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UNITED STATES ARMY AUGUST 1969

AVIATION DIGEST

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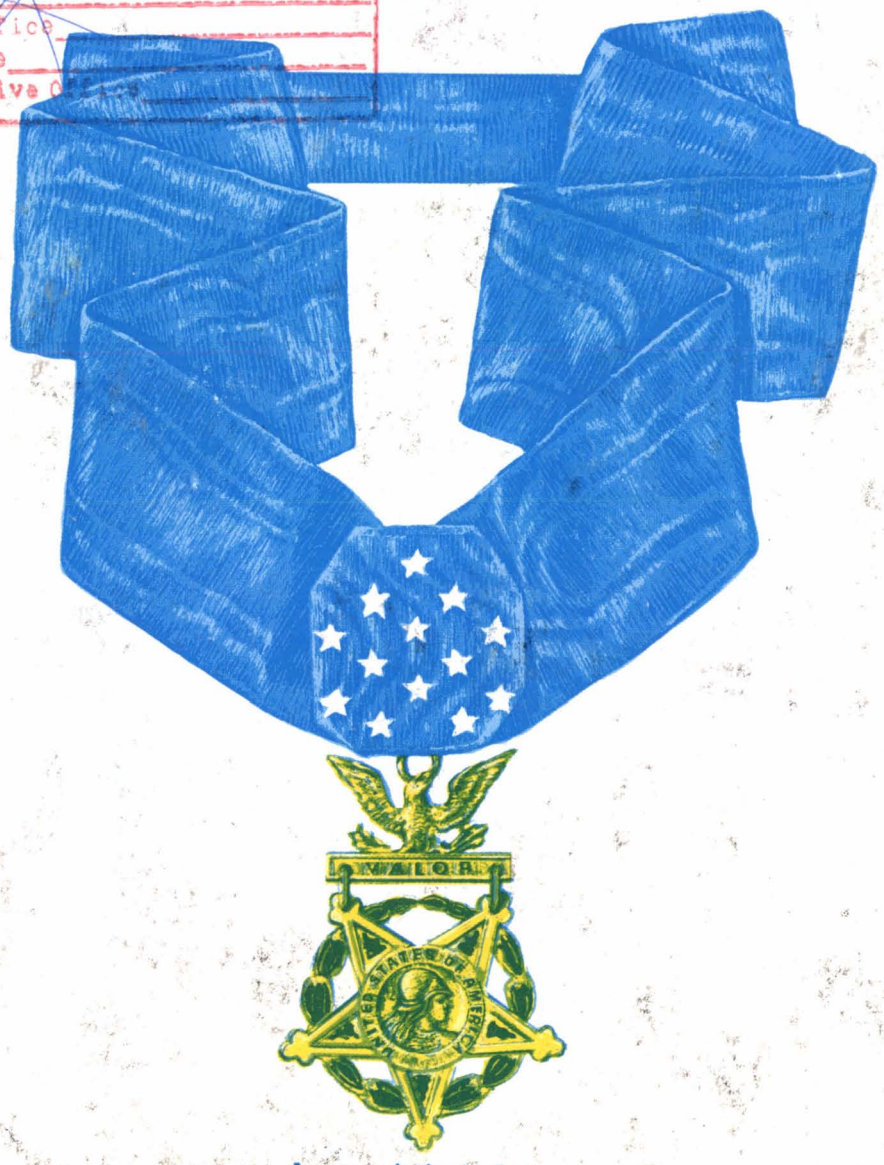

Army aviation's first Medal of Honor winner
see page 2

UNITED STATES ARMY AVIATION DIGEST

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ABOUT THE COVER

The front and inside back covers of this issue are dedicated to Army aviation's first two Medal of Honor winners. SP4 Gary G. Wetzel's story appears on page 2 and CWO Frederick E. Ferguson's story will appear in a later issue.

The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine, and other related data.

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Articles, photos, and items of interest on Army aviation are invited. Direct communication is authorized to: Editor, U. S. Army Aviation Digest, Fort Rucker, Ala. 36360.

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VIEWS FROM READERS

Sir:

In the February issue of AVIATION DIGEST I was reading "Team Effort" by Major Silva. Major Silva stated he turned the mag switch off and the lights went out and turned it back on and the lights came back on.

I have worked with aircraft for a few years and have also been an instructor in aircraft electricity. Major Silva makes it sound like the battery circuit was wired to the mag switch. I cannot see any way the battery circuit could have been wired to the mag switch. If the battery relay was wired to the mag switch the battery would have been on when the mag switch was off, not on, since the mag switch completes a circuit only in the off position.

Could you please explain what did happen to this aircraft? We here have been beating our heads trying to come up with what could have been wrong, so far all blank.

SSG Charles V. Cook
HQ, 15th Trans Bn (AM&S)
1st Cav Div (Airmobile)
APO San Francisco 96490

• The Ft. Wolters, Tex., aviation safety officer states that the magneto switch circuit was thoroughly checked after the engine failure and there was no defect. Major Silva's copilot, who had many more hours in the aircraft than he, feels that the major must have inadvertently turned the master switch to the off position then back on again when lights were lost. We concur with the major's copilot.—The Editors

★ ★ ★

Sir:

I read Major Robert S. Fairweather's article on "Helicopter Slingloads in Flight" in the March 1969 issue of AVIATION DIGEST. The article itself is on pages 16 through 21.

I thought the article was a very good explanation of how an induced harmonic motion of the aircraft, the external load, or both, may be started.

It is my impression, however, that at this time a problem still exists which creates some difficulty in the maneuverability of the aircraft due to this harmonic motion of the external load. It is also my belief that measures have been taken to lessen the effect of this harmonic motion by modifying the method of suspension.

I would think that a better place to exert a dampening effect would be right at the external load because this is where the harmonic motion is instituted. In other words, if FH can be reduced, the drag is necessarily reduced. Also it follows that a reduced drag force will mean a smaller FH.

It is my belief that as the angle A decreases the area exposed will, in fact, be two inclined planes with the drag being a function of $\frac{1}{2}eV^2S$.

There is relatively little that can be done to reduce the air density. This would be desirable because it would mean a reduced drag. Also we would like the velocity to be a maximum. But this would have an effect to increase the drag. It seems to be the only thing left to reduce drag would be the area of exposure or "S."

Would it not be possible to build a lightweight housing for such an external load as a Conex container or any load which might be of standard size? The housing could be of streamlined geometry so that perhaps the area would be cut sufficiently to reduce the drag, much as an airfoil is utilized to reduce pressure and drag on the wing of an airplane. The same principle is utilized for drag reduction on the sides of a watercraft. The housing themselves could be constructed so that they could be removed or attached rapidly and made standard to fit each category of load.

I would sincerely appreciate a response by letter with an evaluation of such a method to reduce drag and consequently induce harmonic motion of the aircraft.

PVT JOSEPH M. BENENATI
Co A, 1st Bn, USAESBDE
Ft. Belvoir, Va. 22060

• The DIGEST consulted with the author who replies as follows: To my knowledge, Boeing-Vertol has explored the area of slingload suspension in more detail than any other agency or company. Most desirable would be hard point suspension to firmly affix the load to the aircraft. In this way, harmonic motion would be bypassed. However, the state-of-the-art is such that hard point suspension is still excessively time consuming. Next choice would be flexible suspension from two or more points. This would reduce load swing and minimize both vertical and horizontal harmonics, but incurs two penalities. First, if one suspension point fails, the load may rotate into the aircraft. And, second, extra time is needed to make the additional hookups. The two point suspension system now being developed by Vertol appears to be a good compromise.

The problem with applying a dampening effect at the load is that loads are non-standard in configuration. If a dampening device were incorporated in the sling, the slings would become very expensive items and require a higher degree of maintenance.

The other solution that you mentioned, development of streamlined lightweight housings for the loads, has merit in that the loads would then take on standard and predictable aerodynamic characteristics. However, I feel that we would again run into the problems of non-standard load configurations, cost and rigging time.

In order to keep the article simple and readable, I attempted to avoid the more detailed true aerodynamic factors affecting the load. Rotor wash characteristics, rates of climb and descent, load surface characteristics and many other factors affect the situation. Flat plate drag of the frontal area (which can be two inclined planes, as you stated) is an approximation of the drag forces. Dynamic ram forces against the planes can also affect the load. Clearly, most data must be collected from experimentation with models in a wind tunnel.—The Editors

★ ★ ★

Sir:

In the May issue of AVIATION DIGEST the article on "Reforger I" explained the mission and activities of the 14th Aviation Company (ATC). The article stated: "The 14th ATC is one of the three air traffic control companies in the Army." The personnel of the 284th Air Traffic Company (ATC), Seoul, Korea, would like to be included in the count. We may be small . . . but we do feel that we are part of the "Team."

MAJ Kyle E. Hart
HQ, 284th Air Traffic Company (ATC)
APO San Francisco 96301

• Right you are, Major Hart. Our apologies—consider the 284th part of the Team.—The Editors

Eyewitness To Valor

Despite his terrible wounds, Specialist 4 (then Private First Class) Gary G. Wetzel climbed back into the gunner's well of the UH-1 Huey helicopter and repelled a Viet Cong attack. For his actions, he received the nation's highest award, the Congressional Medal of Honor

by Captain John L. Hopper as told by Captain William F. Dismukes

THE VIET CONG were starting out of the trees when I saw Wetzel struggling up into the well behind his machinegun. The lead men in the assault wave were on the paddy dike 20 feet away when he opened up on them. They fell and those behind them started falling. The Viet Cong covering the assault from bunkers in the trees turned their fire on us and I could hear bullets rattling all along the left side of the aircraft. The charge faltered in the spray of water and mud thrown up by Wetzel's machinegun and those that could struggled back through the mud to the safety of the bunkers. I saw over 20 men fall in the 20 meters between the trees and the dike before he ran out of ammunition. The crewchief and I finally got the aircraft commander over the radio pedestal and out into the water on the right side. Wetzel toppled out of his seat and fell face down into the water on the other side.

