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File No. 1-0054

CIVIL AERONAUTICS BOARD

AIRCRAFT ACCIDENT REPORT

ADOPTED: August 8, 1961 **RELEASED:** August 14, 1961

CHICAGO HELICOPTER AIRWAYS, SIKORSKY S-58C, N 879,
FOREST PARK, ILLINOIS, JULY 27, 1960

SYNOPSIS

On July 27, 1960, at 2238 c.d.t , a Sikorsky S-58C helicopter, N 879, operated by Chicago Helicopter Airways, Inc., as Flight 698, crashed and burned in Forest Home Cemetery, Forest Park, Illinois The aircraft was demolished. The crew members and 11 passengers were killed.

N 879 arrived at Chicago Midway Airport from Chicago O'Hare Airport at 2215 c. d. t. It was serviced and scheduled to leave Midway at 2230 c. d. t., as Flight 698 for O'Hare Airport, 17 miles away. The flight departed on schedule in VFR weather conditions All radio transmissions were routine.

When the flight had cruised to about the midpoint of its trip, a part of one of the main rotor blades broke away The helicopter began to descend with its landing lights on. Sounds similar to the rapid cracking of a bullwhip were heard by witnesses. Moments later, the tail cone and tail rotor separated from the aircraft, and the angle of descent increased. The helicopter spun around its vertical axis - crashed nose-down on its left side - and burst into flames.

The Board determines N 879 became uncontrollable and crashed as a result of a structural disintegration in flight, initiated by a fatigue fracture of a main rotor blade

On August 3, 1960, the Federal Aviation Agency issued Airworthiness Directive 60-17-3, Amendment 191, Part 507 Federal Register, August 19, 1960, which elaborates the inspection requirements of main rotor blades, and limits their service time to 1,000 hours.

Investigation

N 879 received a preflight inspection beginning before midnight on July 26, 1960, and was released by the night crew to the day crew at 0700[1], July 27, 1960. The helicopter remained in the hangar until repairs were completed on a main wheel brake and was then brought into operation at 1647, July 27.

Flight 698 was the seventh for N 879 on the 27th and there were no pilot squawks entered on the flight log. The operations consisted of trips back and forth between Midway and O'Hare Airports by a route 17 nautical miles in length and over open areas suitable for autorotation landing, should an emergency require it.

1/ All times herein are central daylight based on the 24-hour clock.

The flight departed Midway at 2230 in accordance with company procedures. The cruising altitude assigned was 1,500 feet above the ground. The weather existing at the time of the accident was sky clear; visibility from 8 to 12 miles; temperature 75 degrees; dewpoint 56 degrees, wind from the south 3 to 5 knots; altimeter setting 29.93. Shortly after the accident, a helicopter pilot flying in the area of the accident scene reported the weather was clear and no unusual turbulence existed over or near the scene of impact.

The flightpath, established from the statements of eyewitnesses, indicated the helicopter was on course and at the proper altitude when first sighted Those who observed the aircraft immediately before and during its descent said it appeared to be cruising in a normal manner. A sound similar to the cracking of a bullwhip was heard and the aircraft started to descend. The engine sounded to all witnesses as if it were backfiring and the whip-cracking sound continued. One observer stated the landing lights were on and the whole aircraft was rotating. Another witness saw the tail section break off from the helicopter as it was descending. None of the witnesses observed any fire aboard the aircraft until impact with the ground at 2238.

The wreckage covered an area extending 2,800 feet in the direction of 315 degrees and 1,120 feet wide. The cabin, powerplant, landing gear, main rotor mast, three complete main rotor blades, and about one-third of the fourth blade covered an area approximately 50 feet in diameter.

The tail cone with the tail rotor attached was found back along the flightpath approximately 990 feet from the main wreckage site Scattered in a 500-foot circle around the tail cone assembly were seat cushions, seat webbing, small pieces of fuselage structure, the cabin entrance step, and numerous pieces of fuselage insulation and paper. Farther back along the flightpath an additional 1,900 feet, the investigators found the outer 19 feet of a main rotor blade lodged in a willow tree. This portion of blade matched with the part accompanying the main wreckage.

