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THE KAMAN AIRCRAFT CORPORATION

PIONEERS IN TURBINE POWERED HELICOPTERS

KAMAN Rotor Tips

APRIL, 1961

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THE COVER

Artist visualizes the Seasprite performing an all-weather mission. The HU2K-1 is undergoing cold weather testing at the present time.

IN THIS ISSUE

— PLEASE SHARE THIS COPY —

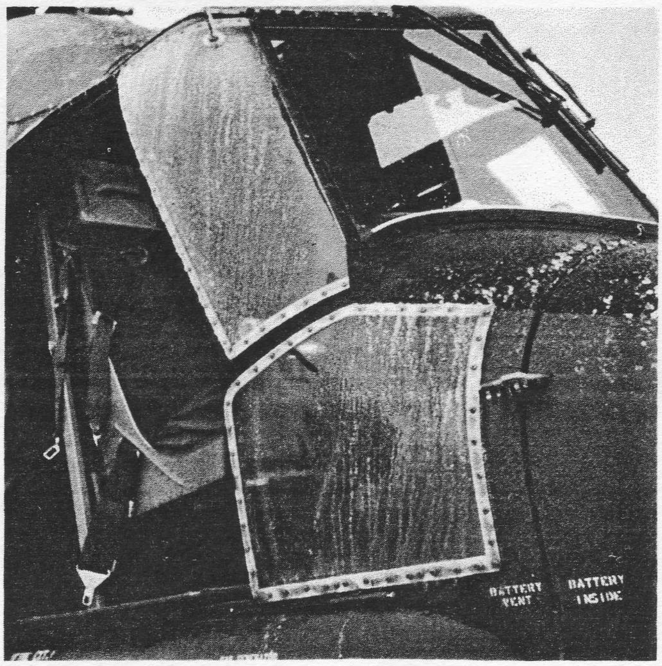
HU2K-1 COLD WEATHER TESTING

by P. H. HORSTMANN
Test and Development Engineer

Winter may be over, but there's still one chilly tale to be told. This is the experience of the Kaman HU2K-1 SEASPRITE as it was put through its paces at the icing flight test site in Ottawa, Canada. Readers of the December, 1960 edition of Rotor Tips may recall an article on cold weather testing of the H-43B — the results of low temperature tests at Eglin Field and icing tests in Ottawa. In its normal development cycle, the HU2K-1 is reversing the sequence, having completed the Ottawa icing tests in December, 1960, it is now scheduled to go to Eglin Air Force Base for climatic hangar cold test. Tying-in with the winter season just past, this is the story of how the HU2K-1 performed when exposed to the rigors of icing flight conditions.

NEXT MONTH: ***ROTOR BLADES***

The SEASPRITE is an all-weather aircraft, and is equipped to be capable of performing its mission in icing weather conditions. In addition to the radio, navigational, and blind flying aids installed in the aircraft for ordinary instrument flight, specific provisions are made for protection against the effects of ice formation. Electrical heating is available for both the pitot static tube and the two main windshield panels, the latter being thermostatically controlled to cycle between 85 and 100°F., with either high or low anti-icing capacity as selected by the pilot's control switch. Thermal inlet protection for the General Electric T-58 turbine engine is provided by compressor bleed air flow to the inlet guide vanes, the front frame struts (the bottom strut



EFFECTIVENESS OF ELECTRICAL HEATING in keeping windshield free of ice is shown in this photograph taken immediately after HU2K-1 left test rig.

is anti-iced by internal lubricating oil flow), and the starter cover or bulletnose.

Production HU2K-1 aircraft are fitted with a so-called "single" engine air inlet which draws air only from the right-hand side of the aircraft rather than from both sides as is the case with the "double" inlet installed on the earlier ones. While this simplified inlet duct is not thermally protected, it is designed to ensure satisfactory operation in icing conditions. A "blow-in" door is provided to furnish air to the engine when ice clogs the standard protective screen which is mounted in the inlet duct. The blow-in door opens automatically when the pressure drop across the inlet screen reaches a predetermined level, and will remain open until closed manually after the flight. The secondary air for the blow-in door is drawn from the main transmission compartment, and is sufficient to sustain normal engine operation throughout its operating range.

An electrical deicing system provides icing protection for the aircraft rotor system. The leading edge of the main rotor blades and flaps are covered with a deicing boot consisting of resistance heating elements imbedded in a rubber blanket with an integral stainless steel erosion shield. Power for the system is furnished by the 10 KVA No. 2, or deicing, generator. The three phase A-C output from this unit is rectified, and 263 volt D-C power is furnished to the blades through the rotating stepping switch on the rotor head. Each blade boot contains eight full span heating elements which are located side by side to cover the full leading edge area. Power is applied to only two blade elements at a time—the same element in each of two opposite blades. The stepping switch distributes power to the 16 pairs of elements in turn, winding up by energizing all four flaps at once to complete a full deicing cycle. Each flap boot contains only one heating element covering the entire boot area. An ambient-temperature-controlled timer automatically increases the electrical energy supplied to the blades as the temperature drops. The only pilot control is a simple system on-off switch which relies on the pilot to recognize possible icing conditions and act accordingly. Provision is made in the basic system for incorporation of tail rotor deicing if this should prove desirable.

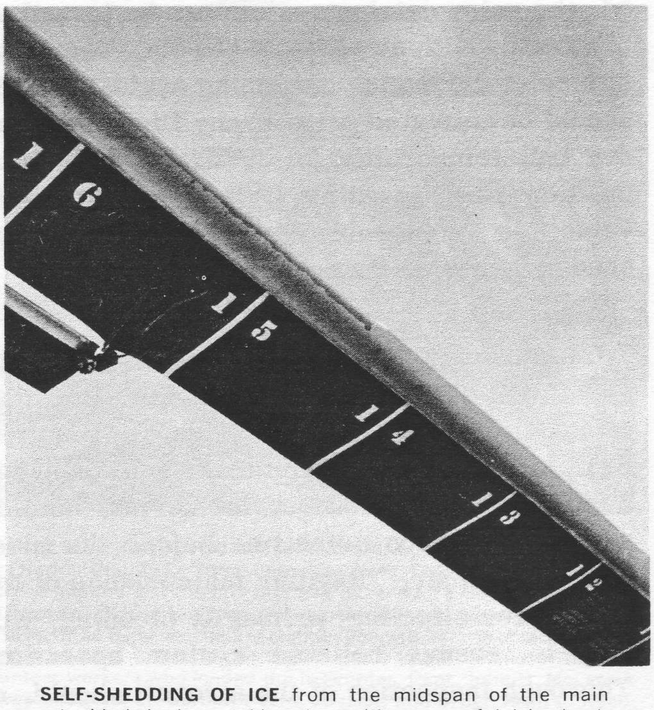
With a few refinements to facilitate test operations, plus a suitable instrumentation installation, the test helicopter conformed with the configuration described above. Inasmuch as this set-up represents the proposed production ice protection system, it marked the first time that an aircraft had been taken to Ottawa for test of a production system without previous evaluation of a prototype installation.