I vividly remember the afternoon of 8 January 1968. As the pilot of a UH-1D blasted by rocket propelled grenades in a landing zone south of Can Giuoc, Republic of Vietnam, I saw my seriously wounded doorgunner expose himself to a storm of enemy fire to turn back an assault wave that would have annihilated my crew and the infantrymen who lay wounded or pinned down around our aircraft. Specialist 4 (then Private First Class) Gary G. Wetzel was recommended for the Medal of Honor for his heroism in the face of the enemy charge. On 20 November 1968, SP4 Wetzel was decorated with our nation's highest award for bravery by President Lyndon B. Johnson and became the first man in the 1st Aviation Brigade to be so honored. The narrative portions of this article are not written to duplicate the actual eyewitness account that accompanied the recommendation but are rather my memories of that unforgettable afternoon when I was an eyewitness to valor. They present a story of remarkable courage and self sacrifice on the part of a young man who placed his life on the line for the sake of others. His heroic actions throw a bright light on the often overlooked role of the doorgunner as part of the Army aviation team.

The Robin Hoods of the 173rd Assault Helicopter Company had been placed on ready reaction force status by II Field Force Headquarters on 8 January 1968, and had used the morning as a maintenance and crew rest period. At 1500 hours the unit was alerted for a mission in the rice paddy area between Can Giuoc and Go Cong where units of the 9th Infantry Division were in heavy contact with a large Viet Cong unit. The company provided a 10-ship flight to extract an infantry company east of Tan An and stage them at the old French fort along the Nha Be River for later insertion as a blocking force.

After shuttling the troops into the staging area at the French fort we started to break down "C" rations for the evening meal. We had just started eating when a flight of four aircraft from the 214th Aviation Battalion landed. The pilots reported that they had been working north of the fort and had lost several aircraft hit by enemy fire while inserting reinforcements. We knew then that the insertion of the blocking force would be no picnic. At 1715 we were called up to man our aircraft. The four aircraft from the 214th joined our formation so we had 14 aircraft and over 80 troops for the first lift.

Our mission was to insert a blocking force in a large LZ on the east bank of the Can Giuoc River five miles south of Can Giuoc. The Viet Cong was trying to break contact with the 9th Division troops to the east and were moving west to where their reserve was waiting in well pre-

A
Monthly Winner
CONTEST

Eyewitness to Valor

pared positions in the tree lines east of the river. The blocking force was inserted in the northwest corner of the large LZ along the river and were immediately caught in a crossfire from bunkers in the trees along the north and west sides. The majority of the infantrymen were wounded or pinned down in the open rice paddy as soon as they left the ships.

We were flying in the number four position of the first element. I had control of the ship with the A/C following through to take the ship if necessary. Looking out the right side I could see the LZ under the aircraft ahead. It looked like about 30 or 40 acres of wet rice paddy bounded on all sides by heavy stands of palm and banana trees. An air strike had been placed across the river by mistake and our gunships had time for only one pass on the treelines before we started our approach. The lead ship took us in close to the west tree line. At 50 feet from touchdown we were met by heavy automatic weapons fire but continued on in. Just before touchdown a rocket propelled grenade was fired from a bunker to our left front and exploded in the left chin bubble. I was knocked unconscious by the blast.

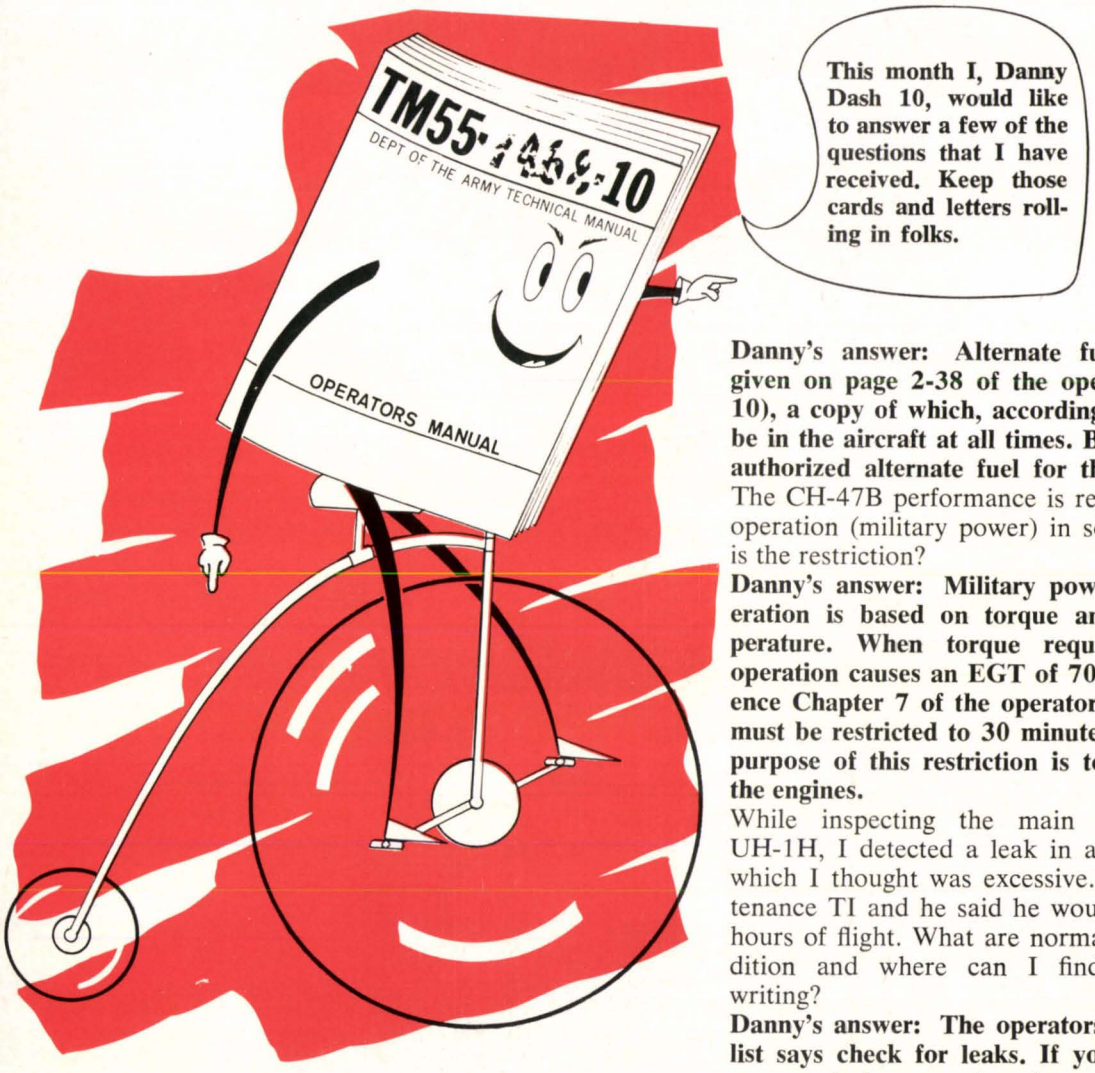
The explosion tore out the left front of the cockpit and mortally wounded the aircraft commander. The gunner and the crewchief were thrown out of the aircraft and reached cover behind nearby dikes. The two passengers who went out the left door were killed within five feet of the aircraft and three were wounded and pinned down 15 feet from the aircraft on the right side. The sixth man never left the cabin. The aircraft settled by itself into the water less than 30 meters from the tree line beside a low dike. The rest of the flight took off after dropping their troops. Two of the aircraft went down within 500 meters of the LZ. Their crews were extracted before the Viet Cong could get to them. Any attempt to rescue my crew would have been suicidal. The automatic weapons fire from the two tree lines was so heavy the few infantrymen not wounded or killed in the LZ could not lift their heads out of the water without drawing heavy fire from the enemy gunners.

The engine was still running when I came to so I shut it down and reached over for the aircraft commander. The Viet Cong in the trees were tearing the aircraft apart with their fire. I saw the crewchief, Specialist 4 Jarvis, coming back across the paddy to help me. He was knocked down by a hand grenade but got back up and climbed into the aircraft behind my seat. Together we started to pull the aircraft commander across the radio pedestal. Wetzel got up from the dike on the other side and waded up to the aircraft. He was starting to open the left door when the second rocket propelled grenade hit the doorframe a foot away, tearing his left side to pieces and mutilating his left arm. He hung onto the aircraft a moment and then pulled himself up into the cockpit to push the aircraft commander out of his seat. The aircraft commander was halfway over the radios when Wetzel fell back out of the aircraft. I saw him start to crawl back toward his machinegun. I looked up and saw the Viet Cong coming out of their bunkers. They were forming an assault wave in the trees to sweep the LZ. There was almost no return fire from the LZ to stop them!

Wetzel managed to climb back into the gunner's well behind his machinegun despite his terrible wounds and turned back the assault wave. While the full attention of the enemy gunners was turned on him the other men in the LZ reached cover behind the paddy dike that ran alongside the aircraft and formed a weak defense behind it that held until dark. I crawled under the tail boom of the aircraft in an attempt to reach the dike but was immediately wounded and pinned down. I lay in the open rice paddy until dark and then joined up with an artillery observer behind the dike.

The artillery observer had just gotten in contact with his unit and the first rounds were starting to hit around the bunkers in the trees. Our gunships had been orbiting the LZ since we first went in and I contacted them through the artillery unit. They had withheld their fire until they were sure of our position. I directed them to the tree line and under their fire we were able to pull back across the rice paddy with our dead and wounded. We formed a perimeter on high ground 600 meters to the east and by midnight had secured enough area for medevac aircraft to come in. I have no idea how Wetzel survived, as badly wounded as he was, but he had been brought into the perimeter with the rest of the wounded and was sent out on the first aircraft. I saw him the next morning in the 93rd Evacuation Hospital. He had been in surgery all night and the doctors said they had almost lost him. They had taken as much shrapnel out of him as possible and had amputated his left arm below the elbow. While I was there he asked me if I thought his family would be proud of him. I told him I was sure they would be.