The blade had fractured 102 inches outboard from the center of rotation. There was no evidence of the fractured blade having hit any foreign object in flight. The fracture face on the part remaining with the aircraft was partially obliterated by ground impact, but the fracture face on the part that was found in the tree was unmarked.

Examination revealed the presence of a fatigue area which had its nucleus at the surface of the lower external back-wall radius of the spar The fatigue had progressed up the back of the spar and 1.2 inches forward into the upper surface of the "D" shaped member. The fatigue had also progressed forward along the lower surface for about five inches. The fatigue zone comprised about 57 percent of the total cross-sectional area at the time of the final separation failure.

The failed blade, S/N 5434, was manufactured by Sikorsky in October of 1956. In June of 1958, when the blade had been in service 180 hours and 40 minutes, it was subjected to a quickstart. The incident of the quickstart was described by the pilot who experienced it as follows: "As I started the engagement, I took the rotor brake off, turned the pump on and pumped oil into the clutch with the engine running between 1200 and 1500 r.p m. . The main rotor had reached approximately 50 r.p.m when there was a sudden mechanical lockage which induced severe torque on the rotor heads and blades. I had no control through the scissors being broken . . . The rotor brake, even though I applied it several times, had no effect on it, so there was nothing to do but . . shut the engine off and let it coast to a stop."

All four blades were sent to the Sikorsky factory for repair The 14 inboard pockets of blade No. 5434 were replaced at this time. In this replacement process the radius where the fatigue crack later started was refinished with a 240-grit paper and the new pockets were then bonded to the spar.

A review of the Sikorsky engineering drawing, from which the blade is manufactured, disclosed that all external surfaces of the blade spar were required to have a 40 RMS surface finish Surface roughness measurements in the fracture area were made by Sikorsky after the accident, and these indicated the finish was within drawing specification. Similar measurements made for the Board by the National Bureau of Standards indicated that the surface finish was 50-60 RMS.

Because the surface finish could have a significant effect on the fatigue life of the blade, the Board conducted a review of Sikorsky's quality control procedures relating to obtaining the required finish. The final finish on the external surface of the spar is achieved by use of an orbital sander. Until 1958, a 60-80 grit abrasive paper was used by the shopworkers to obtain the required 40 RMS finish. This grit paper was selected by the shop after evaluation as the proper grit to achieve the required finish. However, laboratory tests conducted after the accident showed that the actual finish achieved with this grit paper varied and was a function of the newness-oldness of the paper, the pressure applied by the sanding operator, etc. In fact, a 60-grit paper could be expected to produce a finish as rough as 110-120 RMS. This variability of surface finish, using 60-80 grit papers, was verified after the accident by examining the finish of other service blades produced at about the same time as the CHA blade. Discussions with shop inspection personnel revealed that the surface finish in production was judged on the basis of a visual examination and the inspectors' experience, and that, routinely, finish comparison blocks were not utilized.

In 1958, as a result of service experience with their S-56 blade, Sikorsky decided to incorporate as a product refinement, a finer finish on the back corner of their S-58 blades in production or overhaul. At this time the shop began using a 240-grit paper to obtain the desired smoother finish. As stated previously, the back corner of the failed N 879 blade was refinished with this grit paper during the 1958 repair

In May 1960, when the blade had a total time of 1,509 hours and 29 minutes, it was again sent back to the Sikorsky factory for inspection and repair because of a reported vertical bounce condition. It was suspected that the blade was warped or deformed in some manner. During this repair no warpage or deformation was found, but three pockets were removed and replaced However, the pocket at station No. 102, where the blade ultimately fractured, was not disturbed. The blade was again put back in service and had a total of 1,786 hours and 6 minutes service time when the accident occurred. (It had been approved for a service life of 2,450 hours by the FAA.)

The fatigue crack started from an area of sanding scratches made from 60-80 grit abrasive paper used in the finishing process during original manufacture prior to bonding the pockets to the spar. The crack originated at one of these deeper scratches that was nearly perpendicular to the longitudinal axis of the blade.