The Ottawa icing test facility is essentially a large spray frame, supported 70 ft. in the air by a mast, that produces an artificial icing cloud of super-cooled water droplets through steam atomization. Steam and water flow control allows variation of the cloud's icing intensity, and the cloud is large enough to completely envelope the helicopter's rotor system as it hovers downwind from the spray rig.

Test objectives with respect to the rotor system were lumped into two general areas—the effects of icing flight without protection, ice accretion characteristics, self shedding, aircraft flying qualities, engine power increases required, etc.; and the electrical shedding performance of the deicing system. In addition, such things as engine air inlet operation, determination of possible safety of flight conditions due to icing, and function of other aircraft systems affected by ice were evaluated. These investigations were carried out over as wide a range of ambient temperature as weather conditions permitted. In general, the performance of the HU2K-1 and its icing protection systems was quite gratifying.

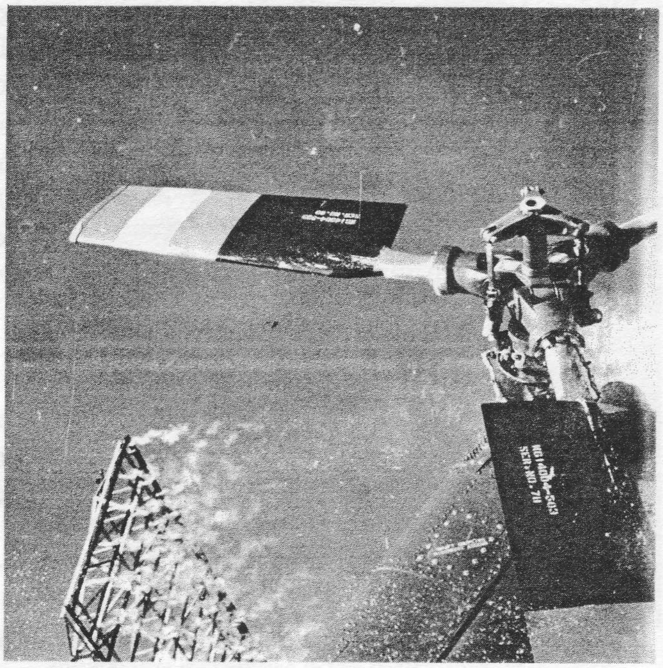
This three-week test period represented the first operation of the SEASPRITE away from the main plant for an extended period of time. No maintenance problems arose during the 20 hours flown in the test rig or during normal operation and the only part or component replacement required was a single oil shut-off valve.

Many of the points noted with the machine in ice came as a pleasant surprise in light of previous helicopter icing work. The degree of main rotor vibration induced by uneven self-shedding of opposite blades was much less than expected, thus eliminating the possible requirement of thermal-matching opposite blades to ensure equal rates of leading edge temperature rise. Flap icing was relatively slight down through 10°F., and the effect of this light ice accretion was negligible in respect to such factors as rotor stability, controllability, and track. Apparently the 20-inch chord blades appreciably delay the onset of serious flap icing. Although it is expected that at lower temperatures more flap ice will form, the electrical protection provided will be fully adequate. Blade retention ice formations were quite appreciable after long cloud exposure, but it was found that the effects of this ice in the area of the various control links and bearings were not seen in the rotor flight characteristics. Comparison flights were made, both in hover and with forward airspeed, first with full retention ice and then with the control links and bearings cleared of ice, and no significant changes in flying qualities were noted.



SELF-SHEDDING OF ICE from the midspan of the main rotor blade is shown taking place without use of deicing heat.

Over-all reaction of the aircraft to hover icing flight, with respect to vibratories experienced and flying qualities, was very favorable. Extensive blade ice buildups, main rotor electrical and self-shedding conditions, were all produced over reasonably long term exposure times with relatively little adverse effect on the helicopter. Tail rotor vibration, due to asymmetric ice buildups, has usually been a serious problem for single rotor machines exposed to icing, primarily because a tail rotor blade is a very efficient ice catcher so that any problem areas show up very rapidly. Such vibratories were experienced with the SEASPRITE, but of so mild a nature as to allow unprotected tail rotor operation down through 15°F. Due to weather limitations thorough tests were carried out only down to 10°F., so that the absolute necessity for tail rotor protection could not be firmly established. However, limited tests of an electrically deiced tail rotor showed that adequate protection will be no problem if required. Similarly, the basic suitability of the main rotor electric deicing system was firmly established. The need for certain improvements and refinements was discovered, but fortunately these can all be made quite simply and do not require drastic system changes.



TEST ENGINEERS found tail rotor performed in a satisfactory manner at 15° F. without electrical deicing. Providing deicing protection below this temperature, if required, will not be difficult.

The other aircraft systems exposed to the effects of icing were found to operate satisfactorily in general. The value of the engine inlet blow-in door was proven when large ice buildups partially blocked the inlet screen, causing the door to open. In all cases normal engine operation continued uninterrupted. Operation without the inlet screen in icing conditions is not recommended in order to avoid the possibility of engine ice ingestion as a result of ice breaking off the unprotected walls of the inlet plenum chamber. Windshield and pitot tube heaters functioned without a hitch throughout the program, and no freeze-ups of movable components or assemblies occurred. The one exception to this generally favorable record was the inability of the rotor droop stops to seat firmly when carrying a load of ice. When required during the Ottawa testing, the stops were brushed in with a common straw broom, but obviously some form of protection will have to be provided in this area.

The improvements and modifications noted above have now been translated into the hardware stage, and are available for evaluation. Although it is obviously too late for further test work at Ottawa this year, these changes will be incorporated in the cold weather test helicopter, so that their influence on deicing performance can be determined by use of the icing spray rig in the climatic hangar at Eglin Field.

As previously indicated, no ice detector is installed in the HU2K-1 in the interest of simplicity and lighter weight. Sufficient advance indications of entry into icing conditions exist to enable the pilot to detect the situation and turn on the deicing system well before serious problems appear. The most obvious of these would be small ice formations on the nose area — windshield wipers, window frames, even rivet heads. In addition, engine power required to maintain a given flight condition will go up due to increased rotor drag. This power increase was found to be on the order of 100 to 120 hp at Ottawa, and can be recognized by comparable increases in N_1 and T_5 indications. A brief, light tail rotor buzz will also be felt after about two to three minutes in ice as the initial self-shedding of tail rotor blade ice takes place. Once flight in icing conditions is established, extreme manuevers should be avoided since blade maximum lift coefficient is reduced by ice formations, even though available lift is essentially unchanged at normal blade angles of attack.

If icing conditions are forecast or anticipated, the rotor deicing system can be turned on in advance with no adverse effects. The same is true of the engine anti-icing system, which should be activated prior to any flight when the dry bulb temperature is 39°F., or below, and the dew point is within 7°F. of the dry bulb value, as a conservative criteria for icing condition probabilities.

