or the factors that prevented experienced pilots from being able to apply corrective action to recover when main rotor rpm is lost.

The Safety Board is concerned that in the above accidents and in other accidents investigated by the Safety Board, qualified pilots were unable to recognize and correct low main rotor rpm or anomalous main rotor behavior before uncontrollable blade pitch and excessive blade divergence followed. The R22 and R44 rpm indicator and the low rpm warning light are smaller and less conspicuous, unlike those found in many other helicopters, and may not provide pilots adequate cues when immediate response is necessary.

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[6]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.

The Safety Board has found that in at least one relevant accident, sound spectrum analysis of background rotor noise on a tape recording of the flight showed that loss of main rotor occurred in the normal main rotor rpm operating range and within the normal operating envelope of the R22.[7] Other aerodynamic characteristics (Mach tuck, drag divergence, dynamic pitch moment changes, and negative blade damping) could also have devastating effects on a low-inertia, high rpm rotor system. Data from FAA certification test reports and Robinson Helicopter engineering reports indicate that no math modeling, computer simulation, or wind tunnel testing was conducted before, during, or after the R22 helicopter was issued its certificate of airworthiness by the FAA. The required flight tests were accomplished in prototype helicopters, but rotor systems were not tested in anomalous conditions such as to-failure or in areas beyond the prescribed normal flight envelope. The data from the flight tests do not indicate whether external disturbances to the rotor system such as turbulence, wind gusts, or other phenomena that could upset a low inertia rotor system were conducted. According to the FAA, the R44 flight test program was conducted similarly to the R22 flight test program. Therefore, the Safety Board is concerned that adequate testing may not have been accomplished during certification to resolve possible adverse aerodynamic characteristics of the rotor and flight control systems of both the R22 and the R44.

Because of its concerns regarding the R22 main rotor system, on July 21, 1994, the Safety Board made two urgent recommendations and one priority recommendation to the FAA:

> 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. (A-94-143)
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> 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. (A-94-144)
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> 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. (A-94-145)

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

The FAA responded to the recommendations on October 7, 1994, stating that it had convened a panel to research the R22 in-flight breakup accidents, to recommend a course of action for the FAA to follow concerning testing, and to evaluate the causes of the breakups. The FAA also resolved to change the DER at the Robinson factory when conditions were appropriate. However, the FAA elected not to restrict R22 flight operations pending completion of the work of the special research panel. On December 13, 1994, the Safety Board classified the first two recommendations "Open--Unacceptable Response" and the third recommendation, "Open--Acceptable Response." The Safety Board stated that it was disappointed that the FAA did not respond to the urgency of the recommendations, which were intended to prompt appropriate interim action to reduce the potential for continuing loss of main rotor control accidents while the cause(s) of main rotor instability were further researched.

The Safety Board is aware that the R44 complies with the FAA's certification requirements and that, following the July 31, 1993, accident, a certification review related to the unique cyclic control system was conducted and evidence of noncompliance with certification standards or of a deficiency that would explain accidents such as those discussed above was not uncovered. However, because of the catastrophic nature of the continuing 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 R44 main rotor and control system. The testing should include flight testing as well as wind tunnel and computer modeling to evaluate the main rotor design, including rotor stability, control responsiveness, main rotor performance in cruise flight, and other possible areas in which main rotor divergence or instabilities may have occurred on accident flights. The Safety Board is specifically concerned that the unique design of the R22 and R44 rotor system may result in flight characteristics that are not adequately addressed by 14 CFR Part 27 certification standards. In addition, the Safety Board is concerned that the R44 main rotor control system, which includes the teetering cyclic control[8] in the cockpit, may have undesirable dynamic characteristics that are not adequately addressed in the flight and ground testing under 14 CFR Part 27 standards. Of special concern to the Safety Board, are the effects that turbulence may have on the main rotor control system and ergonomic factors relative to the interaction between the pilots through the unique teetering cyclic control systems in R44 and R22 helicopters. Anomalies in the main rotor system or cyclic control in the cockpit may have gone undetected during the original certification process.

Because the recent German R44 accidents occurred abruptly and with no apparent warning to the flightcrew, they are of particular concern to the Safety Board. Those accidents and the other similar R22 in-flight breakup accidents examined by the Safety Board indicate that undesirable aerodynamic characteristics of R44 and R22 main rotor blades can result in one or both blades diverging from their normal plane of rotation during normal operation in the approved flight envelope. The Safety Board is concerned that the stability of the R44 and R22 main rotor blades may be compromised by an inherent rotor system design deficiency that may

[8]The Robinson R44, like the R22, has a cyclic flight control that teeters to allow a dual control system for two pilots.