In its original manufacture the blade spar was anodized. When the blade was repaired in 1958, after the quickstart, and again in May 1960, for suspected warpage, Sikorsky records indicated that an alodine coating was applied as required. Neither spot tests nor spectrochemical examination revealed any evidence of an anodized or alodine coating where the fatigue crack originated However, subsequent tests and study disclosed that the post accident cleaning process applied to the spar prior to its examination had removed the alodine coating. Alodine was in fact present on the undisturbed parts of the spar that had been repaired in 1958 in the same manner as the area of the fracture.

Metallurgical examination of the failed blade disclosed that it had been fabricated from 6061-T6 aluminum alloy and that the material complied with the requirements of the pertinent Federal specifications. No evidence of corrosion damage was found, but minute corrosion pitting could not be eliminated since such pitting could have been masked by the sanding scratches. After the accident, when it was initially believed that the alodine coating had not been applied to the spar, Sikorsky initiated a series of fatigue tests in a corrosive atmosphere to indicate the effect of minute corrosion pitting and their tests are presently under way.

Chicago Helicopter Airways performs the following inspections on their aircraft. a daily preflight; a No. 1 every 20 hours; a No. 2 every 55 hours; a No. 3 every 105 hours; and a No. 4 every 210 hours. The inspections are accomplished by a mechanic. Although the inspections cover many subjects, only that of blade inspection will be discussed here.

On the daily preflight and inspections Nos. 1 and 2, it is required that the mechanic: "Inspect main rotor blades for dents, scratches, cracks, corrosion, and damage to spar pockets and trailing edge." The bottoms of the blades, all of which are painted, are viewed by the mechanic with the naked eye while he stands on the ground or hangar floor. The tops of the blades are viewed by him as he stands on the transmission deck and looks down on the blades or as he stands on the floor looking inboard from the tip. From this latter position, a few feet of the top surfaces can be seen because the blades droop when they are not in motion.

On inspection No. 3, it is required that the blades be cleaned with a dry rag before being viewed for cracks, dents, etc. Prior to inspection No. 4, the blades are removed from the rotor head and placed on a stand and washed with soap and water. The company maintenance supervisor stated that the use of optical devices is not required unless something is found in the inspection that requires the use of a power glass to detect exactly what it may be.

All blade inspections had been performed on schedule. At 108 hours and 11 minutes before the accident the blade was given a No. 4 inspection, and 40 hours and 2 minutes later it was again removed from the rotor head, washed, and inspected, because the main gear box and rotor head were due for a change. On the previous day, 3 hours and 1-minute blade time before the accident, it was given a No. 3 inspection. At no time in the history of the blade were any cracks reported as a result of company inspections.

Teardown inspection of the powerplant was made. Aside from impact damage and ground fire, there was no indication of any failure of this component of the aircraft. The same was true of the transmission and clutch assembly.

The flight control system, electrical systems, hydraulic systems, and all auxiliary equipment showed no signs of having failed prior to the fracturing of the main rotor blade.

Review of the maintenance records of blade No. 5434 disclosed that it had been installed on four different helicopters in its lifetime. It had been installed on N 879 on June 19, 1960, 156 hours and 24 minutes prior to the accident. Except for the quickstart incident, while installed on N 865, and the vertical bounce incident, while installed on N-866, no difficulties or unusual incidents occurred to blade No 5434 Several vibration writeups were noted in the flight log of N 879 during the latter part of June and early July of 1960, but there were no further vibration writeups after July 17, when the tail rotor was balanced.

During the Board's investigation of this accident, a review of Sikorsky's rotor blade design procedures was undertaken to determine if these could have been involved in the premature fatigue failure.