Danny Dash 10



Red lines on the UH-1D engine oil pressure indicator are at 25 and 90 PSI. Is it permissible to fly the aircraft with a 25 PSI indication?

Danny's answer: No. Chapter 7 of the dash 10 outlines the oil pressure normal operating range is 60 to 80 PSI. Minimum pressure for flight idle is 25 PSI. Oil pressure may exceed 80 PSI during starts in cold weather but should never exceed 90 PSI.

Recently I landed a U-21A at a civilian airfield for refueling. JP4 fuel was not available, so I filled up with JP5. The checklist doesn't give me alternate fuel requirements, so how was I to know if JP5 was an authorized fuel?

Danny's answer: Alternate fuel for the U-21 is given on page 2-38 of the operators manual (dash 10), a copy of which, according to AR 750-31, will be in the aircraft at all times. By the way, JP5 is an authorized alternate fuel for this aircraft.

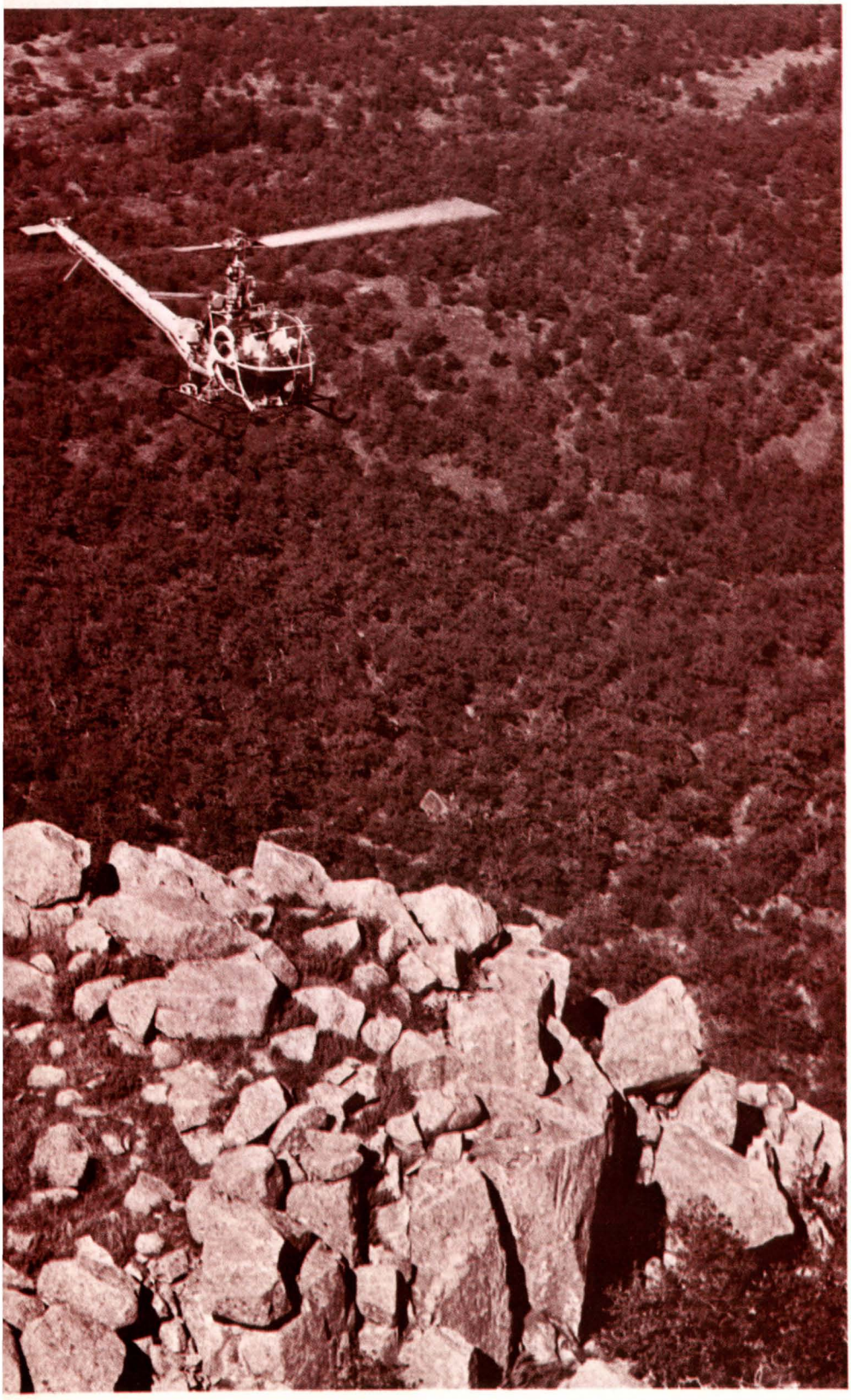
The CH-47B performance is restricted to 30-minute operation (military power) in some cases. Just what is the restriction?

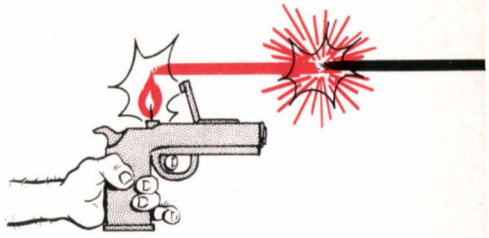
Danny's answer: Military power or 30-minute operation is based on torque and exhaust gas temperature. When torque required for a specific operation causes an EGT of 700°C to 740°C (reference Chapter 7 of the operators manual), operation must be restricted to 30 minutes at that power. The purpose of this restriction is to prolong the life of the engines.

While inspecting the main rotor system of a UH-1H, I detected a leak in a blade grip reservoir which I thought was excessive. I consulted a maintenance TI and he said he would check it after two hours of flight. What are normal limits for this condition and where can I find them specified in writing?

Danny's answer: The operators manual and checklist says check for leaks. If you find a leak which appears to be excessive, do exactly what you mentioned—consult a maintenance technician. The answer to your question can be found in Organization Maintenance Manual (dash 20), page 8-25, para 8-32f. This reference outlines criteria for replacement of grip seals. Seals must be replaced if (1) during a two-hour flight, grip reservoir becomes empty, (2) after a 24-hour period when helicopter is not operated, oil level is not visible in grip reservoir.

Don't forget to send your questions regarding the checklist (CL) or operators manual (dash 10) to: Evaluation Division, Office of the Director of Instruction, ATTN: Charlie Checklist or Danny Dash 10, Ft. Rucker, Ala. 36360.





Your mission, should you decide to accept it, is to land on top of Mae Bong Pinnacle—successfully

CW2 Robert S. Henderson

GOOD MORNING, Mr. Henderson. The picture you are looking at is an illustration of the Mae Bong Pinnacle located in central Korea approximately 84 miles south of the Demilitarized Zone. You will notice that it is 4,300 feet above sea level and has descending slopes on all sides to valley floors 3,000 feet below. Your mission, should you decide to accept it, will be to trans-

By careful study and application of certain fundamentals and techniques, helicopter mountain and pinnacle operations can become "possible missions"

Impossible Mission

port General Jones and his aide on an inspection tour of an installation located near the pinnacle in an OH-23G at 0900 hours this morning. As usual, should you or any of your passengers be injured or killed, the battalion safety officer will disavow any knowledge of your actions. This tape will self-destruct in five seconds. Good luck, Stan."

Suddenly the forecaster's voice on the phone interrupted my reverie. "Get serious now," I told myself. "You have a job to do. This mission shouldn't be any more difficult than the previous approaches you've made into this pinnacle." As I droned out the data regarding my flight, I hoped that my voice sounded as assured as the other pilots did when they called in for their pinnacle missions.

It was a beautiful morning; ground winds were calm, the sky clear and the temperature a comfortable 75 on this nice fall day. Winds aloft at 4,000 were forecast as 030 at 15 gusting to 20 with light to moderate turbulence by midmorning. As I planned this "impossible mission," my mind kept cluttering up with all the various pinnacle and ridgeline approach methods with which I had become acquainted: those I had been taught at Ft. Wolters and Ft. Rucker, those I had read about in safety magazines and those used by the pilots in country. In flight school my instructors had said to use a shallow to steep sight picture (preferably normal but steep if the winds are high to avoid the downdraft on the lee side), a constant rate of closure and land to a low hover in the upper one-third of the area. Oh yeah, and overfly the area to establish true wind direction and get an idea of velocity and turbulence. Most of the magazine articles seemed to stress proper planning with charts to determine the power available for landing and takeoff. According to most writers, I should use a shallow ap-

proach if I am carrying a heavy load but a steep approach if the problem of excessive downdrafts and turbulence outweighs power loss. Yet most of the pilots here seem to prefer very shallow approaches with high airspeed and abrupt deceleration just prior to touchdown.

As these incoherent thoughts raced through my mind, I made myself organize them into a logical analysis. Even after three months of mountain operations in Korea, which included several approaches into this particular pinnacle, I still had reason for concern. Mae Bong Mountain, the highest in this part of Korea, has a helipad located on a ridge, 20 feet wide, approximately 50 feet from its summit. On two sides of this PSP pad, which is about 20 feet square, the ridge drops off almost vertically to the valley floor 2,800 feet below. I considered the three main factors in mountain operations: power, winds and turbulence. On previous approaches to this pinnacle I had experienced no critical power requirement, only slight difficulty in maintaining a constant angle of descent and negligible turbulence. Unfortunately the winds on that mountain top seldom correspond with the 4,000 foot winds observed in the valley 30 miles away. Pilots often report severe turbulence surrounding the mountain even when none has been encountered elsewhere. With these considerations in mind I planned to take off from A-306 in Chunchon, climb along the upwind side of the ridges, then break off at approximately 4,500 feet and overfly the pinnacle. This way at an altitude about 100 feet above the mountain I could verify my winds and turbulence and determine my flight path. My flyby would also serve notice to the ground personnel of our arrival. Then I would set up an approach angle somewhere between five and 15 degrees, take the aircraft into a low hover and set it down.

