Collins

KAMAN *Rotor Tips*

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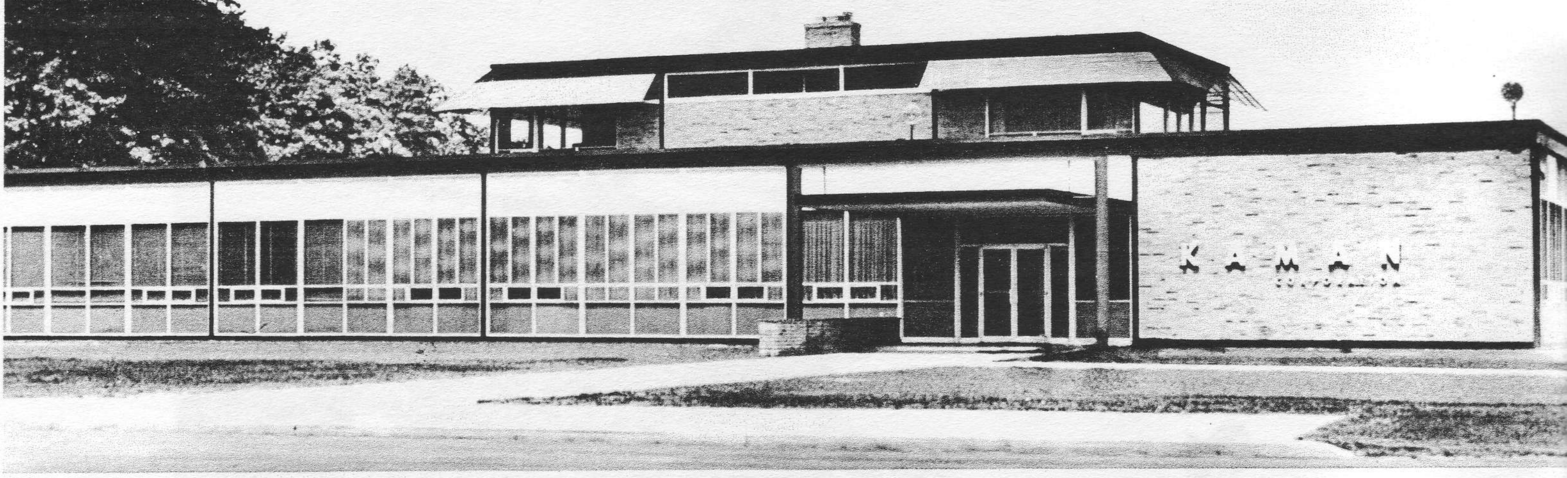

Rotor Tips

John P. Serignese, *Editor*

Volume VIII No. 9

On The Cover

A HIFR exercise as an SH-2F aboard the USS Sims pauses in its LAMPS mission to take on fuel. Photographer unknown.

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Features

Departments

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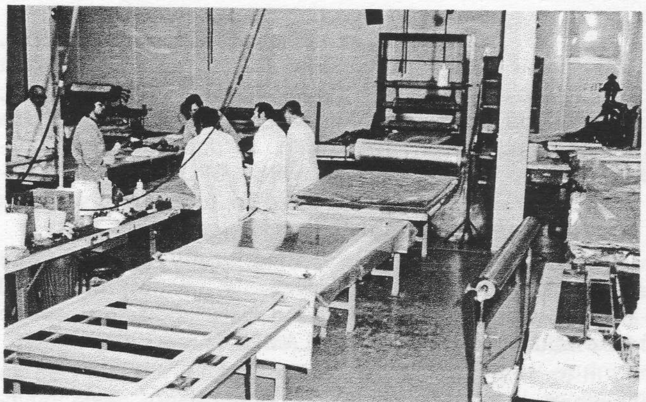
Capabilities

Kaman, one of the pioneer helicopter companies, has been in the business of designing, developing and building helicopters since 1945. Today, the company ranks high as a diversified corporation serving the Department of Defense as a prime contractor and other aerospace companies as a builder of quality components. In addition, Kaman plays a vital role in assisting various companies, both large and small, in the production and fabrication of the latest commercial products. Kaman can be compared to an iceberg . . . only a small portion of our technical expertise and involvement is visible. The purpose of this article is to expose one facet of these hidden talents and reveal yet another side of Kaman Aerospace.

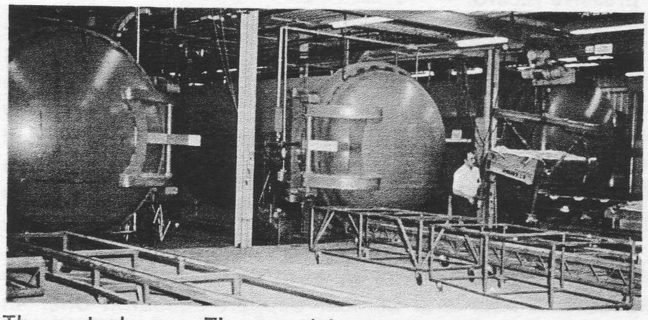
by John P. Serignese

Can you picture a prison without bars? Have you seen a security area without any visible means of restraint? Sound like the future? Not really, it has been here for some time. Kaman Aerospace Corporation has been assisting the General Electric Company in fabricating a special, bullet-resistant window which is used in lieu of bars or solid walls. The product is called Lexgard.

The actual window is made up of layers of Lexan between which is interspersed layers or sheets of a bonding film. The bonding film melts at a specific, although high temperature, thus "fusing" all the layers of Lexan. The amazing part of this is that not only is the window bullet-resistant, it is exceptionally clear! The layers are built-up in a special area at Kaman called "The Clean Room." This room is kept carefully clean of most dust, dirt and other foreign matter. Cleanliness is the watchword. In this room, technicians in dust-free coveralls build-up the required thicknesses of Lexan being careful to place sheets of bonding film in between as necessary. When the correct thickness is attained, the window is encased in a plastic bag-like envelope and the air is removed. The raw window is then placed into one of the huge autoclaves located here at Kaman.



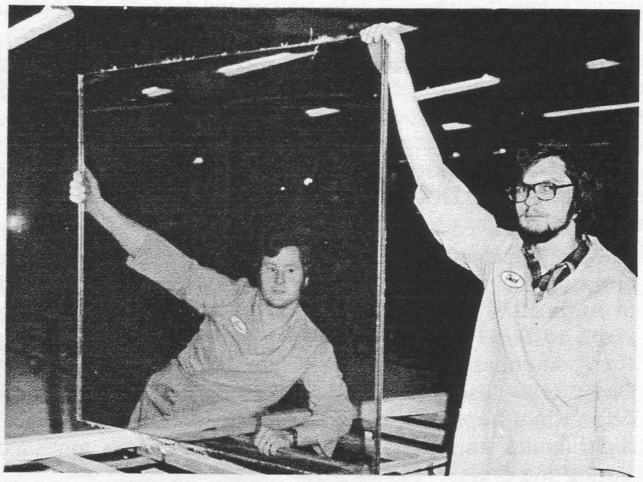
The clean room with technicians building up another Lexgard window. The largest window fabricated to date was 4 x 8 feet, the smallest was 15 x 45 inches. The windows are either 1-inch or 1¼ inches thick.



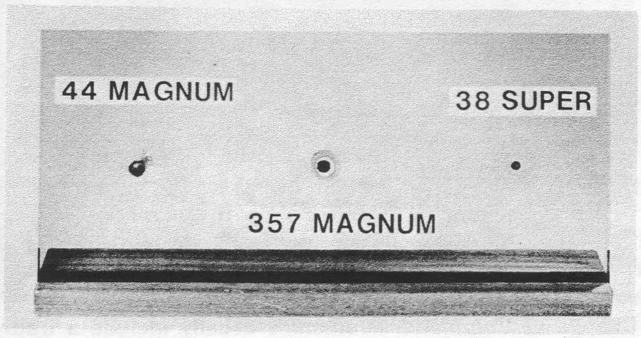
The autoclaves. The special pressure ovens in which Kaman heat-cures many products including the GE Lexgard windows. (Ruggiero photos)

An autoclave is a unique kind of oven. The three in operation at Kaman's manufacturing facilities are large: 8 x 26; 8 x 29; and 10 x 40 feet! These super ovens are capable of temperatures up to 370 degrees Fahrenheit with pressures up to 200 pounds per square inch.