N 879, a Sikorsky S-58C, was certificated by the Civil Aeronautics Administration in 1957 under Type Certificate No. 1H11 which lists as certification basis for approval of the type design, Part 6 of the Civil Air Regulations, dated January 15, 1951, and Amendments 6-1 through 6-6. Fatigue requirements applicable to the main rotor structure are presented in paragraph 6.250 of CAR Part 6, and a method of rotor service life substantiation acceptable to the Administrator is included in Appendix "A" to Civil Aeronautics Manual 6. Basically, the FAA (CAA) approved method correlates measured flight stresses, loading spectrum, and the fatigue strength characteristics of the structure, utilizing the Cumulative Damage Theory to arrive at a predicted fatigue life for the rotor. Further, a suggested loading spectrum is presented in Appendix "A", and the minimum fatigue specimen testing for establishment of an S-n curve is outlined. In addition, the calculated fatigue life is reduced by 25 percent in arriving at the service life of the component.

In complying with the fatigue requirements of CAR Part 6, Sikorsky followed the basic CAM 6 procedure, including additional conservatisms based upon their own experience. Their initial 1956 analysis indicated an infinite life for the outboard portions of the blade (N 879's blade failed in the outboard area) and a service life of 2,450 hours for the inboard portion of the spar. Accordingly, the blade retirement time was established at 2,450 hours. In early 1959, however, as a result of service experience with their S-56 blade, Sikorsky reevaluated the fatigue life of the outboard portion of their S-58 blade, utilizing new flight stress data and a lower S-n curve based on full scale specimens. This analysis indicated that the fatigue life of the outboard portion was 4,560 hours rather than "infinite" as calculated earlier; but since this calculated fatigue life was still appreciably greater than the fatigue life of the inboard spar, the service life of 2,450 hours was not changed. At the time of the accident the service life of the S-58 blade was still 2,450 hours, and a number of blades had successfully accumulated this number of hours and had been retired.

Following the accident to N 879, Sikorsky made a fatigue calculation for the back corner of the spar at the spanwise location where the CHA blade had fractured. This reevaluation indicated that the spar at this location had a fatigue life of 4,690 hours, somewhat greater than the 1959 fatigue calculation -- and still appreciably greater than the actual N 879 blade fatigue life of 1786 hours. Still another fatigue calculation was made, using an estimated CHA spectrum, in the belief that their operation might be more severe than the conservatively modified CAM 6 spectrum On the contrary, this calculation indicated a fatigue life of 5960 hours, a value over three times greater than the actual life of the N 879 blade.

Since the original fatigue calculations and reevaluations of these calculations all indicated that the predicted fatigue life of the blade in the fracture area was appreciably greater than the actual fatigue life of the N 879 blade, efforts were directed at uncovering factors which would account for this large reduction in fatigue life. Specifically, studies and tests were initiated to evaluate the possible deleterious effects of (1) quickstarts, (2) service environmental conditions, (3) manufacturing variations, and (4) CHA's routes and operating practices.

Fatigue specimens were prepared and tested to determine if precompression simulating "quickstarts" had the effect of lowering the fatigue life of the rotor. All of the precompressed specimens tested to date have fallen within the S-n scatter band of the non-precompressed specimens, indicating no adverse effect. Fatigue testing of service blades which have been subjected to actual "quickstarts" is planned, but the results of the precompressed fatigue tests offer no great promise for the planned tests.

Early suspicion was directed toward the adverse effect of the surface finish on the fatigue life As indicated earlier, the fatigue crack started at one of the deeper scratches in the surface made from 60-80 grit abrasive paper used in the manufacturing finishing process. However, fatigue tests of specimens finished with various grit papers disclosed no significant decrease in fatigue life for finishes within the range of manufacturing variation

An investigation was initiated to determine whether the actual CHA S-58 operating spectrum was more or less severe than the spectrum used in determining the blade life. Much valuable data on leading spectrums were already available as a result of the NASA's continual helicopter V-g-h-n program, but specific data for CHA's S-58 operation had not been accumulated at the time of the accident. The NASA studies[2/] show that the periodic loads developed in the various routine flight conditions constitute the principal part of the total fatigue loading on the helicopter, and that atmospheric turbulence and moderate maneuvers have no significant effect on the fatigue life. These research findings have a bearing on the degree of confidence that may be placed in the suggested CAM 6 spectrum. However, the N 879 blade failure raised the question of some possible peculiar loading condition in the CHA S-58 operation. Sikorsky installed, with CHA's consent and assistance, a V-g-h-n type recorder in a CHA aircraft and accumulated some 87 hours of data under actual conditions. Preliminary evaluation of the data indicates that the CHA aircraft was operated substantially in accordance with recommended procedures, and that the CHA spectrum is not appreciably different from that assumed in the fatigue analyses. Sikorsky is also instrumenting one of their own aircraft to continuously record blade stress data and they plan to conduct a simulated CHA type of operation to further verify the adequacy of the design spectrum.