The absence of maintenance problems with the SEASPRITE at Ottawa demonstrated that no specific precautionary work is required prior to icing flight. Common sense might indicate a functional check for normal deicing system operation sometime before the onset of cold weather. Regular maintenance of the main rotor slip ring, primarily cleaning, will help to ensure reliable system operation. Thorough inspection of the aircraft should, of course, be made after flight in icing. Ice shed from main or tail rotor may strike either the other rotor or the fuselage; and although chances of appreciable damage from this source is slight, the possibility should not be overlooked. If the need should ever arise to manually scrape off blade ice accumulations, care must be taken to prevent damage to the boot or the stainless steel erosion shield.

The broad objective of the Ottawa tests was accomplished — to demonstrate the ability of the HU2K-1 to operate in icing flight conditions, one phase of its all-weather capability. This result, plus the successful over-all experience during the aircraft's first field operation, provides justification for confidence in the helicopter's future usefulness to the Navy. Much as the proverbial postman, neither snow, sleet, rain, nor ice will prevent the SEASPRITE from making its appointed rounds. K

The Seasprite takes the icy blast

NO RESCUE JOB IS TOO BIG OR TOO SMALL for the Helicopter Unit at Suffolk County Air Force Base, New York. Flying an H-43B Huskie, three members of the unit dropped more than a ton of grain to distressed wildlife in the area while participating in "Operation Wildlife Save." The flight was held in conjunction with efforts of local sportsmen and the Conservation Department. Shown is one of the volunteer workers who loaded the helicopter. Capt. John H. McLeaish was pilot; 1st Lt. Gordon Hecht, co-pilot; and S/Sgt. Alvin C. Reed, crew chief.

CDR. CHARLES B. CAMPBELL, JR., USN, skipper of HU-2, right, presents engine log book to R. E. Carr, AMCAP; center, and Lt. Cdr. R. L. Moren, VRF-31; as squadron bids farewell to HUK-1. The helicopter was ferried to the Naval Air Station at Jacksonville, Fla. HU-2 first received the HUK-1 on Aug. 1, 1958, and sent the bird cruising early in 1959. While in HU-2, the HUK-1 flew over 6500 hours and was credited with 28 rescues. Perhaps the most outstanding by an HUK-1 was in December, 1960, when Commander Campbell and Lt. (jg) Frank Erhardt rescued nine men from the tanker Pine Ridge after she broke up in heavy seas off Cape Hatteras. (U.S. Navy photo)

More From Les . . .

From time to time in this column, C. L. Morris, Assistant Vice President—Field Service Manager, will comment on subjects of particular interest to operating activities.

INCH-POUNDS or POUND-INCHES?

Our handbooks and our technical articles in Rotor Tips always refer to torque in "pound-inches," or "pound-feet," instead of "inch-pounds," or "foot-pounds." A few months ago, a careful and valued reader of Rotor Tips took time out to write us about it. He expressed the opinion that pound-inches and pound-feet are not common language. He felt this might be confusing to our readers, and that we should use the terms inch-pounds and foot-pounds when referring to torque.

There is certainly much to be said for his point since torque wrenches and various handbooks read that way. Most important of all, however, a good many mechanics use the terms inch-pounds and foot-pounds when speaking of torque. However, one of the specifications that our handbooks must conform with is ANA Bulletin #261 (30 May, 1945) which says a moment of torque is measured in pound-inches and pound-feet. Inch-pounds and foot-pounds are defined as moments of movement. Since our handbooks conform with the ANA directive, we feel that Rotor Tips should be consistent with them. In addition, many physics and machinists' handbooks use the same terminology as ANA 261 when referring to torque.

We are looking into the whole question again, as we have from time to time before. Naturally, however, any change in terminology could only be done with proper authorization. But in the meantime, when you see torque requirements, remember that the numerical values are the same whether you refer to them in inch-pounds or pound-inches—foot-pounds or pound-feet. K

CURRENT CHANGES

FIELD INFORMATION DIGESTS (KAMAN)

Applies - No. A-60, 3 April, 1961
HOK-1 Use of Hub and Rotor Shaft Color Coding as an
HUK-1 Installation Aid.

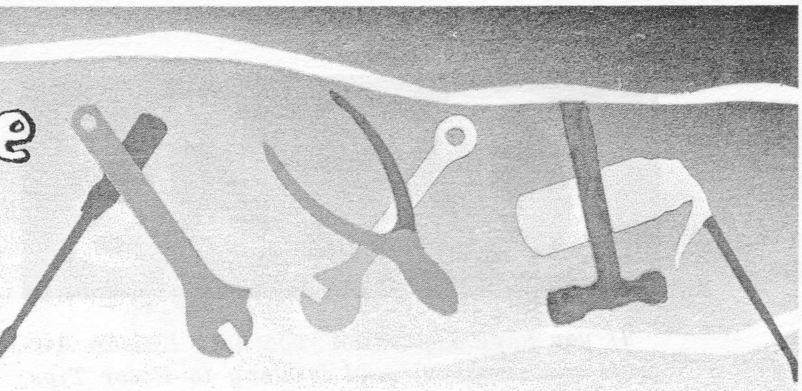
Applies - No. C-8, 3 April, 1961
H-43A Use of Hub and Rotor Shaft Color Coding as an Installation Aid.

Applies - No. B-36, 13 March, 1961
H-43B Use of Locktite Grade "E" on the Threads of the Lag Pin Locknut K310046-11

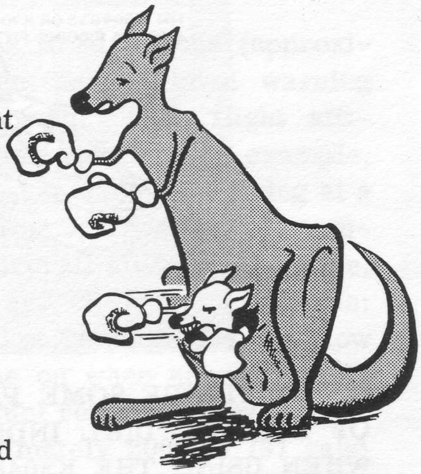
No. B-38, 20 March, 1961
Use of Hub and Rotor Shaft Color Coding as an Installation Aid.

No. B-39, 24 March, 1961
Starter Generator, P/N VG-600-11 Operating Limitation (H-43B).

Maintenance Mailbag



Dear Chuck,



I've been on one liberty since the ship put in here and it will be the last one as far as I'm concerned. Went down to the amusement park last night but it turned out to be pretty dull until I heard this bird in a derby hat start hollering about giving $50 to anyone that could go one round with his "boy" Hoppy. Well I stepped up quick when I found out this Hoppy was nothing but a moth-eaten kangaroo. This turned out to be a mistake. That crazy kangaroo had the quickest footwork and was the dirtiest fighter I've ever tangled with. He had a kinda' Joe Louis shuffle combined with a sideways hop that threw my timing all off. He was doing real good though. Kept batting me in the face and everytime I tried to raise my guard this big, hairy tail would slam me alongside the head. I went into a clinch but had to break quick cause the fumes started to get me. Hoppy either needed a deodorant real bad or had been drinking JP fuel. All the time I was getting clobbered in the face, something kept belting me in the mid section. I took a quick look down and found this nasty little face looking back at me. Then I realized Hoppy was really a lady kangaroo complete with occupied pouch. While Momma was giving it to me up top, "Junior" was leaning out and throwing punches just as fast as he could. He fouled me twice before I could back off. Between the two of them I lasted just one minute and thirty seconds before I hit the canvas. It was all pretty humiliating, especially when that rotten little kangaroo sat on my chest and raised his gloves over his head.