The windows are heated, while under pressure and with a vacuum attached to the plastic bag, for a specific period of time. Then, the heat is turned off, and the window is allowed to slowly cool, still under pressure and vacuum. When cooled, the window is removed from the autoclave and inspected. If it passes inspection, both sides of the window are protected with sheets of masking paper and the completed Lexgard window is ready for delivery.



Mr. Dave Geibel, left, General Electric Tech representative, inspects a completed window. While this window is tinted or colored bronze, it is also available in clear and gray. This is the only all-plastic window currently "listed" by the Underwriter's Laboratories as meeting U.L. 752 Class III, the laboratory's standard for bullet resistant glazing (windows) tested for protection from .44 Magnum Super Power small arms.



A photo of what happens when weapons like the super powerful .44 Magnum revolver with 240 grains, soft point bullet is fired at the Lexgard window. Note the bullets did not go through the window! (GE photo)

HSL-35

Change of Command

by Lt (jg) S. V. Fondren
PAO HSL-35

Exactly one year to the day after being Commissioned, a Change of Command ceremony was held at Helicopter Anti-Submarine Squadron Light Thirty-Five (HSL-35), NALF, Imperial Beach, CA. Cdr Charles D. Craft relieved Cdr Jerry L. Vanatta as Commanding Officer of the newest LAMPS squadron. The new Executive Officer is Cdr Arnold D. Jackmond.

Nicknamed the "Magicians," HSL-35 consists of approximately 45 officers and 180 enlisted men. The squadron is organized into 12 detachments, each consisting of 4 officers and 10 enlisted men with one helicopter.

During their first year of operation, HSL-35 has grown from a handful of men to a squadron deploying four detachments: Det One, aboard the USS Fanning (DE1076), with LCdr Robert Hofstetter, OINC; Det Two, aboard the USS Reasoner (DE1073), cross-decked to the USS Rathburn (DE1057), Lt Hank Matthew, OINC; Det Three, aboard the USS Lang (DE1060), Lt Jack Smith, OINC; and Det Four aboard the USS Myerkord (DE1058), LCdr John Williams, OINC.

The return of Det One was the highlight of the year since it deployed soon after the commissioning last year and boasted an envious cruise record. The Det deployed in April 1974 and returned in October 1974 after paying visits to Pearl Harbor, Midway, Guam, Subic Bay, Hong Kong, Mombassa, Singapore, Columbo, and Djibouti. Det One's crew also saw the Bay of Bengal and the Gulf of Aden while deployed in the Indian Ocean. A total of 202 flight hours and 205 shipboard landings were amassed during the cruise.

Change of Command ceremonies usually include a traditional cake-cutting by the incoming and outgoing CO's. This time, the Magicians of HSL-35 add something new: their wives. From left, Mrs. Bonnie Vanatta, Cdr Vanatta, Cdr Craft and Mrs. Phyllis Craft. (USN photos)

Cdr Vanatta, the first Magician, passes HSL-35's helm to Cdr Craft. Both men have seen extensive duty with Navy helicopters and the LAMPS program.

HSL-35, Det Two, which deployed in September 1974, will shortly return to Imperial Beach. So far, the Det has visited Pearl Harbor; Guam; Auckland, New Zealand; Sydney and Townsville, Australia; Subic Bay, Philippine Islands; and Kaohsiung, Taiwan. To date, the Det's helicopter has flown 128 hours with 150 landings. In addition, Det Two has participated in joint exercises with the New Zealand and Australian Navies.

Dets Three and Four have only recently deployed and their records are not yet available. With professional crews on board, it is felt these Dets will also prove to be a valuable addition to the LAMPS family.

In its first year of operations, HSL-35 has built up an impressive 3,222 accident-free flight-hours while maintaining a high degree of operational readiness. With its second year well underway, members of the Magicians have already shown their intent to improve this impressive record.

HSL-35's Executive Officer, Cdr Jackmond, was commissioned and designated a Naval Aviator in 1959. His initial assignment was to Helicopter Support Squadron Eight based at Imperial Beach, CA. He was subsequently chosen for Navy Post Graduate School where he earned his Bachelor of Science degree. Cdr Jackmond was then assigned to Helicopter Training Squadron Eight in Florida as an instructor. In 1967 he served as Air Officer on the USS Duluth (LDP 6) in Southeast Asia (SEA). He returned to CONUS in 1969 and again deployed to Southeast Asia with Combat Support Squadron One. In 1971, Cdr Jackmond joined the LAMPS community and was assigned to the Naval Aviation Development Center in Warminster, Pa., as LAMPS Project Director.

The new CO and guests pose with outgoing CO. From left, the new Commanding Officer, Cdr Charles D. Craft; RAdm Mark W. Woods, COMCRUDES PAC; RAdm Arthur W. Price, COMPHIBPAC; RAdm John M. Thomas, COMCRUDES Group 5; and Cdr Jerry Vanatta, outgoing Commanding Officer.

Cdr Craft was designated a Naval Aviator in 1959 and immediately reported to his first helicopter assignment with Helicopter Squadron 2 in Lakehurst, N.J. In 1962, Cdr Craft reported to Helicopter Training Squadron Eight in Florida where he served as an instructor. The next two years saw Cdr Craft assigned to Helicopter Combat Squadron Four where he had the distinction of being assigned as OINC of one of the first H-2 detachments to deploy to the Arctic. He was Assistant Air Officer aboard the Iwo Jima and has been associated with all of the Pacific-based LAMPS Squadrons. He served as Maintenance/Material Officer for HSL-31 until HSL-33 was formed and he then became the new squadron's Maintenance Officer. In January, 1974, Cdr Craft was assigned to the newest LAMPS squadron, HSL-35, as its Executive Officer and one year later takes the helm as its Commanding Officer.

Cdr Jerry L. Vanatta, outgoing and first CO of HSL-35, was a member of Helicopter Anti-Submarine Squadron 7, stationed in Norfolk, Va. The squadron became the first Atlantic Fleet helicopter squadron to achieve a fully all-weather capability. His ASW expertise was further advanced when he was assigned to Air Development Squadron One, in Key West, Florida, where he performed operational test and evaluation of ASW related aircraft, systems and equipment. After serving in Korea, he later served as Assistant OINC of the last combat SAR detachments provided by the ASW squadrons. He also completed a tour at the Fleet Anti-Submarine Warfare Training Center in San Diego as a Tactical Instructor. With that substantial ASW background, it seemed only natural that Cdr Vanatta be assigned to the LAMPS program where he served initially as a Maintenance Officer, then Executive Officer for HSL-31 until he was assigned duties as HSL-35's first CO.

HSL-32, Det 6 Returns Home

"Dirty Sally," the H-2 flown by members of HSL-32, Det 6, recently returned home to Norfolk, VA., with her crew, thus ending a busy deployment in the Med. While aboard the USS Garcia, "Dirty Sally" performed ASW missions, Vert Reps, HIFR's, and other "normal" duties of LAMPS aircraft. For example, while on display during a Labor Day Holiday, and aboard the Garcia at anchor in Taormina, Sicily, "Dirty Sally" was called on to perform her rescue role and save the life of an ailing Chief. In one of the many demonstration briefings which LAMPS crews have come to expect, "Dirty Sally" provided SecNav J. William Middendorf, II, with an opportunity to sit in the sensor operator's seat and learn first-hand the capabilities of the Seasprite and her well-trained crew. The SecNav was in the Med touring the Sixth Fleet.

In addition to the Med Deployment, Det 6 participated in Operation Springboard and the Interim Sea Control Ship Evaluations. The able crew flew over 400 hours and made over 4000 shipboard landings while maintaining perfect accident-free flight and ground operations.

Just prior to returning to the States, OINC LCdr Hank Lewandowski made his 100th landing aboard USS Garcia to become Garcia's first Centurion . . . det personnel celebrated the event by providing the OINC with a salt water wash down.