2/ NACA Technical Note 3434, 1955
NACA Technical Note 4203, 1958
NACA Technical Note D251, 1960

Soon after the accident to N 879, when it was established that the blade fracture was due to fatigue, the retirement or service life of the S-58 blade was reduced from 2,450 hours to 1,000 hours. In addition, the Board recommended to the Administrator that (1) a searching review be made of the approximate ten-year old CAM 6 design procedure, (2) CHA be required to conduct a more thorough visual inspection for cracks at all numbered maintenance checks, and that (3) as a precautionary measure all blades subjected to quickstarts be retired from service until such time as it is demonstrated conclusively that such a condition does not adversely affect the blade fatigue life. The Administrator has advised the Board that a revision of the CAM 6 design procedure is being studied; that a more vigorous blade inspection, as outlined in Airworthiness Directive 60-17-3, is being considered; and that it is his view that there is not sufficient justification at this time to require retirement of quickstart blades.

Analysis and Conclusions

Study of all operational aspects of this accident indicates that the aircraft was scheduled and flown properly. There were no radio communications of any unusual nature between ground stations and Flight 698, nor were any adverse weather conditions involved. Nothing would indicate that the flight had collided with any foreign object or that the captain and/or copilot mishandled the aircraft.

When the blade fractured, the main rotor assembly became unbalanced and vibrations of a sufficiently destructive force developed and caused the tail cone to fracture. This resulted in the complete loss by the pilot of control of the aircraft.

That the direct cause of this accident is metal fatigue of a main rotor blade cannot be doubted, and had this been the only determination that the Board had to make in its investigation of this accident the task would have been relatively simple. However, the prevention of similar accidents dictated uncovering all pertinent factors underlying the fatigue failure, and this larger task has been a most difficult one in this instance.

Reduced to its simplest form, the problem of achieving a satisfactory or "safe" fatigue life for a component such as a helicopter blade is a function of (1) design standards and procedures; (2) manufacturing standards and procedures, and (3) service conditions and practices Adverse factors in any one or any combination of these areas can result in an unpredicted failure of the component. In fact, it is becoming more generally recognized that these factors are so intimately involved with one another that tolerable reliability requires the fullest consideration of their interrelationship.

As discussed previously, CHA's operation of N 879 was essentially in accordance with Sikorsky's general recommendations and as approved by the Federal Aviation Agency. Although preliminary evaluation of the recent Sikorsky flight history recorder data indicates no appreciable variations from the design spectrum, the Board believes this program should be continued to insure that there are no uncertainties in this important area. In this general regard, the Board is of the view that industry consideration should be given to installing flight history recorders on all newly introduced air carrier helicopters to verify design loadings early in the fatigue life of the aircraft.

Whether CHA's blade inspection program was thorough enough to insure detection of the fatigue crack before the final fracture is a difficult question to answer. That these procedures were in accordance with Sikorsky's general recommendations and were approved by the FAA was clearly established during the Board's investigation. The lack of precision possible in assessing the time over which the crack developed and progressed to fracture contributes materially to the difficulty of evaluating the adequacy of the inspections performed. From the evidence developed during the investigation, it is the opinion of the Board that inspections of the type conducted by CHA during their numbered 1, 2, and 3 maintenance checks were not conducive to crack detection on the lower surface in the fracture area. Moreover, it is difficult to believe that a fatigue crack would not have been detected at the time the gear box was changed on July 13th -- 68 hours before the accident -- if such a crack were present. This inspection, the equivalent of a No. 4 inspection, where the blades are removed from the helicopter and washed with soap and water before inspection, is considerably more thorough than the blade inspections during the Nos. 1, 2, and 3 checks, and most certainly would have uncovered a crack that had progressed beyond the pocket cutout