Well, enough of my troubles. How's the helicopter business at your end? We have just completed reassembling a chopper which was air-shipped in and whoever did the disassembly job at the shipping end really knew his business. All loose nuts, bolts, and washers and anything else that was small and easily lost had been put in small sacks and labelled as to just what went where and then the sacks were secured to the components. It saved mucho trouble and a lot of time here not having to scrounge all over the place for missing parts. Another thing that's good to keep in mind, label all special tools when they arrive and put them in one place. If they get lost or scattered around, it sure can add to the man-hours it takes to reassemble a helicopter.

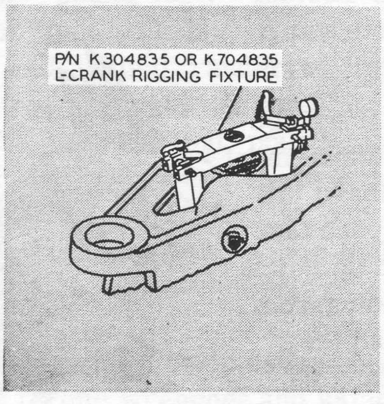
Was talking to John Elliott, the Kaman Service Rep, the other day and he tells me that an easy way to pinpoint elusive oil leaks is to clean the suspected area thoroughly and then dust it with talcum powder. Start the engine and during the runup the oil leak will show up in the powder and indicate the source.

Gotta' hit the sack now. Let's hear from you,

Murph

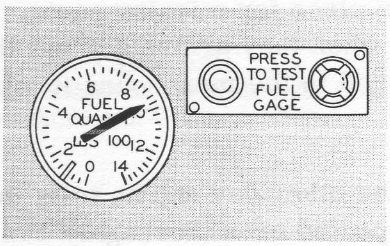
Q's AND A's

If you have a question regarding Kaman Aircraft maintenance, send it along to Rotor Tips. The Service Department's analysts will be glad to answer it.



Q. WHAT ARE SOME PROBABLE CAUSES OF ERRATIC DIAL INDICATOR READINGS WHEN USING THE K304835 OR K704835 L-CRANK RIGGING FIXTURE? (Applies HOK-1, HUK-1, H-43A, H-43B)

A. Looseness between the rotor hub teeter locks and the hub droop stops because of improper clamp-up of the teeter-locks is the usual cause. However, one of the three following serious conditions may be indicated: (1) improper teeter pin torque (2) damaged teeter pin bearings (3) large ID bearing used erroneously on the small end of the teeter pin. These conditions are more apparent when the L-Crank Rigging Fixture, or runout tool, is used with the blades installed. — G. M. L.

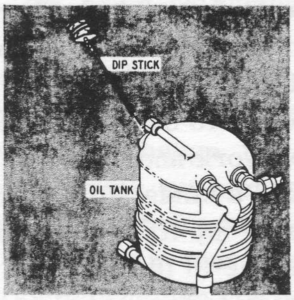


Q. HOW MANY POUNDS OF FUEL SHOULD THE FUEL QUANTITY INDICATOR READ WHEN PRESSING THE TEST SWITCH? (Applies H-43A, H-43B)

A. No specific value. The test switch is only to determine that the fuel quantity indicator is functioning properly.

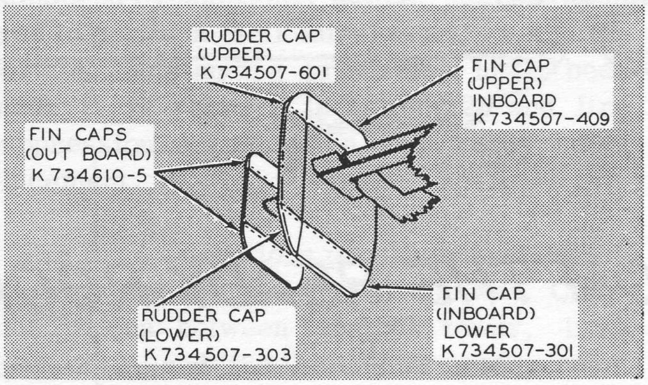
Pressing the test switch simulates a lower fuel quantity; consequently, the pointer should move to a lower reading and stop. This lower reading can vary between aircraft, due to the tolerance in the fuel quantity system units and the amount of fuel in the tanks.

If, when the test switch is released, the pointer returns to its original reading, the indicator is functioning properly. — P. A. G.



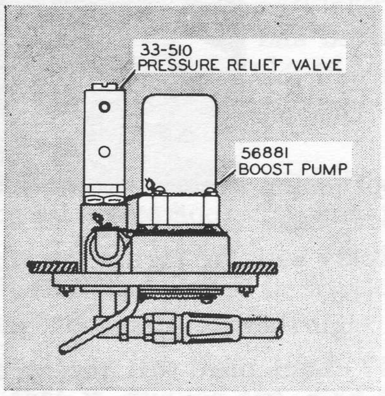
Q. WHY DOES THE ENGINE OIL CONSUMPTION INCREASE WHEN PRACTICING AUTOROTATION? (Applies H-43B)

A. The primary design of the T53-L-1B engine incorporates provisions for air pressure to help the oil seals function properly. During autorotation the engine turns without engine power and the pressure balance of the engine is disrupted. In autorotation only about 65% of the desired pressures are available. This loss of sealing pressure will allow oil to pass through the seal fit into the engine and be consumed with the fuel. This does no harm; however, if extensive autorotation practice is scheduled, maintenance people should keep an eye on oil consumption and be sure that no oil starvation results. At the present time there is no maximum oil consumption established for an engine which uses more oil on a flight when many autorotations have been made. Of course, if unusual oil consumption occurs during flights when no autorotations were practiced, then the condition should be fully investigated. — A. A. W.



Q. WHAT ARE THE PART NUMBERS FOR THE TAIL TIP CAPS IN THE NEW FOUR-FIN CONFIGURATION? (Applies H-43B)

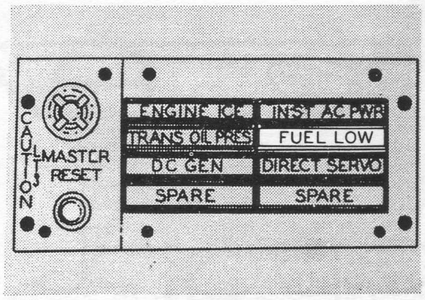
A. The Kaman part numbers for the new configuration are shown above. Federal Stock Numbers for these parts have not yet been assigned. — R. S. W.