The crew of HSL-32, Det 6, and their Seasprite, "Dirty Sally." Standing, from left, AWAN Wyatt F. DeLoach, Jr., AWAN Chris M. Peterson, AMHC Albert Adams, LCdr Henry M. Lewandowski, Lt Mike P. Muetzel, ADJ3 Al W. Waggoner and AMS3 Robert P. McQueen. Kneeling, from left, ADJ3 Charles W. Blackley, AE2 Louis E. Woods, Lt Ed L. Solder, ATAN Jack P. Paulden, ADJ2 James A. Curry and AE3 L. C. Harris. AX1 Thomas F. Vorndran was also in crew but absent when photo taken. (USN photo)

Kaman Develops Field Repairable/Expendable Rotor Blade For Army

By Paul Maloney, KAC
Chief of Dynamic Stress

The total cost of a fleet of helicopters is affected to a significant extent by the costs incurred acquiring, maintaining, and replacing the rotor blades. Experience has shown that few rotor blades operating on the Army's utility and tactical fleet in a hostile climate and military environment ever reach their allowable service life. It became apparent to the Army that main rotor blade costs can be reduced by increasing the number of repairs performed successfully in the field thus keeping a blade in service longer. By reducing acquisition and replacement costs, unrepairable blades can be economically discarded.

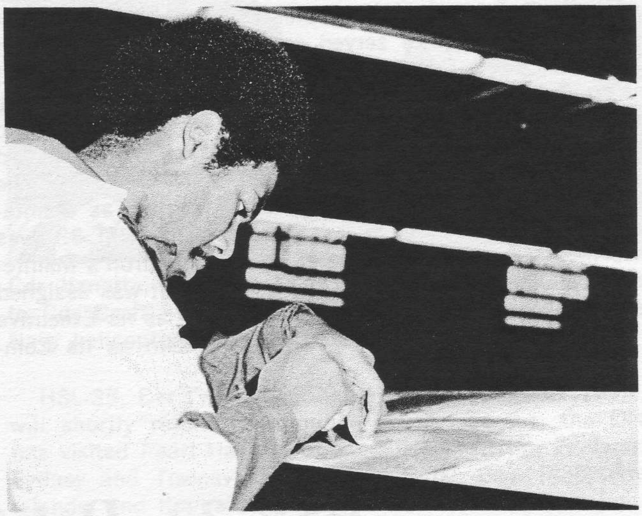
The concept of a field repairable/expendable main rotor blade grew out of the Vietnam environment. This report is based on a development program for such a blade, which Kaman Aerospace Corporation is conducting for the Eustis Directorate, USAAMRDL. The traditional design criterion for long service life, and long fatigue life, is not the dominant factor in determining either service life or blade costs in the Army's environment.

In contrast with commercial operation, or even operation with the other two services, the Army's helicopter rotor blades are subject to much operational abuse. Not only are the blades shot at, but other damage occurs with much greater frequency than in commercial or other service operations. Thus, damage from external sources, such as foreign objects and ballistics, represent the major cause for replacement or repair. The program Kaman is performing for the Army is aimed at minimizing costs by providing a rotor blade less susceptible to crippling damage and more readily repairable at the organizational or field maintenance levels. We shall discuss the effects on blade design, maintainability aspects and total life-cycle costs.

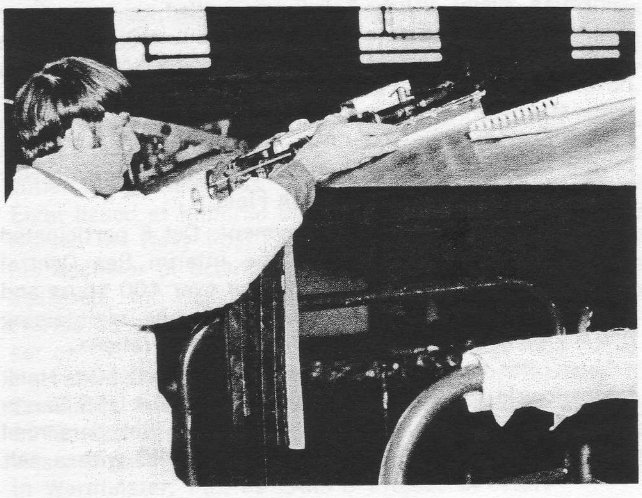
DESIGN CONCEPTS

At the outset of the program, many diverse types of construction and combinations of materials were examined. The potential for achieving the reliability, maintainability, and cost goals was evaluated for each concept. Those specific design features exhibiting the greatest potential were selected and combined, as appropriate, into a reduced number of concepts which were then analyzed for technical and operational characteristics. A total of 26 separate and distinct concepts were examined. These concepts were then evaluated against a set of design criteria drawn up for the development program. The first of these criteria was the necessity for compatibility with the UH-1H airframe and dynamic system at low technical risk. Consequently, none of the aerodynamic parameters were changed and the structure was designed to approximate as closely as possible the stiffness and mass distributions of the current UH-1H blade.

Low initial cost is one of the most positive ways to reduce blade costs and was an important parameter in design selection. Another requirement, reducing costs due to damage, is achieved by minimizing the damage itself, so that reduced vulnerability becomes one of the criteria. When damage does occur, two possibilities are considered: the blade can be removed from the aircraft, or left installed. If left on the aircraft, the damage may be deemed negligible or may be repaired. Negligible



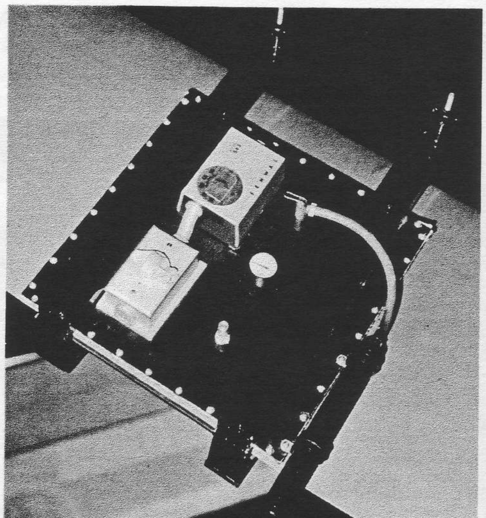
In photo above, Pfc Paul Bynum, Army Aviation Detachment, NAS Lakehurst, New Jersey, prepares a rotor blade surface. In photo below, SP6 Kenneth R. Leighton, also of the Army Aviation Detachment, installs the compact Pressure/Heat pack over the prepared blade surface. After pressure/heat was applied and the patch cured, the blade functioned like new. (Ruggiero photos)



In photo below, a general discussion of one of the demonstrations and the time required to complete a blade repair using the Kaman-developed system. Standing, clockwise from 6 o'clock, F. E. Starses, KAC Maintainability Engineer; J. F. Wynkoop, Airline Systems; Paul Maloney, KAC Program Manager; Conrad Clendenin, KAC Maintainability Technician; C. E. Covington, Bell Helicopter Company, Research Engineer; B. J. Hunter, Bell Helicopter Company, Methods and Materials Engineer; W. I. LaRoza, Hughes Aircraft Company, Reliability and Maintainability Engineer. Seated front row, from left, E. Keast, Boeing-Vertol, Product Assurance; J. N. Sobczak, U.S. Army Reliability and Subsystems Engineer, AAMRDL (Army Air Mobility Research and Development Laboratory); J. A. Longobardi, Sikorsky Aircraft Company, Rotor Systems Division, and Stanley Barlow, Airline Systems. Seated rear, R. J. Spitko, Boeing-Vertol, Rotor System Designer.

damage depends on blade ruggedness, or low vulnerability. The second choice depends on the ease of repair in terms of facilities, equipment, material, skill level, and time, so that repairability is a significant criterion.

The blade design chosen for development by Kaman incorporates a heavy-walled, extruded aluminum spar (for damage resistance), an aluminum trailing edge spline, and an aft structure of fiberglass skins and Nomex Core for ease of repair. A complete coordinated maintainability and repair concept was developed concurrently with the blade design and was allowed to influence the design to meet established maintainability objectives. The main element of the repair concept was development of a special piece of Ground Support Equipment called the Pressure/Heat Pack with corresponding repair kits. The contract requirement for bonded repairs to the aft structure was that 95% of all repairs be accomplished in 3 hours by 2 mechanics (6 man-hours) without blade removal.