However, it is more disturbing to consider that under the approved maintenance procedures, detailed inspections of the No. 4 check type occur at intervals of 210 hours and that the July 13th inspection was only incidental to a gear box change. In other words, in the 2,450 hour lifetime of the S-58 blade (this has since been reduced to 1,000 hours as discussed earlier), a minimum of only twelve detailed inspections would have been permissible. In view of the catastrophic nature of a main rotor blade failure, as demonstrated by this accident, and the demonstrated fact that a fatigue crack can develop and progress to failure in less than 68 hours, it is the Board's opinion that the required detailed inspections of the No. 4 check type should be spaced at shorter intervals. In light of the foregoing, therefore, consideration should be given to increasing the frequency of detailed inspection as the service life limit is approached, or alternatively, and perhaps preferably, to integrate the inspection program in a design reliability analysis to achieve a desirable level of safety.

Although during the early stages of the investigation the surface finish in the fracture area was thought to be a major factor in the premature failure of the CHA blade, subsequent investigation tended to disprove this conclusion. The surface finish of the N 879 blade was not significantly rougher than as required by the drawing. In addition, other blades contemporary to the CHA blade had even rougher finishes and some had accumulated sufficient hours to be retired from service. Furthermore the design S-n curve, in effect, took into consideration these surface finish effects inasmuch as the fatigue specimens were finished in the same manner as production units. Finally, the fatigue testing done subsequent to the accident disclosed that surface finishes within the range of manufacturing variation fell within the S-n scatter band. For these reasons, the Board concludes that the premature fatigue failure of the CHA cannot be attributed to surface finish effects.

The question of corrosion figured prominently in the early considerations of the cause for the premature fatigue failure of the blade. Until the later tests discounted the earlier finding that no alodine was present in the fracture area, it was thought possible that minute corrosion pits, too small to be detected by metallurgical examination because of the roughness of the finish near the fracture, might have precipitated an early fatigue failure. However, the Board believes that it may reasonably be concluded that alodine was present in the fracture area and that corrosion pitting did not play any significant part in the failure.

Except for the refinishing of the back corner radius, without applying the specified alodine coating, the 1958 "quickstart" repair was in accordance with approved procedures and appears not to have been a factor in causing the subsequent blade failure. This last conclusion is borne out by the results of the simulated quickstart specimen testing which disclosed no deleterious effects from precompression of the amount that would be expected from a quickstart. The full-scale testing of service quickstart blades may alter this conclusion, but it appears doubtful at this time.

The remaining area in which the cause for the fatigue failure may be, involves the design standards and procedures. As discussed earlier, the fatigue substantiation methods used by Sikorsky were approved by the Federal Aviation Agency. Furthermore these methods, or ones very similar to them, have been in use in the industry for many years. Although fatigue failures have occurred before to various helicopter components, including rotor blades, the failures could in just about every instance be attributed to factors not considered or foreseen by the designer in applying the approved methods or to factors relating to the service use or maintenance beyond the designer's direct control, such as operation outside of the recommended limitations, improper maintenance, etc. In the subject instance, the absence of such concomitantfactors or, at least, the lack of conclusive proof that the existing factors (quickstart, corrosive effects, inspection techniques, etc.) contributed materially to the fatigue failure is reason enough, the Board believes, to question the conservatism of the approved design procedure. In this regard, extra margins, whether they be in the form of more frequent service inspections or in a more conservative design approach, should be required when the designer elects to use the "safe life" approach.

The Board is convinced that the facts developed during this investigation warrant detailed study by the industry and the Federal Aviation Agency so as to insure that proper conservatism is included in the design procedures for air carrier passenger helicopters.

Probable Cause

The Board determines the probable cause of this accident to be the structural disintegration in flight, initiated by a fatigue fracture of a main rotor blade

BY THE CIVIL AERONAUTICS BOARD.