Q. WHY IS IT NECESSARY TO USE THE GARWIN RELIEF VALVE P/N 33-510 WITH THE ADEL FUEL BOOST PUMP, P/N 56881, IN THESE HELICOPTERS? (Applies HOK-1, HUK-1, H-43A)

A. The Adel fuel boost pump is used on more than one type of aircraft, some having higher fuel boost requirements than the HOK-1, HUK-1 or H-43A.

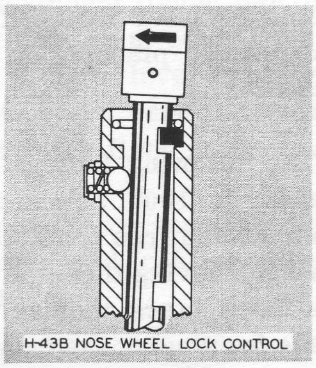
This pump is manufactured to give as high as 10 psi boost pressure. The pressure is determined by tolerances internally, therefore is non-adjustable. The Garwin valve reduces these pressures to the correct operating pressures of 5.5 psi at 70 gph for the above aircraft. ASC 104 has been released incorporating the above pumps in HOK-1 and HUK-1 aircraft. — C. W. J.



Q. HOW MUCH FUEL DO YOU HAVE REMAINING WHEN THE LOW LEVEL WARNING LIGHT COMES ON? (Applies H-43B)

A. From 22 gallons to 34 gallons (approximately) remain when the low level warning light comes on, depending upon flight attitudes and power demands. For example, when the gross weight is 6200 lbs, flying at a minimum power setting and best range condition for the three aircraft attitudes of cruise, level flight, and hover, the remaining fuel is: in cruise at a speed of 85 knots the fuel low level light will come on when approximately 143 lbs (22 gals) of fuel remain; in level flight at 68 knots, approximately 200 lbs (31 gals) remain. In hover and at zero knots approximately 228 lbs (34 gals) remain.

To be sure, read the fuel quantity indicator when the light comes on. — A. A. W.


H-43B NOSE WHEEL LOCK CONTROL

Q. HOW DOES THE NOSE WHEEL LOCK CONTROL OPERATE? DOES THE HANDLE TURN, OR JUST PULL UP? (Applies H-43B)

A. Neither is correct. The handle should be forced sideways towards the pilot's seat in the direction of the arrow on top, and then pulled up to set the brake or pushed down to unlock it. It should never be twisted as this leads to damage to the brake cable and fittings. — R. S. W.

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Report FROM THE READY ROOM

LOCAL BASE CRASH RESCUE

by RALPH R. LEE
Test Pilot

All our military services have been using helicopters as Crash Rescue vehicles for a long time. In the pre-H-43 days, ASR meant merely answering the crash horn, checking your map, warming up the helicopter, then flying to the crash scene, hoping no fires had started and hoping for survivors. If there were survivors and the downed machine hadn't burned, you made your rescue.

With the advent of the H-43 and its fire suppression capability, a new dimension was added to the Local Base Crash Rescue. You get airborne much more quickly with the turbine engine and have a fire suppression capability right with you.

How to make best use of these new capabilities? Each base will have problems peculiar to itself and have varieties of physical layouts, requiring imaginative planning by each local commander to make best use of existing facilities.

The following factors exist in successful operations: (1) The Base Commander is 100% behind the program. (2) The rescue pilots are available, rested, and free from the entanglement of numerous additional duties. The need for having these pilots available is no less important than that of having the firefighters themselves available and standing by. (3) Provisions are made for placing the helicopter, fire suppression kit, firefighters, and rescue pilots in a spot where a quick scramble is not only possible, but also simple and efficient.

The USAF has a number of H-43B Local Base Crash Rescue Units operative, some of which have been in business for nearly a year. One of these helicopter units, at Luke AFB, Glendale, Arizona, is an excellent example of a successful operation.

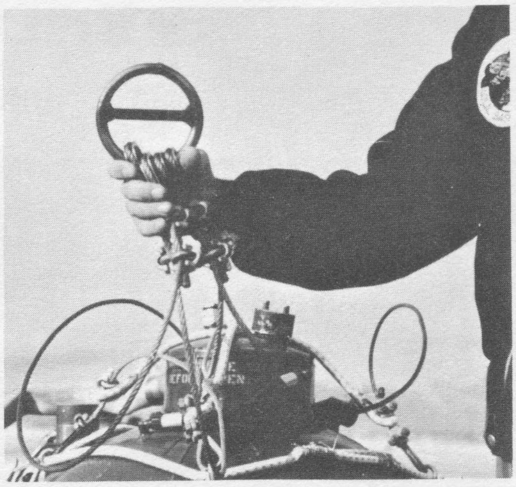
The Luke unit is under the direction of Capt. Walter McMeen, with Capt. Roy Dreibelbis his number one assistant. The people at Luke have the full 100%, unqualified support of their Base Commander, their pilots are unencumbered by additional duties, leaving them free to perform their mission and, very important, outstanding provisions have been made there relative to helicopter and fire suppression kit location and ready room placement.

The Base Operations people understand the program and are behind it all the way. Communications between control tower, base operations, and the helicopter ready room include: (1) GCI/Flight service lines. (2) Base telephone. (3) Crash phone. (4) Squawk box. (5) Radio located in ready room and tuned to student pilot frequency. (6) SAGE lines.

The helicopter itself is located roughly 230 feet from the ready room and encircled by a painted ring on which stanchions have been placed, warning personnel to stand clear when takeoff and landing operations are in progress. The fire suppression kit is placed in front of the H-43B for immediate use (see photograph).

To speed up the rescue process, a new suppression kit cargo hook attaching ring was developed by T/Sgt. Howard F. Alford of the Luke LBCR staff and placed in service. This "Alford Ring" consists of a straight piece of stock, similar to the ring stock, which is welded so that it divides the ring into two sections (see photograph).

Use of this ring has two advantages: (1) the support cables to the fire suppression kit are easier to keep in order. (2) with the added piece used to close the helicopter cargo hook, the hookup becomes a simple, one-hand operation.



THE "ALFORD RING" in use at Luke AFB

On the average, three launches a day are made with the kit, mainly as precautionary measures. It has been found that knowing the helicopter is standing by has been a great reassuring factor to the fixed wing pilots. Usually, in a deferred emergency, the Huskie is airborne with the suppression kit in a minute and twenty seconds. In "crash imminent" situations, about 60 seconds is all these people need.

All six pilots are fully qualified in the H-43B, three of whom are designated Aircraft Commanders for Crash Rescue purposes. Scramble capabilities are immediate, during all scheduled student flying, day or night, and on 30 minutes notice at other times. In order to maintain a high level of efficiency, the people at Luke are required to fly a given number of practice fires each month.

All of these items mentioned above take practice, time, and cost money—but they save lives! K

MAXIMUM SPEED-INTO-ACTION is assured by this "scramble circle" used by the Local Base Crash Rescue Unit at Luke Air Force Base. Other line personnel are required to stay clear of the area as a means of eliminating possible hazard or delay.