Some time later after takeoff and climbout, which went smoothly as planned, I looked at my rotor tip-path plane. From experience we had learned to determine the severity of turbulence by observing the apparent thickness of the tip-path plane. Whereas the pilot of a light fixed wing aircraft in moderate turbulence might feel as if he is taxiing along a set of railroad tracks, a helicopter pilot would not feel the same roughness because of the cushioning action of the rotor blades. An apparent thickness of six to nine inches indicated that we were experiencing moderate turbulence. In addition I noticed my airspeed indicator fluctuating about five knots. This turbulence, while undesirable, did not greatly threaten our safety.

The ridgeline, which runs generally east-west, slopes about 20 degrees away from the peak to the east. Unfortunately it slopes upward again so that an approach from the east along the ridge, otherwise desirable, would require a very steep angle to clear it. Therefore I set up my low reconnaissance heading to the north generally into the wind. At about 100 feet over the pinnacle I felt a slight updraft begin about 150 feet out and grow stronger as I approached. Just on the other side of the ridge it became quite strong as expected. The winds I estimated were blowing nearly perpendicular to the ridgeline at 25 knots with very little gusting and moderate turbulence. So with the general sitting confidently beside me, I decided upon a normal approach from the same direction. About 200 feet out my approach angle was becoming steeper; at 100 feet out my angle was very steep. Since I already had the collective pitch full down to no avail, I made a go-around.

With the general sitting impatiently beside me, I began a second approach keeping alert for likely downdrafts. About 150 feet out as I slowed to approximately 25 knots, the aircraft began to encounter strong downdrafts and occasional sudden updrafts. Once more I went around.

With the general sitting nervously beside me, I started my third approach using a shallow approach angle while maintaining a faster rate of closure. The nearer I came to the pinnacle the more power I had to use, although it was not excessive as long as I did not decelerate. At approximately 75 feet from the ridgeline I lowered the collective pitch and decelerated in order to arrive at a low hover over the pad with zero ground speed. By maintaining effective translational lift until crossing the near edge of the pinnacle, I had adequate power available because I did not have to hover out of ground effect.

Following these eventful approaches, my takeoff seemed rather anti-climatic, simply a matter of gaining airspeed without losing too much altitude. With a sigh of relief I began an easy descent toward Chunchon in the serene valley below.

From this and other similar experiences I developed a sense of judgment and the skills necessary for helicopter mountain operations. First let me list certain fundamentals, confirmed by my own experience, applicable to nearly all pinnacle and ridgeline operations, regardless of country, climate or aircraft type. Begin with the three primary considerations in planning a pinnacle operation: power available for landing and takeoff; wind direction, velocity and gust spread; and turbulence.

Under one or more of these headings fall the basic principles:

• Use smooth, coordinated control techniques.

• Climb on the upwind side of mountain ranges to take advantage of updrafts.

• In all non-combat situations overfly the pinnacle to make a power check and evaluate the null areas.

• Lead collective pitch increase with throttle.

• In general approach to a low hover.

• Plan an approach generally into the wind and avoid obstacles.

• Continually check wind direction and velocity, especially on short final.

• When possible approach along rather than at right angles to a ridgeline.

• Leave sufficient altitude for recovery in case of unexpected downdrafts or unusual attitudes.

• Ordinarily make an airspeed over altitude takeoff into the wind and/or downslope.

In addition to the general fundamentals listed above there are some techniques which we found particularly helpful in Korean mountain flying in OH-23G helicopters. These procedures may not necessarily apply to all mountain flying situations.

• Avoid most downdrafts and turbulence by flying at 200 or 300 feet above and along the downwind side of a mountain range.

• Estimate turbulence by observing the apparent thickness of the tip-path plane rather than by the feel of the aircraft.

• When crossing a mountain range from the downwind side, use approximately a 45 degree angle and allow about 2,000 feet clearance above the ridge.

• Avoid flying near clouds on the lee side of mountains, which indicate turbulent areas.

• Except in cases of severe downdrafts and turbulence, the use of a shallow approach angle and sufficient airspeed (to abort quickly) coupled with a quick deceleration just before touchdown is often the only way to land on a pinnacle. Maintain translational lift until in ground effect.

• On some days the downdrafts and turbulence may make both a slow, steep approach and a fast, shallow approach impossible. Three attempts should be sufficient to determine whether a safe landing can be made.

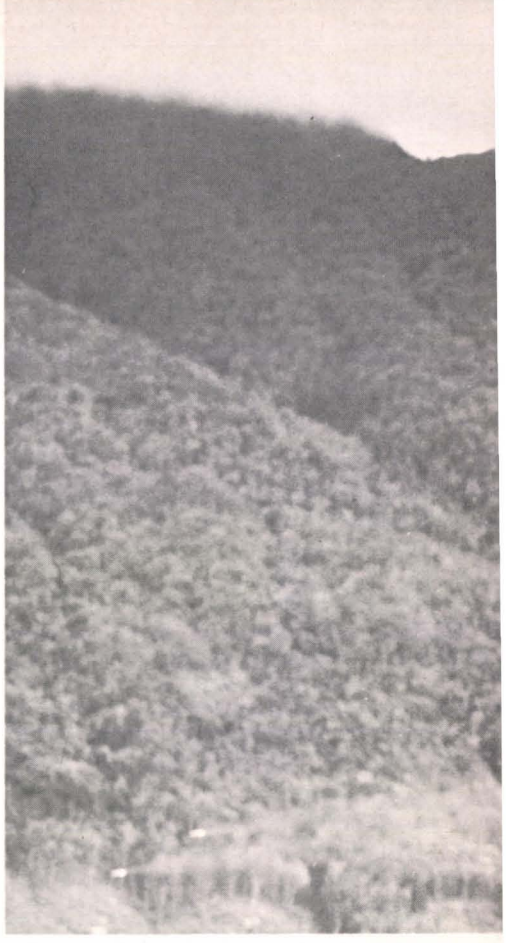
By careful study and application of these fundamentals and techniques as you gain experience, your helicopter pinnacle and ridgeline operations will become a "Mission: Possible."

The same basic principles for mountain flying and pinnacle landings apply to all rotary wing aircraft. In all cases, extra caution and smooth control touch is necessary

Cobra

Hunter Army Airfield is now the site for two training classes which are turning out gun pilots and instructor pilots to fill the Army's need for Cobra qualified aviators

Captain William H. Meeler



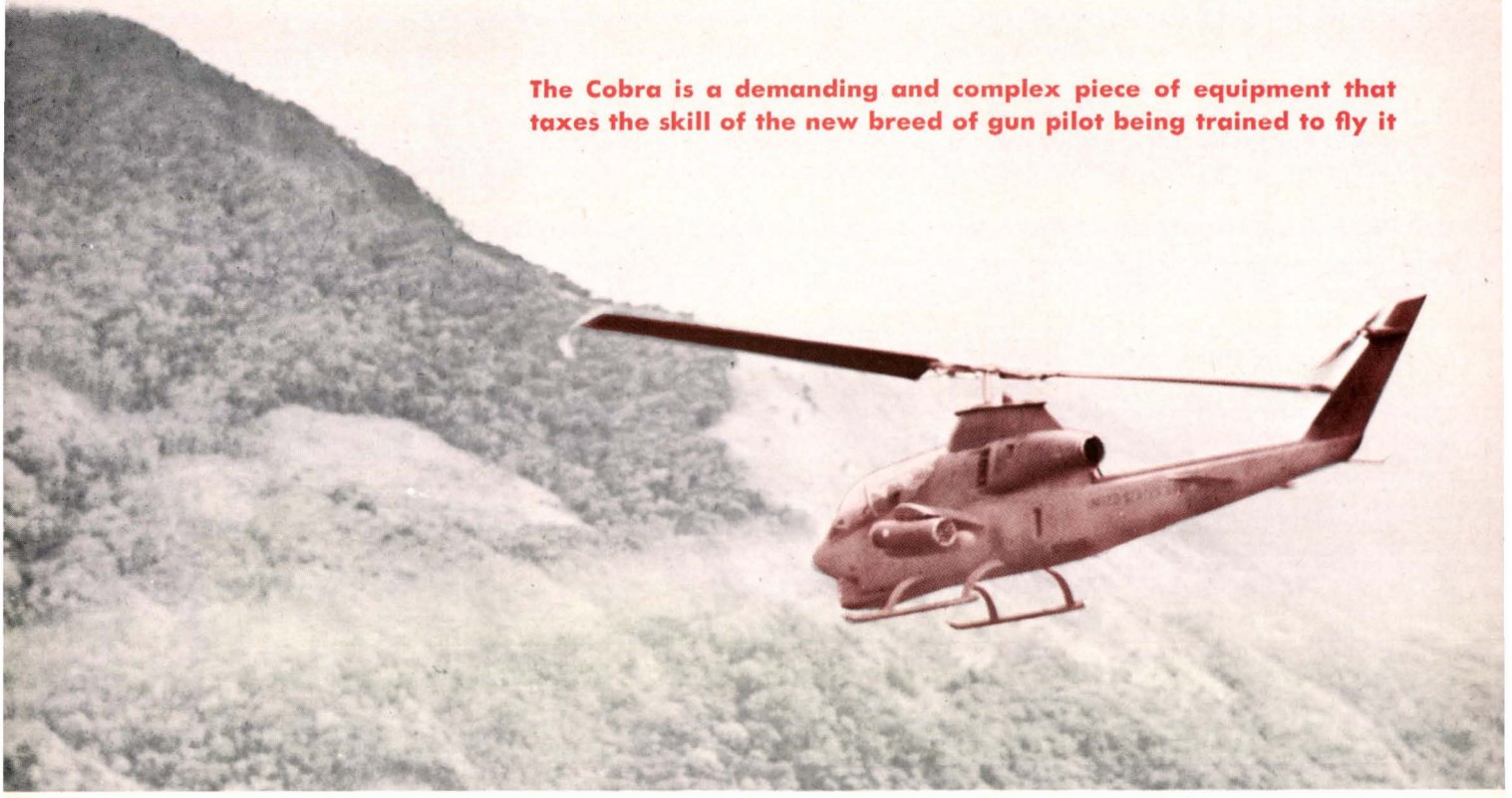
THE AH-1G helicopter (Cobra) is the Army's first aerial weapons platform designed in its entirety for the delivery of air-to-ground ordnance. Except for the loss of the crewchief and gunner, it is the gun pilot's dream. It will fly faster, carry more of a payload and stay in the area of operations longer than any other gunship in existence. It has a very sleek 36 inch wide fuselage which employs tandem seating, a new concept in Army helicopters. At first glance, even the most confirmed fixed wing pilot is sure to be impressed. The smooth, sleek lines of the Cobra coupled with the —13 engine enables the aircraft to obtain speeds of 190 knots in a firing pass. This aircraft is truly designed for the professional aviator and complements the Army's aircraft inventory.