/s/ ALAN S. BOYD
Chairman

/s/ ROBERT T. MURPHY
Vice Chairman

/s/ CHAN GURNEY
Member

/s/ G. JOSEPH MINETTI
Member

/s/ WHITNEY GILLILLAND
Member

S U P P L E M E N T A L   D A T A

Investigation and Hearing

The Civil Aeronautics Board was notified of this accident on July 27, 1960. An investigation was immediately initiated in accordance with the provisions of Title VII of the Federal Aviation Act of 1958. A public hearing was ordered by the Board and held in the Del Prado Hotel, Chicago, Illinois, on September 16, 1960.

Flight Personnel

Captain Robert Meyer, age 37, was employed by Chicago Helicopter Airways on June 25, 1951. He had 8,035 hours total flying time; 2,380 hours total flying time in S-58 helicopters, 1,333 hours of which were at night. He had 203:45 flying time in the preceding 90 days, of which 63·04 were S-58 day, and 122:48 were S-58 night. He had flown 16:24 in the last seven days and 4.35 on July 27, 1960. Captain Meyer was checked out as captain on July 11, 1951, had flown three years and eight months over the route, and had practiced 51 autorotations, eight of which were at night, within the previous six months. He held ATPR No. 335518, with ratings in the Bell 47, S-55, and S-58. He held ratings for commercial, single-engine land, and flight instructor for airplanes and rotorcraft. The date of his last first-class medical was March 14, 1960.

Copilot John Walker, age 25, was employed by Chicago Helicopter Airways on May 16, 1960 He had 1,015 hours total flying time, 171 of which were S-58 day, and 10:45 night, with the company. He was checked out as copilot with the company on May 16, 1960, and had practiced 11 day autorotations. He had a commercial pilot certificate No. 1411365 with single and multiengine land, instrument, and rotorcraft. He had flown 4:35 hours the day of the accident, 21:36 in the past seven days, and 71.02 in the last 30 days. Mr Walker had a second-class medical dated May 16, 1960.

The Carrier

Chicago Helicopter Airways, Inc., is a Delaware corporation with principal offices in Chicago, Illinois. This corporation holds a current certificate of public convenience and necessity for scheduled operations, and possesses valid air carrier operating certificates for these operations.

The Aircraft

N 879 was a Sikorsky S-58C; manufacturing serial No 58420, date of manufacture was January 11, 1957; and date of delivery to the company was July 2, 1959. It had first been delivered to New York Airways in January 1957, then to Vertol Corporation in June 1958. The engine installed was a Curtiss-Wright model 989C9HE2, reciprocating engine; serial No. 505014· TSO 68:09 and TT 2300·17. The four main rotor blades had serial numbers and total time as follows. No. 7350, 2293.05; No. 6184, 457·18; No. 5434, 1786:06; and No. 10773, 1990:02.