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 R44 and R22 as training and light utility helicopters. However, until the causes of the accidents cited above are determined, and appropriate flight envelope restrictions and operating limitations are defined, the FAA should prohibit further flight.

The Safety Board has paid particular attention to the R22 main rotor blades and the rotor head during an ongoing special investigation because the in-flight breakup accidents under investigation were found to be more likely caused by blade divergence that initiated failures at the main rotor, rather than initiating failures in the transmission, its mounts, or the main rotor control system. As a result of its scrutiny of the main rotor, the Safety Board requested Material Review Records (MRRs) for the main rotor blades involved in those accidents. The Safety Board's review of several MRRs of rotor blades not involved in an accident caused the Board to become concerned with the disposition and subsequent approval of blades containing defects or not passing quality assurance testing. The Safety Board is concerned about the reported use of main rotor blades on new R22 or R44 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. Main rotor blades should be carefully examined for defects, and any blade not meeting the original design inspection requirements should be rejected unless modification of the design inspection requirements are specifically approved by the FAA. The Safety Board believes that additional FAA oversight of the R44 and R22 main rotor blade manufacturing quality assurance program is necessary to ensure that these blades are properly inspected and approved; and if inadequacies in the approval process are found, the FAA should modify and correct the approval process as necessary.

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

> Prohibit further flight of the Robinson Helicopter Company R44 helicopter until (1) adequate research and testing are accomplished to determine the cause of in-flight main rotor blade divergent behavior, and (2) modifications are made to the helicopter or appropriate limitations are placed in the flight manual to preclude divergent main rotor behavior and in-flight breakup accidents where pilots are unable to prevent loss of main rotor control in the approved operating envelope. (Class I, Urgent Action)(A-95-1)

> Prohibit further flight of the Robinson Helicopter Company R22 helicopter until (1) adequate research and testing are accomplished to determine the cause of in-flight main rotor blade divergent behavior, and (2) modifications are made to the helicopter or appropriate limitations are placed in the flight manual to preclude divergent main rotor behavior and in-flight breakup accidents where pilots are unable to prevent loss of main rotor control in the approved operating envelope. (Class I, Urgent Action)(A-95-2)

Conduct flight, ground, simulation, and modeling tests to determine the responsiveness of the Robinson Helicopter Company R44 and R22 rotor systems in all flight conditions to ensure that any qualified pilot, including students approved for solo flight and low experienced but rated helicopter pilots, may be expected to receive adequate warning of rotor system anomalous conditions and be capable of recovering from rotor system revolutions per minute decay or rotor system divergence safely when warned of anomalous conditions. (Class I, Urgent Action)(A-95-3)

Determine if the Robinson Helicopter Company rotor system low revolutions per minute (rpm) warning and indication systems in the R22 and R44 helicopters adequately alert the pilot in time to initiate prompt control inputs to correct a low rotor rpm condition, and require modifications to those systems if deficiencies are found. (Class II, Priority Action)(A-95-4)

Examine the appropriateness of the teetering cyclic flight control used in the Robinson R22 and R44 helicopters and make any design and modification changes to the cyclic and collective control systems as necessary to ensure that pilots-in-command and flight instructors can respond in time to prevent loss of control of the main rotor following in-flight main rotor anomalies initiated by low main rotor revolutions per minute or turbulence encounters in flight. (Class II, Priority Action)(A-95-5)

Conduct special studies and reviews of the Robinson R44 certification similar to that being conducted now for the R22, to determine that the flight control and main rotor system may be safely operated in all modes of flight and throughout the approved flight envelope by all pilots qualified to operate the helicopter. (Class II, Priority Action)(A-95-6)

Conduct Robinson R44 main rotor blade design and manufacturing process reviews and testing to determine if there are any main rotor blade construction deficiencies, either in design or in the manufacturing process, that may be contributing to main rotor divergence incidents or accidents, and modify the design and structure of the blade as necessary. (Class II, Priority Action) (A-95-7)

Conduct special reviews of the Robinson R44 and R22 main rotor blade inspection criteria and practices to determine if blades not meeting quality assurance inspections are inappropriately being approved by company personnel,and if inadequacies in the approval processes are found, modify and correct the approval process as necessary. (Class II, Priority Action)(A-95-8)

Chairman HALL, *and Members* HAMMERSCHMIDT and FRANCIS concurred in these recommendations.

By: Jim Hall
Chairman

National Trar ation Safety Board
Washin , D.C. 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.

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

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.