The Army selected Hunter Army Airfield, which is part of the Ft. Stewart complex located at Savannah, Ga., as the training area for the Cobra. The aircraft are actually based at an old Air Force SAC building now called Cobra Hall, which is the center of student training. Two separate courses are taught—transition and instructor pilot qualification. The AH-1G transition student receives 25 hours of flight instruction. The criteria for selection to attend the Cobra school is also divided. The transition students are merely required to be rotary wing rated; however the instructor pilot students must have a minimum of 500 hours of helicopter time. Gun pilot time is, of course, desired for an IP student but is not required.

Generally speaking most students would describe flying the Cobra as not being really difficult, just different. Actually not only gun pilot time but any previous flight experience will aid the student in learning to fly the Cobra. An instructor can expect that a dual rated student will have an easier time keeping the aircraft in trim because the pedal control is much like that of a fixed wing aircraft. He knows an old cargo pilot will have a better control touch. Even the new aviator will have an advantage because he is more accustomed to stage field flying and will not have to readjust his thinking. Naturally the instructor pilot course is more demanding and requires more attention to instructional techniques from the student. This is due to the increased speed range, more sensitive flight controls and other more unforgiving flight characteristics to which the student must adjust.

Probably the most difficult adjustment the new student has to make is to remember that when he receives a forced landing while flying at more than 120 knots indicated airspeed (KIAS) an immediate reduction of collective is *not* the correct procedure. Aft cyclic must be applied before reducing the collective. If the above procedures were not followed mast bumping could be encountered. This is caused by the stability and control augmentation system (SCAS) correcting violently for the inherent characteristic of all helicopters to pitch up when power is abruptly decreased.

Another problem the student must be more than just familiar with is the abundance of power and the possibility of overtorquing the power train. An example of



The Cobra is a demanding and complex piece of equipment that taxes the skill of the new breed of gun pilot being trained to fly it

this can be experienced when the student is executing a high speed dive. When the aircraft reaches 170 KIAS the student is expected to make a simulated tactical pull-out which of course increases the G-load on the aircraft. At this point any old gun pilot will tell you that you must apply collective pitch to keep those big 540 blades from overspeeding. The rotor system is unloading during this maneuver so the torque meter is not completely accurate; therefore, the pilot has no way of knowing just how much torque was added to keep the rpm down. This additional pitch will be held until just before leaving the increased G situation. In the conventional gunship if you were late in reducing this additional pitch as you started to load the rotor you would pull the rpm down because the engine could not supply the power. However, in the Cobra, the engine can supply the power and the result would be an overtorqued power train, 50 pounds of torque being the limiting factor.

It will interest the reader at this time to note that the Cobra is pilot derated. By this we mean the pilot has at his disposal 1400 horsepower, however, the maximum horsepower the power train can withstand is 1,100 or 50 pounds of torque. After satisfactorily handling the above problems there is still another factor to lick. We are talking about placing the aircraft in an average firing break to the left and overtorquing the system. In a left turn the advancing blade has a great amount of additional pitch placed on it due to the shifting of the relative wind in relation to the blade. This additional drag requires more power which the N^2 governor senses and supplies; therefore, it is very easy to get as much as a 20-pound torque increase during this situation. Assuming that the aircraft was cruising at approximately 35 pounds of torque originally, the additional 20 pounds would then produce an overtorque. The opposite is encountered in a right turn. Perhaps the corrective action for the above situations can best be stated as staying ahead of the aircraft.

The reader can easily see that the Cobra is a demanding and different machine. The increased speed, range and complexity of the Cobra requires that the student be almost instantaneous in recognizing and correcting any emergency situation. The student is prepared for this daily as the IP conditions his reaction to inflight emergencies from his initial flight to his final check ride. After completing the course and receiving his diploma, the student realizes that not only has he learned to fly a more complex machine but also can walk a little taller because he is a member of the new breed of gun pilot.

THE
MAIN
EVENT

TSTM VS OH-13G

A fight to the finish described for you by

MAJOR RICHARD L. BURDICK

The challenger is doing his best to dodge and slip these potent blows, but now the champ scores with a hard left

GENTLEMEN: For our main event, we have two old adversaries. In the red, or danger corner, wearing the greyish-black trunks, streaked with lightning bolts, Mr. Tango Sierra Tango Mike. Due to his size and bad disposition, weighing was impossible. In the blue corner, we have old faithful himself. He is wearing OD trunks, and weighs approximately 2,350 pounds. Let me present Mr. Oscar Hotel-13 Golf.

This shall be our main and final event of the day. It is customary in our great outdoor arena to give a brief description of the main event contenders.

First, I shall describe Mr. TSTM. Please fellow aviators, hold the booing and hissing to a minimum. Though he is our foe, he has been and will be around for quite sometime. So you see, we'll just have to live with him. He is very hard to describe accurately because of the scud and roll clouds hovering around him. His height is fairly recognizable as his anvil shaped head usually towers above everything. He is a very dark grey with lighter grey fringes. He has very good forward speed and can deliver a knockout punch with either hand.

His seconds for this bout are Wind, Visibility and Wire. Mr. Wind is a sly one and always adds power to TSTM's punches. Wind is bound to be a tremendous asset in this battle against man and machine. He also lends a helping hand to Mr. Visibility and bears careful watching. Wind can envelop and blind you in a matter of seconds—very tricky individual as he augments the third helper, Mr. Wire. This guy is stationary. He waits for the others to bring the opponent to him. Rumor has it, that he will play colead in the bout just minutes away. Thus we have a very formidable crew in the red corner.

Now for our compatriot and gallant warrior, Mr. OH-13G. His dimensions are easily discernable. He is around 42 feet long, 9 feet high and carries 200 horses within his frame. His arms, from tip to tip, are 35 feet, 1½ inches long. His shiftiness makes up for a lack of speed. With the aid of his chief second he can dodge and dart about the skies very easily. His second is known as Man. Man in

TSTM VS OH-13G

this case, carries the nickname Ace. He is a graduate of one of the finest schools in the land, the U. S. Army Aviation School at Ft. Rucker, Ala. Therefore, his qualifications are very adequate. He has the responsibility to out think and out maneuver Mr. TSTM and his seconds.

Now that you have a description of our participants, let's go to Round I.

Round I: Ace journeys to a post about 350 nautical miles away from home station. His purpose is to pick up our contender, Mr. OH-13G. There is a very important field exercise in a few days and Mr. OH is needed. Ace approaches Mr. OH and proceeds to make a very thorough preflight. It takes all of five minutes. This is because of two fallacies in Ace's makeup as an aviator. One being he doesn't want his newness to show. Somewhere he has gotten the word that all old helicopter pilots just kick a skid and crank the lid. Also, as you might have guessed by now, old Ace feels he can fly the crates they come in. Knowing that he is being closely observed, he climbs aboard Mr. OH. After excessive cranking he motions the grizzled old maintenance sergeant over and states, "She just won't start." The sergeant tells him to try again. As Ace begins cranking, the sergeant flips the mag switch to Both and 200 horses come to life. Undaunted, Ace decides to put OH through the paces before departing. Also he notices the maintenance officer and his crew are still standing around. Ace just can't resist showing his skill to others. After making a max take-off and climbout to 500 feet he immediately chops power. While descending in autorotation, he notices the rotor rpm hanging light around 230. Being as sharp as he

is, Ace puts OH on the ground and requests the rotor rpm be adjusted. He is informed this will take a while thus delaying his departure time. This doesn't shake Ace because he needs some night cross-country and anyhow, being so completely satisfied with himself, he forgets all about re-checking enroute weather. Thus, giving us the setting for Round II.

Round II: Pitch is pulled approximately four hours later than originally intended. Enroute weather (WX) still has not been rechecked. Mr. OH-13G, with Ace at the controls, is flying along very nicely. There is to be a landing about every two hours for refueling. During the third fuel stop, Ace decides on some refreshments for himself. While partaking of these refreshments, he hears some local pilots talking about the nasty squall line approaching the area. He finally decides to check the weather. There is WX due between his present position and home station. Minimums will be about 300 feet with 1/4 mile visibility. Chuckling cagily to himself, he hangs up the phone, thus missing the part about the squall line with winds up to 65 knots. Due to what he did hear Ace isn't worried a bit. You see part of his training was in the Tiger course, where treetop level was too high. We now have the setting for the third and final round.

Round III: Ace, living in his own little world, just doesn't realize how bad the weather really is. Of course, all those people back there who tried to tell him, really didn't realize just how good he was. Mr. OH is destined to meet his foe, Mr. TSTM. The old man back at the airport sadly shakes his head while watching the OH disappear into the settling darkness and haze. Evidently the old man's short prayer reaches the right headquarters, because a few minutes later the OH reappears and lands. Ace had done something right finally, and is very pleased with himself. Actually WX had gotten pretty rough and visibility so poor that Ace had become lost. He actually thought, until he landed, that he was at the next small town. He covers very nicely though, making one of those oft heard statements like, "Discretion is the better part of valor" or something of that nature. After cancelling his flight plan he hangs around awhile to shoot the breeze with all the local aviators. After enlightening them on the fine art of helicopter flying, he decides to get some shuteye. Sleep comes easy to one so self satisfied.