SCROLL OF HONOR

KAMAN SCROLLS OF HONOR awarded for their participation in the HUK-1 rescue of nine crewmen from the tanker Pine Ridge are displayed by members of the Helicopter Utility Squadron Two, Naval Air Station, Lakehurst, N.J. Front row, left to right, are V.M. Proto, ADR3; C. E. Reuther, ADR3; and K. L. Heliin, AM2. Rear row, Mr. C. L. Morris, Assistant Vice President and Field Service Manager, Kaman Aircraft Corp.; Cdr. Charles B. Campbell, Commanding Officer of HU-2; Lt. (jg) Frank J. Erhardt; and David Rush, Field Service Representative, KAC. (U.S. Navy photo)

Chief Aviation Machinist's Mate Martin D. Sims, Jr., (AP), USN, and his crewman, Arlington L. Levi, AD3; of NAS Agana, Guam; have been awarded Kaman Scrolls of Honor for their rescue of two Navy swimmers who had been swept to sea and were approximately 600 yards offshore.

The rescue, accomplished in an HUK-1, was made despite choppy waters, poor visibility caused by the combination of whitecaps and a setting sun, and turbulent air conditions.

The mission began after one sailor found he was unable to swim back to shore due to the strong tide. The other sailor jumped into the sea to assist his friend and also found it impossible to buck the strong current. In his report of the incident, one of the survivors summed up his feelings with a heartfelt, "I would like to take this opportunity to thank the people in the helo. They certainly knew what they were doing."

A few days after this mission, personnel from the Agana Naval Air Station were once again called upon to rescue swimmers caught in a treacherous rip tide. Lt. (jg) Allen E. Weseleskey, already holder of the Kaman Scroll of Honor, and his crewman, S. O. Davis, AD3; responded in an HUK-1.

One of the swimmers, a Navy Chief, was unconscious and being held up by a Navy Chief Warrant Officer. The first pickup was made smoothly, even though rain showers hampered visibility during the entire rescue. Davis brought the chief aboard and immediately administered artificial respiration. After successfully reviving the survivor, Davis then hoisted the second swimmer aboard. He was completely exhausted by his exertions and narrow escape from death.

ICE FLOE RESCUE—H-43B helicopter crew from Selfridge Air Force Base, Mich., receives congratulations for rescuing seven of 14 persons marooned on an ice floe in Lake Erie. Three others were picked up by boat and four others by a Navy helicopter. Left to right are T/Sgt. Donald A. Anderson, crew chief; 1st Lt. Gerald F. Petty, co-pilot; 1st Lt. Owen A. Heeter, pilot; and Bill C. Welden, KAC Field Service Representative. The crew members have been awarded Kaman Scrolls of Honor. (USAF photo)

HARMONIC DRIVE

by R. B. BOSSLER
Project Engineer
Harmonic Drive

A revolutionary power transmission system called Harmonic Drive will be studied by The Kaman Aircraft Corporation for possible application as a helicopter transmission under contract with the United States Army Transportation Research Command, Ft. Eustis, Virginia.

Originally conceived and developed by the United Shoe Machinery Company, Harmonic Drive departs radically from conventional gear box design. Inherent in the Harmonic Drive system is extremely high efficiency and weight reductions of up to 50 per cent of existing transmissions. Very high speed reduction ratios — as much as 200,000 to one – are attainable.

Kaman Aircraft is entering into the Army contract under a working agreement with the United Shoe Machinery Company.

Work to be done by Kaman Aircraft will look to the possible use of Harmonic Drive under the high power input, heavy loading conditions, and high reduction ratios imposed by helicopter operations, especially with gas turbine installations. To date the Harmonic Drive has been used only in relatively low power and torque input levels in such applications as nuclear reactor control rod drives, antenna drives, power takeoffs and servomechanisms.

The typical Harmonic Drive departs from conventional drives in that it makes use of one or more of the flexible mechanical elements. A typical unit of a single stage contains only two moving parts, the input and output elements.

Transmission of power is accomplished not with gears as in existing systems but through the combination of two splines, one rigid and one flexible.

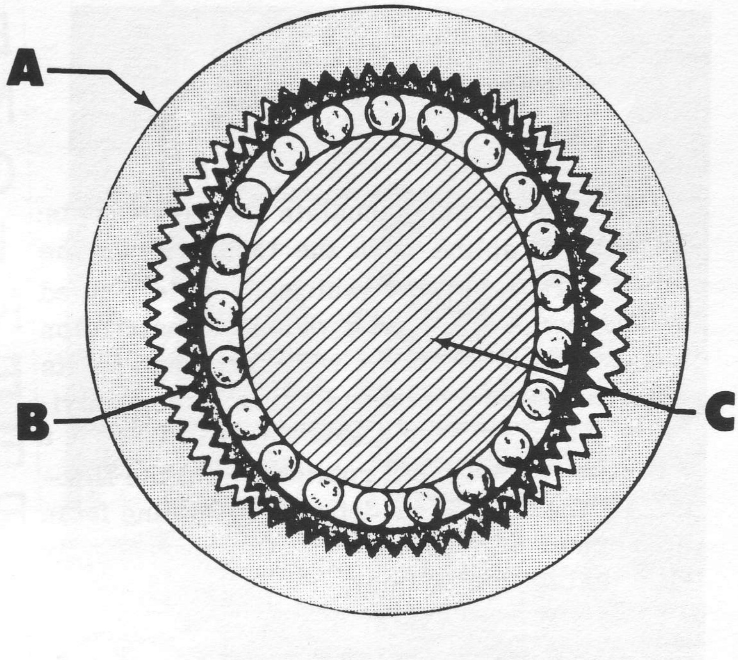
The typical unit consists of three parts: a circular spline with the teeth cut on the inner circumference which is rigidly fixed and is normally a part of the transmission case; a flexible spline with teeth cut on its outer circumference and which is concentrically mounted in the circular spline; and a wave generator which rotates within the flexible spline and which deflects the spline from its normal circular shape into a generally elliptical or oval shape.

With the wave generator mounted within it, the flexible spline, or Flexspline, attains two definite axes, one longer than the other, as in an oval shape, with the longer axis occurring at the point of contact of the wave generator. Spline teeth are firmly engaged at the points of the long axis and totally disengaged at the short axis.

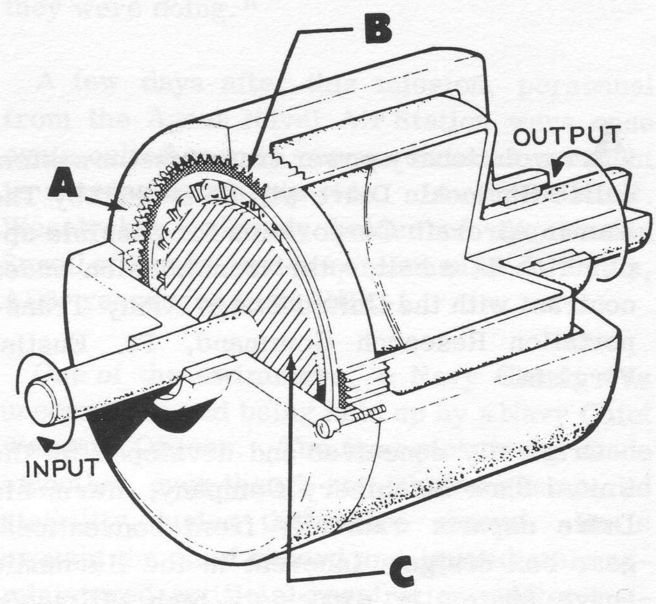
The Flexspline is designed with two or more fewer teeth than the rigid circular spline. As the wave generator is rotated by the power input, the point of contact of the Flexspline rotates with respect to the fixed circular spline. The net effect is the creation of a wave action in the Flexspline.