Pressure/Heat pack installed on blade prior to curing cycle.

That this goal was met was conclusively demonstrated during the Maintainability Demonstration conducted at Kaman in January, 1975. Two appropriately rated Army helicopter mechanics, selected at random, were trained in the Kaman-developed procedures for one week. These men then demonstrated to an Army and industry panel that all repairs could be satisfactorily accomplished by one man in less than three hours (3 man-hours) on the aircraft. Blades repaired by the Army mechanics during the demonstration were subsequently whirl tested and showed no adverse effect on structural integrity, rotor track or vibration.

Due to the success of the program, it is anticipated that future Army procurements of blades or helicopters will include many of the features of Kaman's Field Repairable/Expendable Blade and that Army helicopter operations will derive substantial cost savings as a result of using this approach.

Change of Command NETPDC Pensacola, Florida

In ceremonies on January 10, 1975, Captain Richard T. Thomas assumed command of the Naval Education and Training Program Development Center (NETPDC) at Pensacola, Florida. Capt Thomas is a graduate of University of Nebraska's Naval Reserve Officer Training Corps (NROTC) program and the post graduate school at Monterey. He has served as ship's company on the USS Princeton, the USS Antietam, the USS Lexington, and, most recently, as Commanding Officer of the USS Camden (AOE2). Among his flying experiences are tours with VP48, VP8, and VP5. He also was a formation flight instructor at NAS Whiting Field, Milton, Florida.

In his first speech to Ellyson personnel, Capt Thomas spoke of the future challenges. "What of the future? With the advent of a smaller, more elite, all-volunteer Navy, it is even more important to ensure available assets are used in the most efficient ways. Systems to both train and educate tomorrow's sailor to maximize return of investment on weapons systems and to allow the individual to function and interact capably are an absolute requirement. Much of the development of the instructional methodology necessary to bring these desirable goals to fruition will be accomplished here at NETPDC Ellyson. We must ensure that the vital jobs now being performed maintain a superb quality even as our interests and enthusiasms are fired by the challenges of the future."

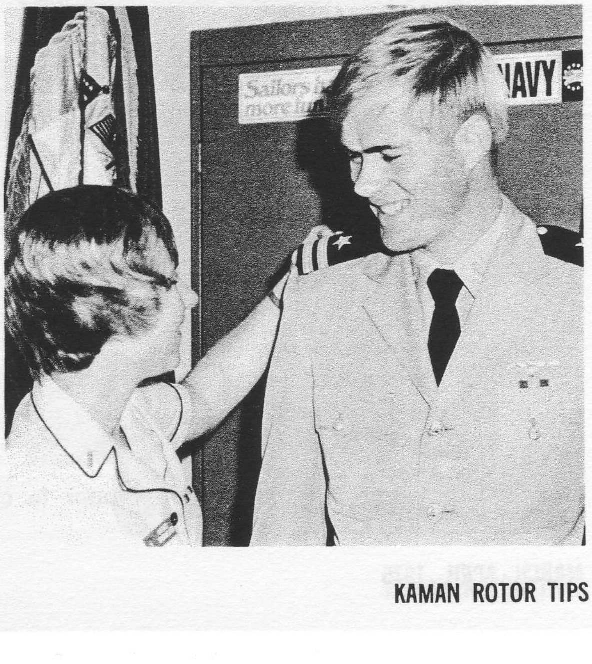
Outgoing CO Capt David L. Hughes has had a long and effective association with Navy helicopter programs. When serving in the Pentagon office of the Deputy Chief of Naval Operations for Air, he made notable contributions during the formative stage of the LAMPS program.

At top of page, Capt H. Grow, USN (Ret) center, cuts the ceremonial cake with the assistance of outgoing CO Capt Hughes, left, and Capt Thomas. Captain Grow was Ellyson's first Commanding Officer. In photo, right, Capt Hughes, on right, introduces Capt Thomas to Pensacola's mayor, the Honorable Barney Burks. (Photos by Rita L. Petway, assistant editor, NETPDC, New Dimension.)

HSL-33 Claims Another First

by ENS M. W. Baumstark
PAO HSL-33

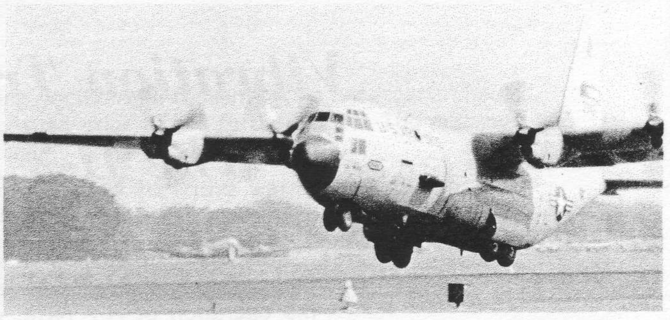
"THE FIRST HUSBAND AND WIFE LAMPS TEAM"



Lt David Youngblood stands tall as his new wife, Lt(jg) Cathey Youngblood, adjusts his "railroad tracks" in photo on right. For a time, there were two Lt(jg) Youngbloods and confusion reigned as the question was frequently asked, "Which Lt(jg) Youngblood?" Both of the newlyweds are members of HSL-33's Administrative Department. Mrs. Youngblood, the former Cathey Dykes, recently won an award when she placed second in the woman's division of the Eleventh Naval District Cross-Country Championship races.

If all goes well, the members of HSL-33 may again have to ask the question: "Which Youngblood?" only this time it may be: "Which Lt Youngblood?" (USN photo)

AWRS Equipment Repair Facilities



by Michael Fiaschetti,
AWRS ILS and SRA
Manager

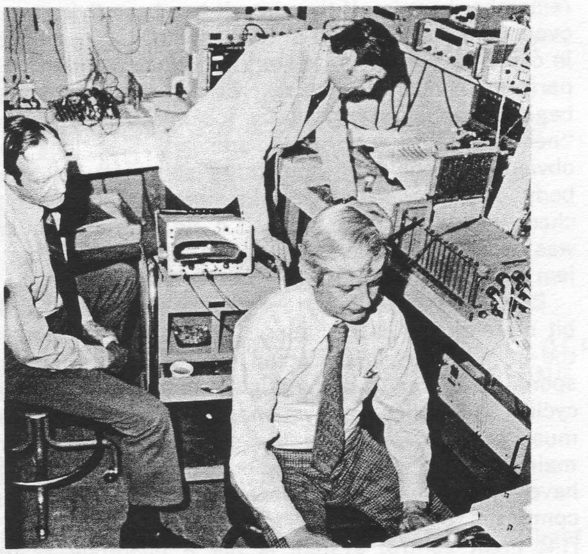
The Airborne Weather Reconnaissance System (AWRS) which was delivered to the U.S. Air Force in June, 1974, has provided highly accurate and reliable weather data, never before available in an airborne installation. The system was developed and installed by Kaman Aerospace for the U.S. Air Force Air Weather Service (AWS). In the past several months of operation, AWRS has provided valuable data which has been used by the National Hurricane Center (NHC) in predicting storm paths. The AWR System was also instrumental in assisting the 54th Weather Reconnaissance Squadron, stationed on Guam, M.I., in gathering data on typhoons in the Pacific. Both of these two weather phenomena, hurricanes and typhoons, cause high loss of life and billions of dollars in damage each year. The AWR System is installed in an Air Force WC130 affectionately nicknamed "PORKY."

In May of 1974, Kaman Aerospace Corporation was awarded a contract for the Depot Level Maintenance (DLM) of certain, highly sophisticated electronic equipment installed in the AWRS aircraft. Presently, the Air Force maintenance concept for AWRS is limited to the Intermediate Level (fault isolation to the module/card level). A Specialized Repair Activity (SRA) was set up at Kaman Aerospace to further this capability and provide maintenance down to the "bit/piece" level. This facility is responsible for approximately 130 items. These items range from assemblies down to the modules/cards making up these assemblies. The contract was awarded to Kaman by the Sacramento Air Logistic Center, located at McClellan AFB, Sacramento, California. Since the contract award, several pieces of equipment have been cycled through the facility and each was processed well-ahead of schedule. Assistance was also provided to the Air Force in several critical areas that were not within the SRA responsibility.