Arising bright and early the next morning, he proceeds to the airport. There is not a soul around to unlock the airport office. This doesn't bother Ace because he knows he can file from the air. He cranks Mr. OH, remembering the mag switch this time and proceeds to climb to 800 feet. This is as high as he can go due to weather. This condition should have indicated something to Ace, but I'm afraid he doesn't receive the message. Of course he is unable to contact Radio from 800 feet, but this doesn't shake him. As our gallant contenders proceed on their way, Mr. TSTM and his seconds are sneaking in to do battle. First comes some 30 to 35 knot punches by the wind. Mr. OH is doing his best to dodge and slip these potent blows. As we have all realized by now, Mr. TSTM is very close. Creases begin to appear on Ace's forehead as he is forced to about 50 feet above the trees.

Now, Mr. Visibility enters the picture and begins to close in. Just at this time, one of those always talked about but rarely seen lights comes on inside Ace's hard hat. He remembers a very nice, large field that he flew across just a little while back. This serves to rebuild a slightly shattered confidence to an all time high. Ace is well aware of his ability to land Mr. OH on a dime. Of course in this wind and rain it might take a quarter, but he has an acre field, so why worry. You see, he knows that his nickname didn't come from bending elbows at the "O" Club Bar. What he doesn't take into consideration is Mr. TSTM's speed along with his seconds, wind, visibility and wire. As he performs a 180 and heads for the landing area, he goes over landing procedures as taught by the school. While performing his high recon, he sees nothing. This is almost 100 percent true because he is losing contact with the ground. He starts his approach and low recon. Wind and rain are quite strong now and visibility is "zilch." Old cagey Ace just opens the door and slips Mr. OH to see the ground. Even with this brilliant maneuver, ground contact is almost impossible. However, he is but a mere 35 feet off the ground, and just knows he has it made.

Enter Mr. Wire. This is it! Ace, looking out the door for ground contact, is unaware of Mr. Wire until he joins him in the bubble. This kind of shakes up old Ace. However, his reactions are perfect. An immediate flare brings him to a halt. But Wire wasn't through. He coils tenaciously around Mr. OH's long neck and proceeds to roll him up like a yo-yo. Thus the KO punch. Ace keeps him level, but he hits going sideways, somewhere in the neighborhood of 10 knots.Scratch one OH-13G as Mr. TSTM and his helpers win another unanimous decision.

What happened to Ace? He's still around but much, much wiser. He realized, what many of us have come to realize, that Mr. TSTM and his aids hardly ever come out second best. They are tough, cold-blooded killers and will get you, fellow aviator, if you care to challenge them in our great outdoor arena.

The Flight Surgeon

A general practitioner, with wings? A senior pediatrician for aviators? What goes into the training of the Army flight surgeon?

Major Donald F. Miller, M.D.

EMPHASIS ON airmobility has increased the responsibilities of Army aviation medical officers . . . a relatively new area of specialization in the Medical Department, Army aviation medicine is concerned with promoting safe and efficient flight operations, maintaining the health of aviators and contributing to the overall mission of Army aviation."—Lieutenant General Leonard D. Heaton, MC, USA, The Surgeon General, United States Army.

Every Army aviator knows who the flight surgeon is and what the flight surgeon does. He is the gentleman in the air conditioned office with the large "GROUNDED" stamp, who occasionally graces an Army aircraft with his professional presence. Of course, this is a somewhat distorted picture, but even among those aviators savvy enough to know who the flight surgeon really is and what he does, few are found who can tell you what the flight surgeon is and how he got that way.

A general practitioner with wings? A senior pediatrician for aviators? Father confessor, fellow drinker, R&R buddy, sawbones—the flight surgeon is all of these. Just what turns an ordinary Army physician into that phenomenon, the Army flight surgeon?

Training is the thing. After submission and acceptance of his application, the Army physician who aspires to become a flight surgeon may take one of three training programs. In order of length these are the Navy, Air Force and Army programs.

The Navy has a six month course at the Naval Aerospace Medical Institute, Pensacola Naval Air Station. This includes six weeks at VT (Training Squadron) I, Saufley Naval Auxiliary Air Station also in Pensacola, during which time the student flight surgeon undergoes ground school and flight training culminating in solo flight in the T-34B Mentor. At the conclusion of the six month period the doctor is awarded his Navy "Wings of Gold" and is designated a Naval Flight Surgeon.

Physical examinations take up most of the flight surgeon's time

The Air Force Program, nine weeks in length, is conducted at the School of Aerospace Medicine, Brooks Air Force Base, San Antonio, Tex. Basic course content is about the same as the Navy course, with perhaps a bit more emphasis on the "space" portion of the program. No flight training is included in this course.

Since these courses are heavily oriented toward the administrative procedures and aircraft types of the Air and Naval services, Army doctors who attend these courses are required to take the Army Aviation Medical Officers' Orientation Course, conducted by the Department of Aeromedical Education and Training, United States Army Aviation School, Ft. Rucker, Ala. This two-week course is designed to introduce the new flight surgeon to Army aircraft and administrative procedures. It includes introductory "stick time" in rotary and fixed wing Army aircraft. At the end of these two weeks, the now fully-trained physician is awarded the wings of an Army Aviation Medical Officer.

The third program producing the flight surgeons to serve the Army aviator is the Army's own, also conducted by the Department of Aeromedical Education and Training at Ft. Rucker. Here the prospective flight surgeon spends a period of seven weeks in the classroom and the field, learning his trade. Besides introductory training in weather, navigation and aircraft systems, the student flight surgeon is given Link training and sufficient time at the controls of the Army's basic aircraft inventory to become familiar with the machines his future patients will operate.

The major portion of the course time, though, is spent in furthering the prospective flight surgeon's medical education in matters relating to the aviation environment. Heavy stress is laid upon such subject matter as the basic physics of the atmosphere, the physiology of respiration, the effects of lack of oxygen, the physical effects of altitude and the basic Army oxygen systems. (The course includes altitude chamber qualification and a shot in the Martin-Baker ejection seat simulator.)

Examination and function of the eyes and ears, particularly with regard to disorientation and visual disturbances, are thoroughly covered. The heart and blood vessels are discussed as they pertain to function in the aviation environment. Additionally, the student is given basic instruction in acceleration and G-forces, with particular emphasis on their application to aircraft accident investigation. Human factors, pathology and toxicology are also covered in the investigation of aircraft accidents.

The Flight Surgeon

The physician's professional role in aeromedical evacuation is stressed, with particular emphasis on proper selection and preparation of patients for air movement.

Stress and fatigue, survival and escape and evasion are taught by classroom discussion and field exercises.

Of course, the flight surgeon's traditional role in the physical examination and selection of the aviator is covered at length, along with the direct medical treatment of the flier, since these two activities will take up the majority of the flight surgeon's duty time.

After successful completion of this course, the doctor is given his wings, designated an Army Aviation Medical Officer and sent off to his first assignment with an aviation unit.

If, after a year of duty in the field, the flight surgeon desires to make a career of aviation medicine, he can apply to the Office of The Surgeon General for residency training in Aerospace Medicine, a three year program which leads to speciality certification in this field.

Aerospace (until recently Aviation) Medicine has been a recognized medical specialty since 1953, when the certification of specialists was begun by the American Board of Preventive Medicine in Aviation Medicine.

The Army does not have a complete residency program of its own in this field. Army flight surgeons undergo training in programs conducted by either the Air Force or the Navy. Since the author is personally familiar with the Air Force course, it will be used as an example. Both programs are essentially similar in content.

The resident's first year of training is spent at a civilian university. Most residents choose the University of California, Harvard or the Johns Hopkins Schools of Public Health. At the end of an academic year covering such subjects as administration, preventive medicine, industrial and occupational health and the traditional field of public health, the physician is awarded the post-doctoral degree of Master of Public Health.

During this year, the flight surgeon is required to meet his flight minimums by flying nights and weekends at any nearby military aviation facility. While at the University of California at Berkeley the author flew from Crissy Army Airfield, Presidio of San Francisco; NAS Alameda, near Oakland; and Hamilton AFB north of San Francisco, in all manner of strange and wonderful aircraft. The doctors at Harvard flew many varied Air Force mission at Otis and Hanscom Air Force Bases.

Heavy stress is laid upon such subject matter as the effects of lack of oxygen, the physical effects of altitude, the physiology of respiration and the basic Army oxygen systems

With their degrees in hand the residents then hang up their sandals and academic robes and return to the military. For most, this means the United States Air Force School of Aerospace Medicine in San Antonio, Tex.