As a point of contact between the two splines moves, the spline teeth continually engage and disengage. Since there are fewer teeth in the Flexspline, this element literally "walks" around the fixed circular spline, imparting rotation to the Flexspline in a direction opposite the rotation of the driven wave generator. Rotation of the Flexspline is the power output of the drive system.

The difference in the number of teeth between the Flexspline and rigid spline determines the reduction ratio. In this example the Flexspline has 198 teeth and the rigid circular spline 200, resulting in a 100:1 ratio. Combining two or more stages can produce extremely high reduction ratios. K



THIS SCHEMATIC DIAGRAM illustrates the three basic parts of the Harmonic Drive system. (A) is the rigid circular spline which is part of the transmission case; (B) is the flexible spline which also supplies output power, and (C) is the wave generator driven by power input. The elliptical shape of (C) when driven clockwise deflects the flexible spline (B) whose teeth progressively engage teeth on the rigid spline (C), causing (B) to rotate counterclockwise.



THE ARRANGEMENT OF PARTS in a typical Harmonic Drive assembly is shown in this cutaway drawing. Rigid spline is at (A) as part of the case; flexible spline is at (B) and wave generator at (C). Power input rotates (C), deflecting (B) and causing teeth to engage (C) progressively. Rotation of (B) supplies output power at the right. As can be seen, only two parts of the system are in motion.

CHECK AND DOUBLE CHECK—U.S. Air Force and KAC personnel met recently at Kaman Aircraft at a Command Review Conference held to carefully examine the H-43B Flight Manual and consolidate the experience of the various using Commands in formulating a production-type manual which will be technically complete and accurate, and support the missions of all using commands. As a result of the Command Review, the manual will be reissued with all required changes. Among those attending the Review were, seated, left to right, Maj. R. C. Kirkland, ATC, Stead AFB; Capt. J. R. Luttinger, TAC, Pope AFB; Mr. C .F. Peters, MAAMA, Olmstead AFB; Mr. M. Czuczko, WAAD, Wright-Patterson AFB; Maj. R. R. Tyler, MATS, Scott AFB; Capt. W. C. McMeen, TAC, Luke AFB; Maj. J. T. Hamill, ATC, Stead AFB; Mr. E. C. Gustin, MAAMA. Standing, front row, L. A. Barrett, Military Operations Research Engineer, KAC; Capt. W. T. Calva, TAC, Nellis AFB; Capt. J. Womack, MATS, Orlando AFB; Capt. J. B. Grasser, ATC, Stead AFB; Capt C. R. Ratcliffe, Jr., ADC, Kincheloe AFB; Capt. W. B. Haaser, WAAD, Wright-Patterson AFB; Mr. D. R. P. Sweeney, MAAMA. Rear row, Capt. J. S. Honaker, ARDC, Edwards AFB; Capt. R. E. Hennessey, SAC, March AFB; Maj. S. B. Jennings and Maj. R. B. Bailey, SAC, Barksdale AFB; S/Sgt. T. Lee, ADC, Kincheloe AFB; J. F. Higgins, Technical Writer; G. L. Wood, Group Leader, Service Publications; P. J. Russell, Senior Test Pilot; R. E. Sluis, Technical Writer, KAC. Other service-attached personnel who attended the Review are: Lt. Col. J. C. Schwartz, Mr. J. Young, Mr. D. Norman, WAAD, Wright-Patterson AFB; Lt. F. J. Albrecht, USN, BUWEPS; Mr. K. R. Ferrell, ADRC, Edwards AFB; Capt. R. L. Maddox, ATC, James Connally AFB; Capt. R. L. Hurlbert, MATS, Scott AFB.

The introduction of the turbo-jet engine into the rotary-wing field has also introduced "jet-talk," a language with which many of our readers are probably already familiar. A refresher of basic physics terms in this issue will help to visualize how the principles are used in the turbine-jet engine. Questions from readers are always welcome.

TURBINE TALK

FORCE: The cause of work being done, or an action being accomplished in opposition to some natural restraint. When a man pushes against the helicopter, the force of his pushing is restrained by gravity and friction with the ground; but when he pushes hard enough to move the helicopter, he has overcome the restraint and certain work is accomplished.

WORK: As above, work is the result of a force acting through some distance. No work is accomplished unless motion results from the application of force.

POWER: When force is applied to a resistant and causes it to move and the rate of this movement is considered, then a statement of power is possible. Power expresses the rate at which work is accomplished. As there is no work evidenced by a force until movement is achieved, so there is no expression of power until the element of time required to complete the movement is added.

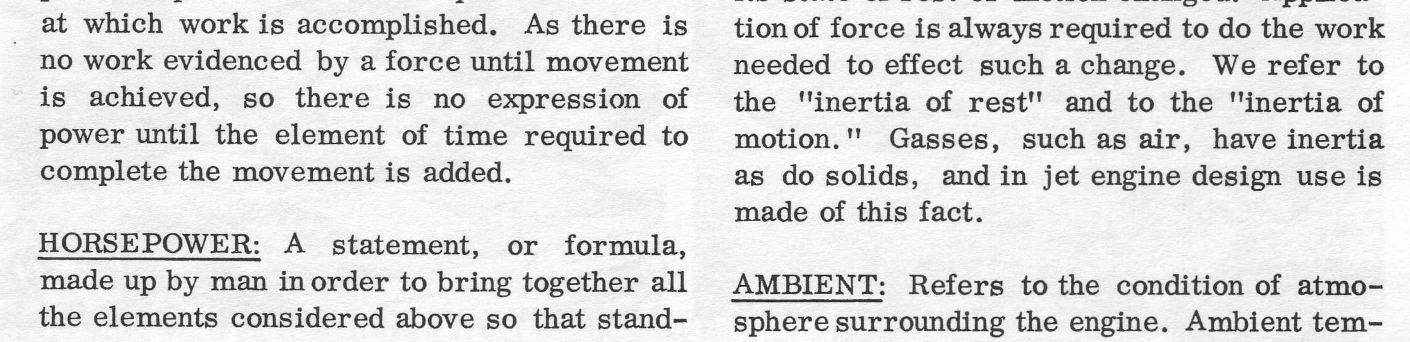
HORSEPOWER: A statement, or formula, made up by man in order to bring together all the elements considered above so that standard measurements can be used, is called "horsepower." One horsepower is the amount of power resulting from a force moving a weight of 33,000 pounds a distance of one foot in one minute against the force of gravity. This power guide is an accepted measurement of power, and techniques for measuring power output in terms of horsepower are now standardized in industry and science.