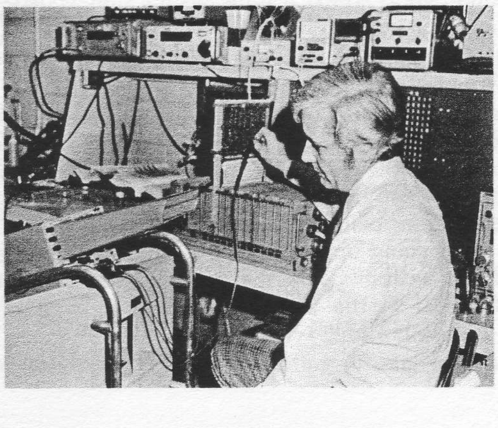
In order to accomplish depot level repairs, it was necessary for Kaman to fabricate a test set similar to but more sophisticated than the Maintenance and Test Set (MTS) developed and built by Kaman for the Air Force Intermediate Maintenance Level. Additional Engineering aids were also designed and fabricated in order to assist Kaman Engineers and Technicians in troubleshooting the complicated modules/cards.

The chain of events from a failure aboard Porky to the repair and return of the component is as follows: If the Diagnostics in on-board computers detect a failure in a component such as the Interface Adapter Unit (IAU), the IAU would be removed from the aircraft and transported to the Intermediate Level shop. There the unit would be tested utilizing the semi-automatic MTS and applicable T.O.'s. The MTS would fault-isolate the malfunction to a particular module/card and a spare RFI module/card would be drawn from supply and installed. The IAU would then be tested for performance and made available for installation. Failed module/cards are sent to the SRA at the Kaman facilities in Bloomfield, Ct. When the malfunctioning module is received at the SRA, Kaman engineers and technicians perform tests on the unit to determine the cause of the problem. The failure is then traced to a particular component through the utilization of the SRA test set, computer programming techniques, and other various engineering aids. The malfunctioning component is replaced and the module/card is tested several times utilizing specific test procedures to insure a perfectly functioning unit. The unit is then returned to the Air Force as a serviceable RFI spare. During the complete operation, from receipt of a failed part to the return of the part to the Air Force, the SRA coordinator tracks the part and compiles detailed data on all aspects of the operation.

The AWRS installed aboard Porky has proven to be extremely reliable. Air Force maintenance hours are far below that predicted. Even though the SRA has not been flooded with repair work, personnel involved with the facility have investigated new techniques to aid in troubleshooting AWRS equipment. AWRS SRA personnel are constantly trying to develop new ideas which will improve the already dependable system. When the production decision is made, Kaman will be able to provide the Air Force with an even better, more reliable product.



In photo above, Howard Horsmann, left, and James Harrington, right, troubleshoot a failed module in the IAU as Michael Fiaschetti observes. In photo below, technician Harrington checks test point of faulty module with aid of oscilloscope. (Ruggiero photos)



Vibration Troubleshooting The H-2 Helicopter

Part 3

Part 1 explained how to recognize vibration frequencies and methods of isolating the problem to a general area on the helicopter. Part 2 presented information on the operation of H-2 basic systems because without knowledge of what a system is supposed to do, it is sometimes difficult, occasionally impossible, to determine if a system is functioning properly.

by Jack King,
Senior Field Service Rep

Having determined that the vibration is a one-per-rev and that the auto blade tracker is operating properly, the next step in our logical process would be to check past maintenance records to determine if any maintenance action has been taken which could affect the rotor area. For example: Has a 28-day inspection been performed? Was a rodend bearing replaced on a tower rod? Any recent maintenance on any of the components which comprise the main rotor system (remember, these rotate at main rotor frequency) should be cause for suspicion. Very often troubleshooting efforts will end here. It could be that a servo flap was incorrectly installed during a 28-day inspection. Perhaps a flap clevis was installed without sufficient rod-roll at the flap horn. If the clevis is binding, it could result in a vibration. This article will not discuss additional details of what could be installed wrong or misadjusted; the MMI should be consulted and the recently-installed item re-checked and verified as being correctly assembled and adjusted. The point to remember here is: If the aircraft has been flying smoothly over a prolonged period of time, something had to change in order for vibrations to start and since maintenance was performed, maintenance records are the logical place to begin. Do not start out by looking for the proverbial "needle in the haystack." Instead, first look for the obvious. It could be something so obvious that everybody else overlooked it; take nothing for granted and check everything thoroughly. If no recent maintenance was accomplished, or indicated by the records, the problem will be a little more complex.

Before performing further checks, pause and reflect a bit more on the H-2 rotating flight control system. Since the azimuth bar is the small disc or "control rotor" responding to non-rotating flight control inputs from the cyclic and collective systems, and since these inputs must be transmitted to the component which controls main rotor blade pitch (the servo flap), it is necessary to have control linkage between the two. This linkage is composed of various bellcranks and control rods. The H-2 flight control system is not a push-pull system in collective pitch from the stick up or in cyclic pitch from the azimuth up. Because of the centrifugal force on the long control rods which run spanwise through a good portion of the main rotor blades, it is more of a case of an upward force being imposed on the controls which is being resisted by the pilot. Essentially then, the system is always loaded "in tension." Accepting this, it becomes apparent that any abnormal wear in any one azimuth-to-blade control path would result in an effective tension increase in that path and cause the affected blade to fly higher than the other three. *Remember this:* the abnormal wear would have to be from the azimuth bar out, because abnormal wear in the collective system below the azimuth would result in the entire cone going up, not just one blade. Abnormal wear in a cyclic system below the azimuth would result in an increased tilt in the entire rotor disc with no resultant out-of-track vibration.

For example, assume that a bolt securing a control joint in the A blade control linkage started to wear due to the bolt and nut being in an "undertorqued" condition. The A blade would, as the wear progressed, begin to fly higher and higher. The tracking system would sense this and send signals to the C blade motor which would then run until the C blade was once again in dynamic balance with the A blade. Over a period of time, the C blade would travel to its tracking actuator limit in the upward direction; however, the A blade would continue to wear and fly even higher. Since the C motor would be "topped," it could not move further to balance with A blade and consequently, a one-per-rev vibration would develop. (The problem might have been caught before this point if the pilot or mechanic had questioned the reason for progressive A-C blade cone change.)

Conversely, if the wear was on the linkage in the C blade azimuth-to-flap path, as the C blade flew higher due to the wear, the tracker would continually keep bringing it down until the actuator was in a bottomed condition. Again, further wear would result in a one-per-rev, since the additional travel required for correction would not be available. Actually, the limitations on the amount of actuator travel is extremely important since unlimited travel in the blade track actuators might result in the tracker "covering up" a progressive failure which eventually could result in a critical failure.

Now to the nitty gritty: What causes one-per-rev vibrations? It should be apparent from the previous discussion that worn control components or binding in the system can cause one-per-rev vibrations. There is another area however, which can also cause one-per-rev problems: the degree of "stiffness" in the blade and retention assembly, from the main rotor hub outward.

The stiffness we are concerned with is primarily between the blade and the retention at the folding pin axis and between the blade and the hub at the lead-lag axis. The folding pin axis was designed to permit blade folding for reduced size when the aircraft is to be stowed. Any looseness in this joint when the blades are spread in the flight position will manifest itself as a vibration. A loose, or badly seated, folding pin will produce a one-per-rev. Folding pins should be checked for proper torque and seating whenever a one-per-rev is encountered. Assuming that the C blade tracking motor is bottomed, the A blade and C blade pins should be checked. Why bother with B-D blades when the vibration is not caused by that pair? Folding pin contact area can be checked by checking the folding pin torque. If, after successive flights, the pin is continually losing torque, it should be disassembled and checked for contamination and/or surface contact. If, after several checks, it is determined that the pin maintains the proper torque, the pin is firmly seated and should be disregarded as a possible cause of the one-per-rev.