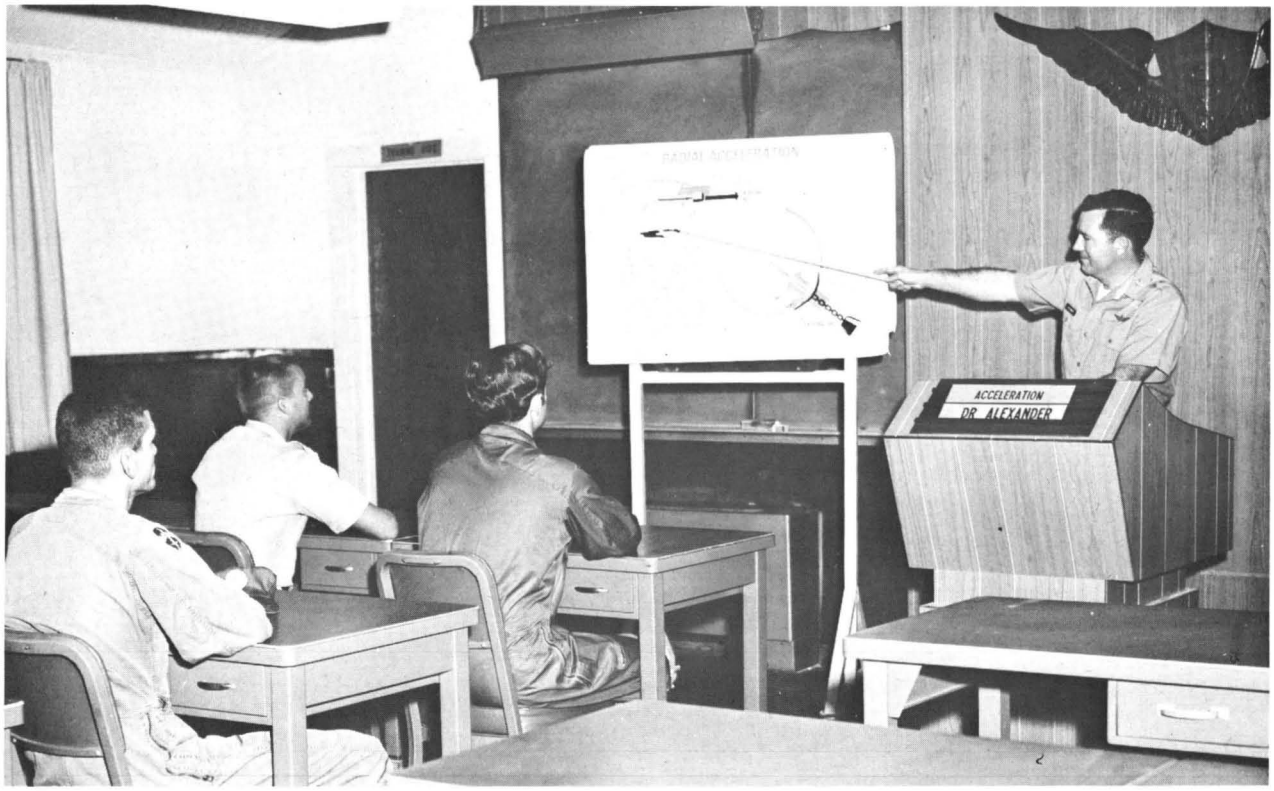
The second year of the course is devoted to more intensive and thorough training in the basic responses of the human body to the flight environment. Aviation physiology, including the effects of temperature, pressure, atmospheric components, acceleration and life support in closed systems such as space cabins, is studied. The flight surgeons are instructed in the recognition, prevention and treatment of aviation related disorders, including the environmental hazards, both physical and psychological, faced by aviation and ground support personnel.

Aircrew selection procedures and the evaluation of aviators for return to flight status following disease or injury are covered on both an academic and practical level.

But the year isn't all spent in the classroom and laboratory. Traveling in the School of Aerospace Medicine's KC-97, the residents spend about one-third of their time away from San Antonio. There are scientific visits to United States and Canadian Aeromedical facilities; aerospace industry orientation; missile medicine experience at Vandenberg AFB; briefings at Headquarters, Strategic Air Command and Military Airlift Command. These travels even included an orientation tour at Ft. Rucker —rather like old home week for the Army residents.

To acquaint the flight surgeon with survival problems likely to be encountered by the aviator, the residents undergo training courses in jungle and arctic survival at Albrook AFB, Panama, Canal Zone, and Eielson AFB near Fairbanks, Alaska, where they sleep—or try to—on an overnight exercise, usually at "forty below."

To further acquaint the resident with the environment of flight, a five-week period is spent in flight familiarization in the T-37A "Tweetie Bird," a twin-jet trainer often irreverently referred to as a "three-ton dog whistle" because of the screech it emits at ground idle.



Prospective flight surgeons learn introductory flight techniques

Some class time is spent in weather, navigation and aircraft systems familiarization. Flights include VFR, IFR, formation, night and cross-country experience. The first jet penetration under IFR conditions conducted by a flight surgeon with essentially zero hours of flying time is a new thrill for the IP!

Lest the reader think all this input produces no output, the resident faces at least five oral exams by experienced specialists in Aerospace Medicine, covering each phase of his training. The last of these is a "murder board" of at least six examiners, covering the entire year's work.

With the first, or academic, and the second, or didactic, year behind him, the resident now begins the final, or applicatory, year of his training. During this final year the flight surgeon applies the knowledge he has gained under the guidance of an experienced board certified specialist in Aerospace Medicine.

While this year is usually spent at a major Air Force headquarters, there is one approved training site for the third year, under the auspices of the USAF School of Aerospace Medicine, at the U. S. Army Aviation School, Ft. Rucker. Here the resident operates under the overall supervision of the Post Surgeon and Commanding Officer, Lyster Army Hospital. While at Ft. Rucker he serves in turn as chief of Aviation Medicine, Lyster Army Hospital; post Preventive Medicine Officer; and as Chief, Aeromedical Consultation Service. He also serves as a consultant to flight surgeons in the field on aeromedical problems.

His period of formal training over, the new specialist is awarded a C prefix to his MOS, and sent to his duty assignment, usually at staff, headquarters or command level.

After sufficient practice to bring his total time in the specialty to six years, the flight surgeon is eligible to take the Board exams which, if successfully completed, bring him certification in the specialty of Aerospace Medicine, and a B prefix to his MOS from the Surgeon General.

From this point on, the Army specialist in Aerospace Medicine can contribute his knowledge of the aviator's capabilities, limitations and needs—from the care of the flier and his family to the investigation and prevention of aircraft accidents. He is also available to offer useful advice in the formulation of policy on qualification and utilization of flight personnel and equipment. In this field, even the sky is really no limit.

Career Notes

The following article from the Aviation Personnel Management Office, FIELD ARTILLERY BRANCH, OPD, discusses answers to questions most frequently asked by the aviator in the field; the authors have made a special effort to insure that the information is applicable to aviators of other branches as well

Lieutenant Colonels Vladimir A. Pospisil and Neil I. Leva

TRANSITIONS

The best way to obtain the training of your choice is to request several transition courses in priority according to your interest. This allows the assignment officer some latitude should your first choice not be available. To be selected for transition training there must be a requirement for an officer qualified in the type aircraft and a school quota must be available. A Field Artillery aviator who has served one tour in Vietnam and is being considered for a second tour in Vietnam will normally receive some additional aviation training enroute. It is possible, due to the needs of the service, that some second tour officers will get instructor pilot qualification training. Officers who are ordered to the Advanced Course or Degree Completion Program while enroute to Vietnam normally will not receive additional qualification courses prior to their arrival in Vietnam because of the time involved. The Chief, Field Artillery Branch, closely monitors assignments to insure equity in second tour assignments for Field Artillery aviators. Time spent in the sustaining base between tours in Vietnam is approximately two years. Indications are that this time figure will remain constant for the near future.

GROUND DUTY

Ground duty assignments are a distinct probability in your future. To those who felt that aviators would be reaching the grade of lieutenant colonel without having had ground duty, the recent decision to authorize category B assignments came as welcome news. All Field Artillery aviators are eligible for ground duty. For aviator captains this will mean battery commands; for majors, jobs as battalion executive officers, S-3's or other significant branch material jobs at division artillery and higher levels. Outstanding lieutenant colonels will be given the opportunity to command Field Artillery battalions. Success in aviation duty is not limited to "flying well." There are many aviators who fly well, but who lack the ability to perform equally well in command and non-flying duties. This type officer has a narrow career potential. The outstanding Field Artillery aviator is characterized by his versatility. He has mastered the technical and tactical application of both Field Artillery and Army aircraft to accomplish assigned missions.

The Field Artillery aviator should begin now to prepare for a ground duty assignment by studying the equipment, tactics and techniques peculiar to his branch. He should visit Field Artillery units at every opportunity and talk to the key officers. He should participate in the correspondence course program offered by the Field Artillery School. The need for experienced captains and majors in Field Artillery units should assure that aviators obtain career development duty positions.

EDUCATION

Army aviators may now participate in the Degree Completion Program and Advanced Civil School Program. Any officer who does not have a degree and who is not participating in off-duty education is losing valuable time. Recently, the Field Artillery Branch desired to assign 12 lieutenant colonel aviators to Category B, branch immaterial assignments. The assignments available were meaningful assignments which would improve the officers' careers. Only two could qualify—10 of the officers did not have a degree. The aviator at Ft. Rucker, Ala., and Hunter-Stewart, Ga., has the advantage of an on-post advance degree program. Other posts will soon have the same program. Tuition assistance of three-fourths of the cost, without dollar limitation, is authorized for officers participating in off-duty study.

The Degree Completion Program, the subject of AR 621-5, is available for officers who have six months or less "on-campus study" remaining to obtain a degree. The Field Artillery Branch will assist officers desiring to participate in the program, if they will apply after acceptance from an accredited institution. To qualify, an officer must have three years of active, continuous Federal commissioned service prior to attendance and at least two years service remaining after completion. At this time, one-third of all Field Artillery officers now in the program are aviators.

ADVANCED CIVIL SCHOOL PROGRAM

All aviators with undergraduate degrees are encouraged to apply for participation in this program. The selection process is highly competitive. An officer's overall academic record, which includes military, civilian and graduate record examination grades, and his overall manner of performance are compared with his contemporaries. Other factors to include age and service remaining are considered. Although he may apply for training in any field listed in DA Circular 351-2, the aviator is particularly encouraged to apply for training in the following listed fields of study:

Journalism, writing, editing
Production Motion Pictures
Business Administration Industrial Management
Industrial Management Comptroller
Management Research Program
Commercial Aviation Transportation
ORSA—Business
Comptrollership
Management—General
Transportation and Traffic Management
Business General
Aeronautical Engineering
Engineering, Electrical Design
Engineering, Electronics
Engineering, Industrial Design
Engineering, Mechanical
Engineering, Transportation
Systems Analysis
Operation Research Analyst Engineer
Engineering, General
Physics, Nuclear
Statistics
General Science
Education General (Teaching) Administration
Industrial Relations

The Degree Completion Program is also available for those who can qualify for a graduate degree in a six month period.