MASS: Any tangible substance must contain "matter." Matter is anything which occupies space. Mass is thought of as the amount of matter contained within a substance.

DENSITY: When a specific amount of a substance is measured in respect to its reaction to gravity, then the mass is considered in terms of a stated volume of the substance. This measured amount is called density. Density is simply a statement of how much mass is present per unit of volume. Thus the density of lead is 11.4 grams per cubic centimeter, and the density of cork is 0.25 grams per cubic centimeter.

INERTIA: The opposition of a body to having its state of rest or motion changed. Application of force is always required to do the work needed to effect such a change. We refer to the "inertia of rest" and to the "inertia of motion." Gasses, such as air, have inertia as do solids, and in jet engine design use is made of this fact.

AMBIENT: Refers to the condition of atmosphere surrounding the engine. Ambient temperature and ambient pressure express values of the air in which an engine is operating. There may be other ambient values, such as percentage of moisture, or the dust count, but these are not of such direct interest to the engine man. Ambient values change with altitude, location, time of year, etc., and are always factors influencing engine performance. K

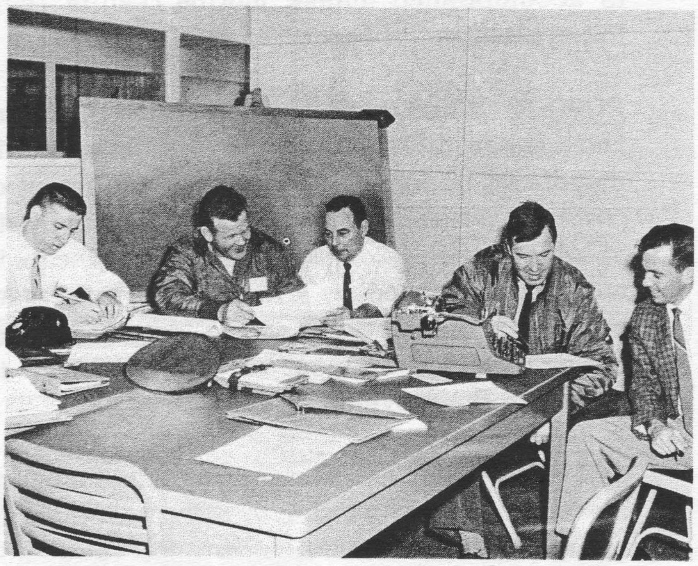


CAPT. B. K. LLOYD, U.S.N.
Ready for check flight

MR. R. L. WERNECKE, ENGR. and CAPT. D. A. SPURLOCK, USMC, Pause during inspection

LCDR. J. L. BLADES, USN, and MR. W. J. HOERMAN, KAC Making pre-flight inspecti

CAPT. L. K. KECK, USMC, and LCDR. D. J. ROULSTONE, USN
Looking over their in-flight notes



MR. R. C. DUMOND, ENGR; AD-1 R. H. HAGLER, USN; MR. B. H. CRAIG, ENGR; LCDR J. L. BLADES, USN; MR. C. H. VAN CLEAVE, ENGR. Evaluating flight data

Members of the three divisions at the U.S. Naval Air Test Center, Patuxent River, Maryland, are presently conducting Navy Preliminary Evaluation (II) with the HU2K-1 helicopter. Members from Flight Test, Service Test, and Weapons System Test have been flying the SEASPRITE under all weather conditions and both day and night. Their work includes evaluation of flying qualities, mission capabilities, and functional tests of electronic and associated systems. The teams are gaining familiarity with this new, high-performance helicopter. From their work will come recommendations and suggestions for improvement or changes which will further enhance the efficiency with which the HU2K-1 will perform its vital mission.

Naval Air Test Center personnel who have been in attendance during NPE II are: Capt. B.K. Lloyd; Cdr. P.L. Sullivan; Cdr. C.B. Hamilton; Lcdr. D.J. Roulstone; Lcdr. J.L. Blades, USN; Capt. D.A. Spurlock; Capt. L. K. Keck, USMC; AD-1 R.H. Hagler; ADR-1 D.E. Felix; AD-2 K.L. Adams, USN; Mr. R.L. Wernecke, Mr. R.C. Dumond; Mr. C.H. Van Cleave; Mr. B.H. Craig and Mr. W.M. Browne, Engineers.

HOT TO GO

Delivery of H-43B HUSKIE helicopters to Air Force Bases all over the United States has been going on for a year now, but never have they received a greater or more enthusiastic welcome than at England Air Force Base in Louisiana recently. Here's what happened according to an "eyeball witness"—Field Service Rep Bob Lambert:

The two helicopters arrived one night aboard a C-124 in a driving rain storm but, despite the weather and the hour (2230), about 30 officers and enlisted men converged on the delivery aircraft. They unloaded the helicopters with "loving care" and then took them to a hangar where the covers were removed. Afterwards a question and answer session was conducted about the performance and maintenance of the aircraft and the theory of the synchropter. This session lasted well into the morning.

A few hours later, at 0730, assembly of the helicopters began. Due to their eagerness to get the H-43Bs flying and to learn more about the helicopter, all pilots in the Helo section donned coveralls and assisted the three assigned mechanics. The first aircraft was ready to be serviced the next day at 1400!

12 MINUTES FROM SCRAMBLE

Shortly afterward an H-43B crew from England AFB proved that the "HOT TO GO" spirit still prevailed. Twelve minutes after scramble they carried out a spectacular wheels-in-the-trees pickup 12 miles from the base.

Flying in the HUSKIE were Lt. Hubert Berthold, IP; Capt. Joseph Kail, co-pilot; M/Sgt. E.E. Pompier, medic; S/Sgt. C.E. Meston and A1/C F.B. Gautreux, firemen. They scrambled in the "B" after an F-100 from George Air Force Base flamed out 12 miles north of their base. When the pilot, who had bailed out and was uninjured, was located a few minutes later it was impossible to pick him up immediately due to the 150 to 160-foot trees. Lieutenant Berthold directed the F-100 pilot to an area where the trees were not as tall, and in the new location it was possible to accomplish a hoist pickup by hovering the turbine-powered helicopter in the tree tops, which came half way up the fuselage, and fully extending the hoist cable.

ARRIVAL

ASSEMBLY

AVAILABLE

SO HIGH—M/Sgt. Edward Pompier, Medic; shows how high tree tops reached during rescue. Watching are, left to right, Capt. Joseph Kail, co-pilot; S/Sgt. H. Sonnier, Fireman; Lt. Hubert Berthold, pilot; and Robert Lambert, KAC tech rep. (USAF Photo)

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on field assignment

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Wichita Falls, Texas
Perrin AFB
Sherman, Texas
James Connally AFB
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Vance AFB
Enid, Oklahoma
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Laredo AFB
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Portland, Ore.

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