Again, consider the flight control path from the azimuth to the flap, and check every inch for abnormal wear or binding. Look for anything which will cause the effective length to change and cause the blade to fly higher or lower.

If all the preceding have been checked and nothing can be found amiss, where do we go from here? Well, the vibration could be the result of normal operating wear. You might expect that normal operating wear would be relatively equal on all four blades, resulting in a change in cone height rather than a one-per-rev. However, on occasion, slight variations (or other subtle differences) in the hardness of a couple of component alloys can cause one cyclic control joint to wear slightly faster than the others, but not to a degree that is readily apparent. This condition could progress over a period of many months of flying until the tracking actuator reaches its limit of travel, the amount of movement on each flight being so slight that the gradual progression goes unnoticed until the vibrations become apparent.

Although it is difficult to pinpoint the cause for this type of vibration, one squadron evolved an excellent method. They placed a form in the front of the Yellow Sheet book and logged all servo flap adjustments as they were accomplished. Included on the form were cone adjustments and individual flap adjustments. Why the new form? Well, shortly after the SH-2F models were introduced into the inventory, the Maintenance Control Chief of a Squadron presented this writer with a stack of MAF's (Maintenance Action Forms). Every MAF in the stack called for an adjustment of the servo flap on one particular aircraft. Also, adjustments had been accomplished in a relatively short period of three to four weeks. The Squadron Q&A Department had wisely decided that so many adjustments over such a short period of time constituted a reason for suspecting a problem. Accordingly, they downed the aircraft pending investigation. Our troubleshooting revealed that three of the four blades were back to the flap settings which existed at delivery of the aircraft and the fourth blade was only ½-turn from its original position. Further investigation disclosed a *lack of lubrication* and, when the MMI was followed, the track problems and vibrations vanished.

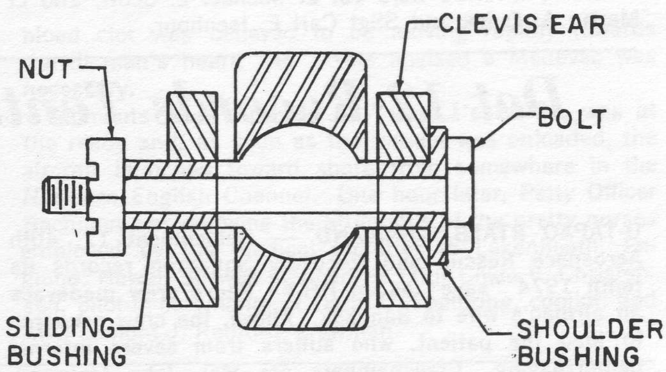
How does this tie in with the previous discussion? Consider the hypothetical aircraft with the one-per-rev, the actuator bottomed, and nothing amiss discovered during the investigation. A MAF is then issued calling for a ½-turn adjustment of the C blade flap in the downward direction. (Remember, Red you lower, White you raise.) Why the ½-turn? Because ½-turn is equal to tracking actuator travel from neutral to either extreme. The adjustment is then logged on the form in the Yellow Sheet book with the date, MAF serial number, and direction adjusted in the column pertaining to the C blade. The aircraft is then released for further flight. If the adjustment was required because of normal wear, the result will be a smooth flying aircraft for another prolonged period of time, with no further adjustments required.

However, assume that the mechanic was not as thorough in his investigation as he should have been and there is an "under-torqued" bolt joint and it is causing the bolt shank to wear. A few more hours of operation and the mechanic is going to be faced with the same condition that caused the initial vibration. The C blade actuator will, as the wear progresses, travel until it once again is bottomed. It should be apparent at this time that the tracker is trying to tell the mechanic something. It's a warning that a thorough investigation be conducted. It could be that once again, nothing amiss can be found, but if the aircraft has a flap adjustment and entry made again, and after a flight or two comes back yet again bottomed, *STOP!* There is a problem and some real close looking, including disassembly, as necessary, should be accomplished prior to any further flight. The message here is this:

"Do not disregard repetitive warnings in the form of flap adjustments on a main rotor blade, especially those in the same direction, and over a relatively short time frame." This is a warning that something is happening which, if not corrected, could lead to a critical failure.

Although it does not apply to one-per-revs, changes made to all four flaps concurrently for auto-RPM changes are also logged. The reasoning here is simple. Since the azimuth (collective thrust rod assembly housing) is the single point by which all collective pitch changes are made in the rotor cone height, abnormal wear of the tulip bearing would manifest itself as requirement for repetitive cone changes, ALWAYS IN THE DOWN DIRECTION. Make sense? Remember, the blade control rods are always pulling up, therefore, tulip bearing wear would result in increased cone height, a decrease in auto-RPM, and a corresponding requirement for all four flaps to be adjusted.

In the text, we referred to "undertorqued bolts" as being a leading cause of abnormal wear in the rotating flight control system. One of the most important maintenance actions in this system is to apply precise torque to the control pivot points. The critical joints are identified by a white stripe painted adjacent to the joint. This white stripe means "Special torque required, use a properly calibrated torque wrench."



Typical Clevis Installation

The figure shows a typical clevis installation in a flight control system. Note that on one side, a shoulder bushing is installed, while a straight bushing is installed on the opposite side. The straight bushing has a longer length than the thickness of the clevis ear and is designed to slide into the clevis bore. As torque is applied, the sliding bushing moves until it contacts the inner race of the bearing. Additional torque then preloads the entire stackup between the bolthead and the nut. The result is to "lock" the inner race and prevent it from rotating. With the inner race unable to move, bearing action takes place between the uniball and the outer race as the design intended. Inadequate torque on the bolt or failure of the sliding bushing to press against the bearing inner race will result in rotation around the bolt and resultant bolt wear. Remember, this condition causes the blade to fly higher and the opposite tracking actuator will move to compensate and . . . sound familiar?? It should, we have been discussing it for the last few paragraphs . . .

More on vibration troubleshooting in later issues.

Missions of Mercy

"Pedro" From 56th ARRSq Aids Base

KORAT RTAFB, THAILAND — HH-43 "Pedro" helicopters and crews of the 56th Aerospace Rescue and Recovery Squadron (ARRSq) lent a hand to Korat's base Military Civic Action Office recently.

Villagers in Ban Kam Pang and Ban Kasieo, who frequently became sick from unclean water, needed drinking water storage tanks. Ground vehicles could not transport the 400-gallon tanks due to impassable water obstacles so Capt August G. Juannarone, Civic Actions Officer, asked for "Pedro" help.

With approval from base and higher headquarters, two "Pedro" flights were made. A later flight brought in the materials needed to support the two tanks.

Base and Thai officials have long-range plans for helping villagers at nine more sites. Once approved, the 56th ARRSq will again help improve public health while gaining experience by training in remote areas of Thailand.

Crewmembers were Capt Riley Carruthers, 1st Lts Ecmon D. Thompson, and Larry W. Williams and SSgts Dennis R. Bumgartner, Charles D. Majors and Allyt L. Mattieson.

Others involved were 1st Lt Michael E. Scott, 2nd Lt Martin A. Quick and SSgt Carl E. Isenhour.

KORAT RTAFB, THAILAND — A 56th Aerospace Rescue and Recovery Squadron HH-43 "Pedro" helicopter eases down to unload a 400-gallon drinking water storage tank. Base and Thai officials combined recently to help improve public health in remote areas of Thailand. (Courtesy Rescue Review)

Det 12 Records Tenth 1974 Save...And...