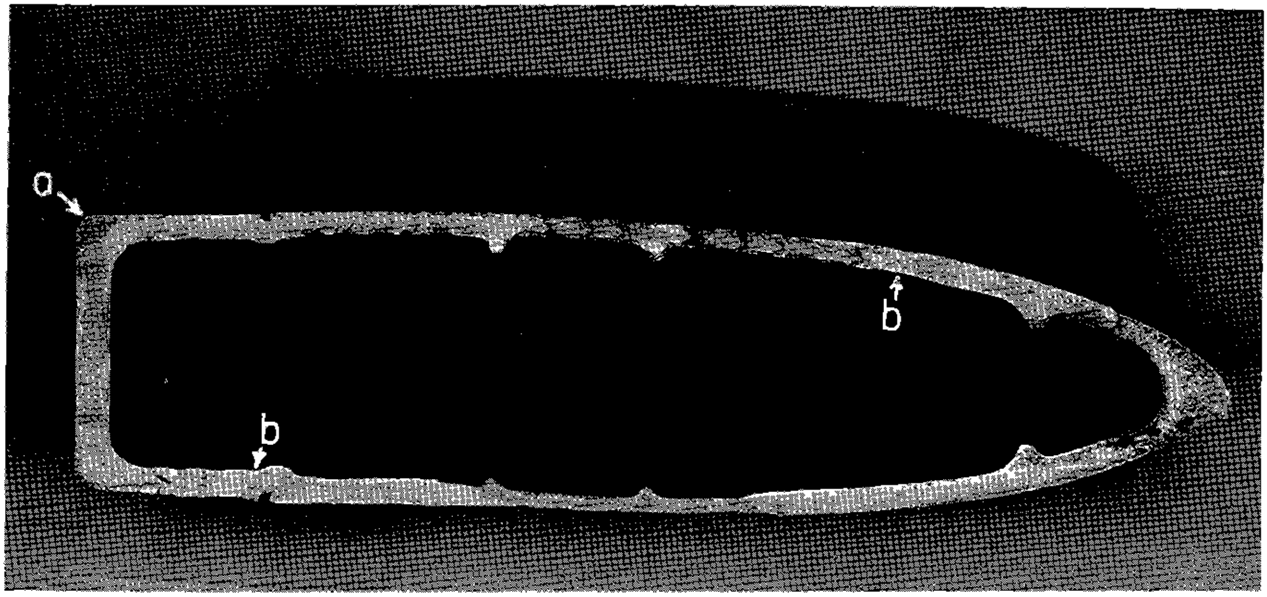
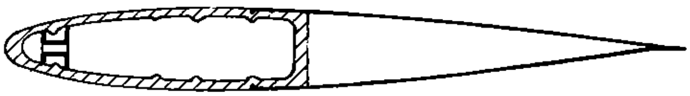


Figure 1 Surface of the fracture in the blade from Chicago Helicopter Airways Arrow "a" indicates the origin and arrows "b" the ends of the fatigue fracture X 1



Typical Blade Cross Section

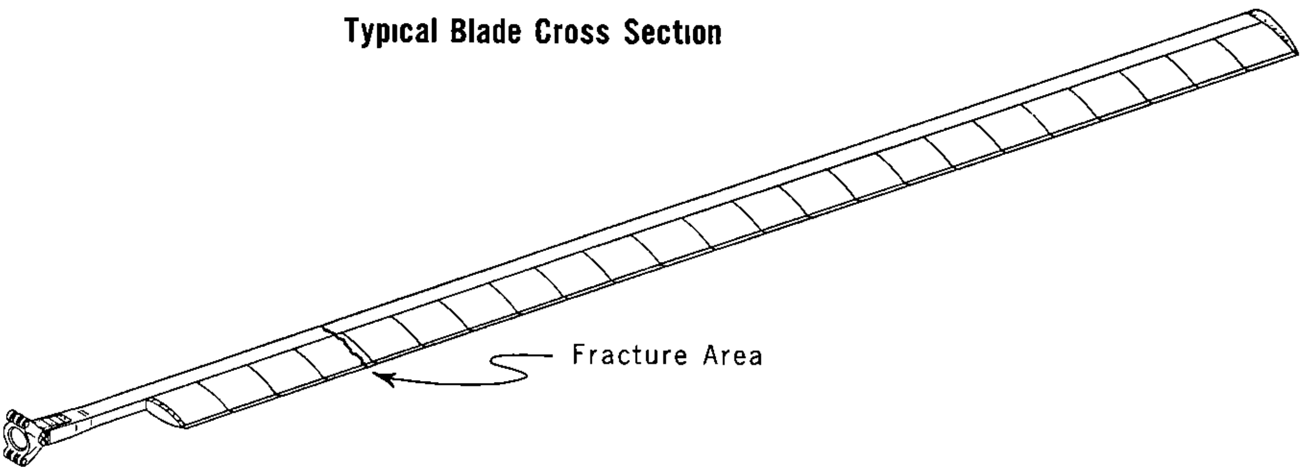


Figure 2 Main Rotor Blade

FOREST PARK, ILLINOIS, CHICAGO HELICOPTER AIRWAYS, N-879, JULY 27, 1960