U-TAPAO RTAFB, THAILAND — Detachment 12, 40th Aerospace Rescue and Recovery Squadron records its tenth 1974 "save" as an HH-43 Pedro crew medevacs an airman's wife to Bangkok. Above, the crew prepares to load the patient, who suffers from severe internal hemorrhaging. Crewmembers are Maj. John Flournoy, pilot and Det. commander; 1st Lt. Thomas Kemper, copilot; Sgt. John Coiro, flight mechanic; and SSgt. Howard Sheets, medical technician. (Courtesy Rescue Review)

The First Save of 1975

It was close to midnight on 16 January, 1975, when Base Operations at U-Tapao RTNB, Thailand, notified Det 12 that a Medevac was needed for Jean Wallace, dependent wife of Sgt William Wallace. The patient was in a coma caused by a head injury incurred in an automobile accident. Doctors at the 11th USAF Hospital reported Mrs. Wallace responded only to deep pain and they noted several neurological abnormalities. Her systolic pressure, which should have been between 100-140 was ±80. The ambulance arrived at the waiting helicopter and the patient was quickly placed on board.

Assisted by his copilot, 2nd Lt Kenneth H. Charfauros, Capt Russell J. Spahr lifted the Huskie off the ground and proceeded to speed toward Don Muang Airport in Bangkok. Also on board the aircraft were crewmen TSgt Ronald K. Allen and Sgt Michael Misiewicz. Capt Rodger W. Althoff, a Medical Doctor, was on board attending to the patient. The night mission was complicated by several thunderstorms which had to be circumnavigated. After landing at Bangkok Airport, Dr. Althoff and TSgt Allen accompanied the patient to Bangkok General Hospital in the ambulance which was waiting at the airport. On the return flight to U-Tapao, the thunderstorm activity increased to such a point that Capt Spahr decided to return to Bangkok Airport. The crew remained in Bangkok overnight and returned to U-Tapao the next day. Dr. Althoff stated that a Save should be credited to the professional crew of Pedro, the HH-43 Huskie.

HSL-32, Det 1

In photo above, all hands turn to and carefully help onload the ill shipmate. (USN photo)

by ENS Ronn Rygg
PAO HSL-32

Although the primary mission of the Navy's LAMPS detachments is ASW (Anti-Submarine Warfare)/ASMD (Anti-Ship Missile Defense), it is not uncommon for Dets to become involved in other missions. One of these "other" missions is the all-important Medevac. HSL-32, Det 1, stationed aboard the USS McCandless, recently performed a critical Medevac while the ship was participating in Northern Merger NATO Operation and transiting to Portsmouth, England.

In late 1974, one of the ship's personnel, GT3 Bachman, was diagnosed by the ship's chief Corpsman as suffering from a serious blood clot condition. Since the blood clot was believed to be moving rapidly towards the ill man's heart, Det 1 was advised a Medevac was necessary.

Moments later, "Hawaii 50," Det 1's SH-2F, was at the ready and, as soon as the patient was onloaded, the aircraft launched toward shore from somewhere in the Northern English Channel. One hour later, Petty Officer Bachman was enjoying the attentions of the pretty nurses employed by the medical facilities in Lakenheath, England. Hawaii 50 was manned by LCdr Clyde V. Christensen, pilot-in-command; Lt Daryl C. Spelbring, copilot; and AW3 Lamont J. Redford, crewman.

VX-1 Hosts Kaman Representatives

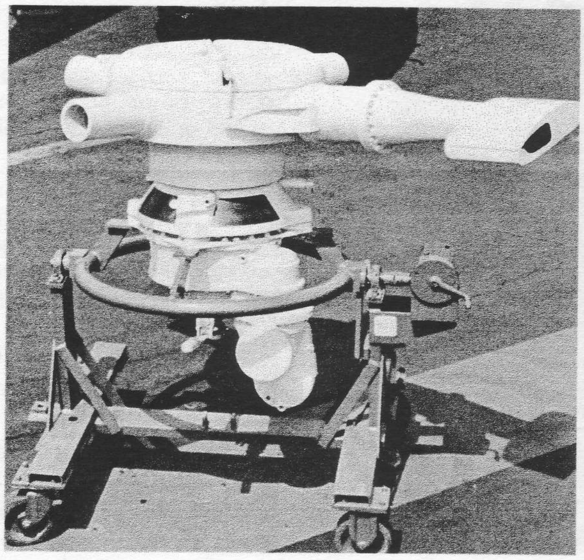
by Lt G. Y. Clark
PAO VX-1

Rrepresentatives from Kaman Aerospace Corporation visited VX-1, NAS Patuxent River, Maryland, on 29 January 1975. VX-1 is currently conducting operational testing of the ASQ-81 MAD (Magnetic Anomaly Detection) equipment based on Fleet experience to date. As a result, possible new uses and potential tactical improvements will evolve. This information is not only intended for use with the present SH-2F LAMPS Mark I program, but will also provide base-line data for the development of future LAMPS operations. VX-1 is participating with the Naval Air Development Center, Warminster, Pa., in the testing of the forthcoming Mark III avionics suite.

Pictured below are, from left, LCdr Don Morgan, VX-1; LCdr Bo Cannon, VX-1; Mr. David Rush, Kaman Service Representative; Lt(jg) Marshall Graves, VX-1; Lt (jg) Neil Baker, VX-1; Mr. Bruce Goodale, Kaman Military Marketing Manager; Lt Jack Adamson, VX-1; Mr. Jack Goodwin, Kaman Senior Marketing Representative; and Lt Ron Christenson, VX-1.

KAMAN AWARDED CONTRACTS

Circulation Control Rotor (CCR)



Full scale mockup of the CCR hub mounted on actual H-2 main transmission. (Ruggiero photo)

Kaman Aerospace Corporation has been awarded a contract by the Department of the Navy, Naval Air Systems Command, for the design, development and flight test of a Circulation Control Rotor (CCR) system. In 1973, Kaman and Lockheed-California were both awarded one-year contracts after an industry-wide competition for design feasibility studies of the CCR concept. With this new contract, Kaman has been funded for the follow-on demonstrator phase.

The circulation control rotor is a new, very advanced concept in helicopter rotor systems and promises to result in improved performance, greater reliability, and reduced mechanical complexity leading to reduced maintenance requirements. In conventional rotor systems, control is achieved by mechanically changing the pitch angle of the rotor blades once during each rotor revolution. In the CCR system, control is effected by modulating the flow of a thin jet of compressed air which is ejected from slots near the trailing edge of the rotor blades. Kaman plans to flight test this new rotor on a Navy/Kaman H-2 helicopter within 3 years. The CCR rotor system offers potential benefits to future helicopters of all sizes.

Rotor Hub Subject of Army Study

Kaman Aerospace Corporation has received a contract calling for design of a new low cost rotor hub concept for large helicopters. The effort will be funded by the U. S. Army Air Mobility Research and Development Laboratory, Eustis Directorate, Fort Eustis, Va.

The twenty-two month program is divided into two phases. The first involves baseline hub definition and preliminary design. Phase two will encompass detail design and concept verification. Initial funding covers 100% completion of Phase I and 10% of Phase II, the extent of work effort through 15 August 1975.

According to Dr. R. Mayerjak of Stress Engineering, who has been assigned project responsibility for the engineering program, the concepts involved in this design will use basic load paths that are both highly efficient and easily fabricated using composite materials.

KAron—A New Bearing

A new self-lubricating bearing developed by Kamatics Corporation, a Kaman subsidiary, has been officially qualified by the U.S. Government testing agency to its latest specification. Marketed under the trademark KAron, this new bearing has repeatedly demonstrated superior performance in a wide variety of tests and service trials over the past year. It is now in use by many airlines to solve difficult bearing problems and in other demanding applications in jet engines, helicopters, ships, and industrial machines.

The KAron bearing uses a new polymer composite bearing material and injection molding techniques recently patented by Kamatics. These innovations represent a significant advance in technology and are considered unique for this type of bearing.

KAron bearings are fabricated in journal, spherical, and thrust carrying configurations having diameters ranging from ¼ inch to over 2 feet, and are priced competitively with conventional teflon fabric lined bearings. Many sizes are currently available as standard catalog items.

In addition to low wear, the KAron bearing offers a combination of performance features including resistance to moisture and corrosion, low predictable torque, zero backlash, reduced liner deflection, and wide temperature range.

Kamatics Corporation was founded in 1966 by Kaman to manufacture and market its KAcarb ceramic/carbon bearing which was an outgrowth of Kaman's helicopter technology. Success led to a broadening of its markets and today Kamatics products are sold worldwide.

Kaman Test Pilot Featured

Veriflite, the publication of The American Helicopter Society, recently featured one of Kaman's test pilots in its column titled "Pilot Profiles." The article is reprinted here with permission. (Ruggiero photo)

Pilot Profile:

Andy Foster

In the rhetorical "You actually flew **that thing?**" department, Francis Andrew "Andy" Foster has made his mark on aviation history. (Ruggiero photo)

Foster, chief test pilot for Kaman Aerospace Corp., is remembered as the pilot of Kaman's imaginative SAVER — the experimental rescue ejection seat with the split personality. SAVER stands for "stowable aircrew vehicle escape rotoseat" and is under development for the Navy's aerial escape and rescue capability (AERCAB) program.

Foster was the first and, to date, the only person to fly the little jet autogyro with folding, telescoping rotor blades. SAVER's flight tests, in December-January, 1971-'72, came just 28 years after he first soloed in a Piper Cub as a Naval flying officer candidate in the CAA's wartime civilian pilot training program. That says something for the durability of the seat-of-the-pants breed, for SAVER is distinctly such an operation, with a seat, an engine, a set of rotor blades, a joy stick and little else.

As in most experimental flight testing, the airworthiness demonstration was right at the leading edge of aerospace technology. It is an area where Foster has been before, most notably when he explored the outer reaches of thin air controllability in an Air Force/Kaman HH-43B Huskie, leading to the U.S. recapture of four high altitude and time-to-climb world records in 1961.

With the Marines in WWII, Foster flew F4U Corsairs in the Philippines and China, and farmed for a few years in California until recalled to active duty in F6F's during the Korean conflict. Helicopters opened up for Marines about this time and, because they were new and promised an interesting career, he remained in service. After rotary wing transition, he flew on search and rescue missions in Korea and Japan, finally leaving the Marines for Kaman in 1958. At that time Kaman was producing HOK's for the Marines, and it was a natural environment. He was in on the initial testing of the Air Force H-43A and turbine-powered Huskie, laying the groundwork for the altitude and distance records eventually achieved by the Air Force.

How has experimental flight test piloting changed in the 16 years Foster has been in the business? "It's no longer entirely a kneeboard and eyeball operation. We've got all kinds of goodies working for us now. Computer programs, stress sensors, telemetry and recorders — instant analysis that tells you when you've reached your target points. You've got a lot more to learn."

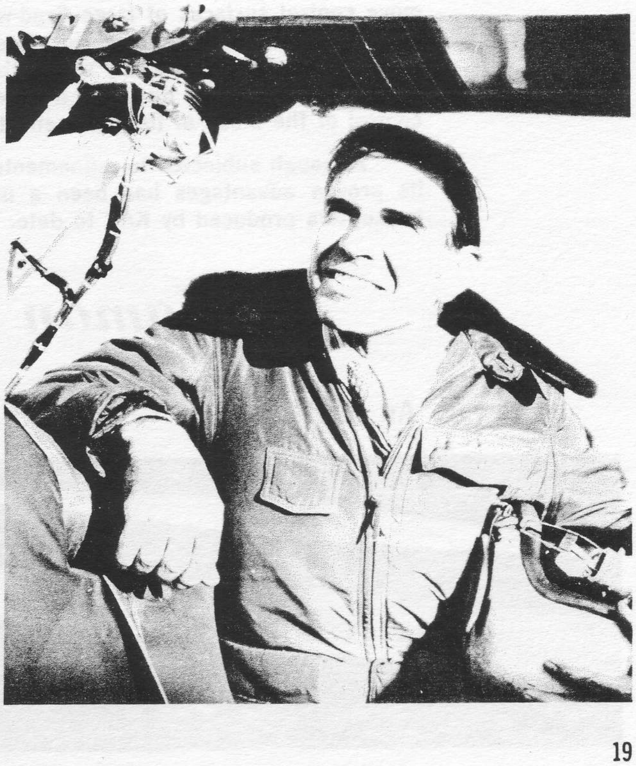
He cites the continuing evolution of the H-2 as a case in point. Through seven major model reconfigurations and numerous, electronics-loaded, experimental versions — each requiring structural and flying qualities verification. Most notable is the introduction of the '101' rotor system with the SH-2F.

"The '101' rotor development has been most rewarding — the improvements and refinements brought about in an already good system. It works to perfection now and the performance figures prove it. The Navy likes it and we're all proud we had a part in its development. It took a lot of hard work."

Lately, Foster and his team have been preparing for the eventual flight test of new exotic hardware — the Kaman elastic pitch beam tail rotor and dynamic anti-resonant vibration isolator (DAVI), which will be flown on UH-1 Hueys under Army R&D funding. These programs represent their own unique challenges.

For Foster, flying is and always has been an enjoyable job. He leaves it at the office and flight line and doesn't take it home. Neither his wife, Barbara, nor any of their five children are particularly interested in flying as recreation or vocation. Flying is not his entire job, however, for at Kaman, the chief test pilot also is a planner, administrator, manager and — in some respects — public and community relations man. The community he is involved with is the professional one — the Society of Experimental Test Pilots, Navy Helicopter Association, and AHS.

Periodically there are good will and "look see" tours of Navy and Air Force bases where H-2's and Huskies are flown. There, the young buckaroos can get a look at an "old pilot" and true professional.



1945

Thirty years ago, on December 12, 1945, Mr. Charles H. Kaman launched an idea which was the prelude to creation of a prime helicopter manufacturing facility and later, a multi-product corporation. Kaman had two exceptional assets going for him. He had absolute faith in his design and an unrelenting drive to transform these ideas into functional hardware readily applied to helicopter rotor/flight control systems. Consider that in only two tough years, the young Kaman Aircraft Company had its first flying aircraft and incredibly, within four years, the Civil Aeronautics Administration had certified two Kaman helicopters for commercial use. These beginnings were marked with a heavy emphasis on individual capability which is still one of Kaman's strong points.

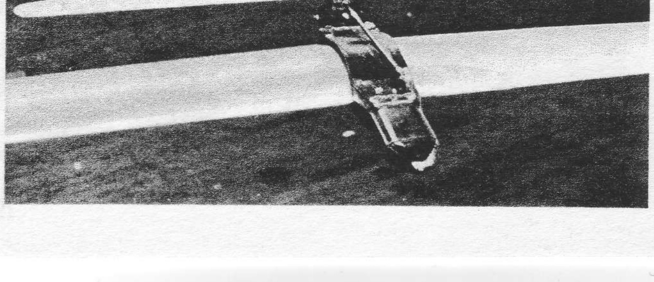
In top photo, one of Kaman's early test rigs with a few of the men who made it happen. From left, Louis DeRosa, mechanic; William R. Murray, Chief test pilot and now president of Kaman Aerospace Corporation; Charles H. Kaman, president Kaman Aircraft Company, and now president of Kaman Corporation; Salvatore Giarrantana, Engineer; and Donald LaPointe, of LaPointe Industries. Faced with the problem of trying to test a helicopter rotor blade without the facilities to house a permanent test rig, these pioneers took a stock automobile chassis with engine intact and mounted it on a trailer frame. Next, a stock truck rear-end was slightly modified by removing one axle and mounting it so the remaining axle pointed skyward. Attached to the top of this axle was Kaman's first rotor blade featuring the Kaman innovation . . . the servo flap.

In most helicopters, pilot-induced control movements cause the blade to rotate around its pitch axis, but in Kaman helicopters the pilot controls the servo flap which then causes the blade to change pitch. Because the servo flap uses energy drawn from the airstream to pitch or twist the blade, control forces need only be high enough to deflect the small flap. This effect is similar to the use of servo tabs to move control surfaces of large fixed-wing aircraft. Thus, boost systems may be very much smaller than required for direct pitch control systems. If the boost fails, control forces are still easily within the capability of the pilot to control manually — for the entire mission duration, if necessary. Another servo flap advantage is positive control of the blade at the more effective outer portion of the rotor disc.

Although subjected to refinements through the years, the servo flap concept with its proven advantages has been a unique feature incorporated into all production helicopters produced by KAC to date.

Kaman Servo Flaps

An Early Design



The Present Design