Every effort is made to get every Field Artillery aviator through his Advanced Course before he is promoted to the rank of major.

ASSIGNMENTS

In recent weeks Field Artillery aviators have been ordered to ROTC assignments, non-flying (Cat B) attached assignments, and numerous National Guard advisor positions in Category A and B are being filled. One officer has just been selected for duty as a TAC officer at the Air Force Academy. This does not suggest that the Field Artillery aviator always has his choice. Assignment horizons are unlimited for the Field Artillery aviator who insures that he is well qualified in his branch, performs well in all assignments, has at least a bachelor of arts degree and who strives for continued personal and professional self-improvement.

To obtain the assignment he desires an officer must prepare himself to insure he is qualified to perform in the position—and he should submit a preference statement containing his assignment preference in order of priority. If an officer indicates only one choice and no requirement exists for that choice, the officer will be assigned to a position for which he appears qualified and in an area for which there is a requirement. Assignments are determined based upon the needs of the service, the desire of the individual and as influenced by the career development requirements of the officer.

FIELD ARTILLERY BRANCH

In the present period of extreme personnel turbulence, it is beneficial for the officer to periodically telephone or visit the Field Artillery Branch for a discussion of his career and opportunities available to him; in any case, he should establish some form of contact with the branch at least every three years for the purpose of exchanging information. The Career Development Section of the Field Artillery Branch will discuss with the officer his competitive standing as compared to his contemporaries. He will also be advised on how to improve his overall manner of performance. Officers who have taken advantage of this service, with rare exception, state that they have benefited from these discussions. The Assignment Section will give the officer an indication of future assignments. This information can help the officer to chart his career and it will help the assignment officer to knowledgeably match the officer's preferences and abilities with the needs of the service. The Field Artillery Branch will "tell it like it is" during these visits, because that is the way the Field Artillerymen have said they want to hear it. A visit to the Branch is helpful to the officer and the branch.

There is no foolproof way to detect metal fatigue before damage occurs. But constant vigilance coupled with various inspection techniques and the checklist outlined by the author, should aid in reducing the cost of metal fatique

Captain John D. Sterrett III

DID THE TAIL BOOM on your helicopter or tail wheel on your airplane ever drop off for no apparent reason? Don't laugh! Technically it could happen. Metal can become fatigued and break under conditions and loads which are far less than those for which it was designed.

How often have you read an accident report citing the cause as metal fatigue? It has caused the early demise of many flying careers and could be an important factor in determining how long you stay in the air.

What is the cost of metal fatigue? If the aircraft is an expensive one the cost can be enormous. More important to the military is that it may mean mission failure. Costs of this nature cannot be measured in dollars and cents; they are most often counted in terms of the number of lives lost. This is why it is important that you have some knowledge of metal fatigue.

Let's take a good look at metal fatigue. When metal parts are subjected to repeated loads which vary in weight or constantly move or tend to bend the metal, the part may become fatigued and break. This is what happens when you break off a can top by bending it back and forth.

To obtain a better idea of what is happening during the fatigue process let's take a step by step look at it. First, the metal must be subjected to forces which constantly change. We will call this cyclic stressing. A good example of this is the continual stressing and unstressing of a helicopter tail boom caused by the continuous pitch changing of the anti-torque rotor. Another example is the loading and unloading changes in rotor

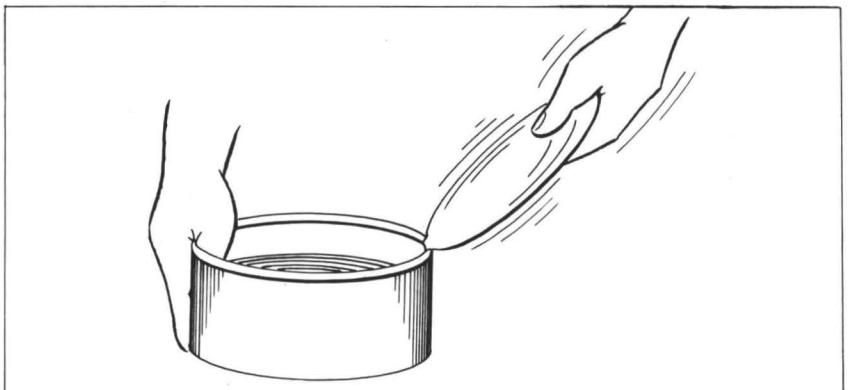
pitch which causes stress on the attached parts. This cyclic stressing causes slip lines to develop within the crystalline grains which make up the metal. These slip lines are formed immediately after cyclic stressing takes place.

As cyclic stressing continues these slip lines intersect and become more numerous. This may be happening either over extended or short periods, depending on the amount and number of times the metal is stressed within a given time frame. These lines will form very rapidly if the metal is overloaded. The intersection of slip lines eventually leads to microscopic cracks. Most often these cracks begin in areas where stress is highly concentrated and form very early in the fatigue life of the part.

The microscopic cracks grow and intersect just as the slip lines did, forming cracks which may be detected by penetrant dye and radiographic inspection. Up to this point you will find no noticeable stretching or bending of the metal, however, the surface may appear to be quite brittle.

Finally a visible crack will appear. This normally occurs during the last 20 to 40 percent of the fatigue life. Until this crack forms and begins to spread, the rated strength of the metal remains unchanged but the crack may spread more rapidly from this point until it finally has traversed so much of the cross-sectional area of the part that the remaining portion can no longer support anywhere near the normal load. This remaining unstressed portion will fracture suddenly under a load far less than normal.

The cause of fatigue failure is the accumulation of cyclic strain which tends to deform the metal in much the same way as you would bend a candle by placing stress upon it with your hands until it finally begins to change shape.



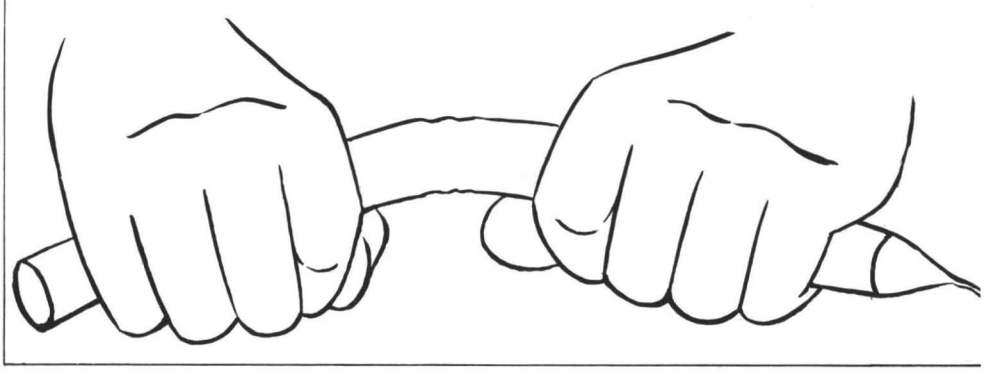
Metal fatigue can result from constant bending

This type of stress is usually in a lateral direction. In addition to the lateral stress, a tensile or longitudinal stress must be present to spread the crack resulting from this progressive fatigue process.

Failure due to metal fatigue normally cannot be traced to the metallurgist. Fatigue or metal working of dynamic components is inherent in their use. Some of this can be designed around in one manner or another such as increasing the bulk of the material or overdesign factor. There ALWAYS exists compromises in aircraft design. Dynamic components are placed on time changes, a time known to be short of the component fatigue life, in order to avoid weight increases through overdesign. Despite this, these components often fatigue fail due to an accumulation of unpredictable circumstances—often caused by user misuses or abuse by performances exceeding the design envelope. All of this does not preclude the necessity of good engineering design practices.

One of the most frequent causes of metal fatigue is the high concentration of stress found around notches in the metal. For our purpose notches include keyways, grooves, holes, contour changes, threads and even scratches. Generally, the harder the metal or the higher the tensile strength the quicker a notch will affect it. Due to this effect it is imperative that during any inspection of an airframe particular attention be given to rivet holes, bolts, bolt holes and stamped indentification numbers. One example of the latter is found on the UH-1 series helicopter on which no identification numbers

Cyclic strain deforms metal, as stress bends a candle



may be stamped into such parts as the blade grips due to the tremendous, constantly changing stress they undergo.

Inclusions (non-metallic particles in the metal) may also cause fatigue. A concentration of stress around the particle will result in the progressive failure process (Figure 1). These cases are rare in today's highly refined metals.

Iron alloys have carbon in them. Some substances will react with the carbon on the surface causing decarburization which makes the surface soft. This has the same effect as a notch. Chromium-vanadium and silicon-manganese spring steels, as well as some bolts and forgings, are particularly subject to this.

It is common knowledge that corrosion eventually weakens and shortens the life of a metal part. One reason for this is that the pits formed on the corroded surface act as notches causing a concentration of stress around that area. Another reason is if the corrosion is actively occurring at the same time a stress is applied to a part the corrosive material may fill a notch or pit in the metal. When this happens the material acts as a wedge and when stress is removed the metal tries to return to its original shape. The corrosive material forming the wedge causes the metal to crack and the fatigue failure process begins.

There is often a concentration of stress around a clamp or pressfit. This is due to changes in the size of clamped or pressfitted parts when stresses are transmitted through the fit and to fretting (rubbing together) surfaces. Engine parts and fuel lines, especially, fail due to clamping. This type often goes undetected until failure occurs.

In addition to factors we have discussed some processes such as cold working, heat treatment, cold straightening, drawing or rolling, etc., often cause an internal stress known as residual stress. This is actually a tensile or longitudinal stress within the metal's surface. This, when added to the normal tensile strength designed into the metal, may add up to more stress than the designer anticipated and could result in fatigue fracture when a frequently changing load is applied.

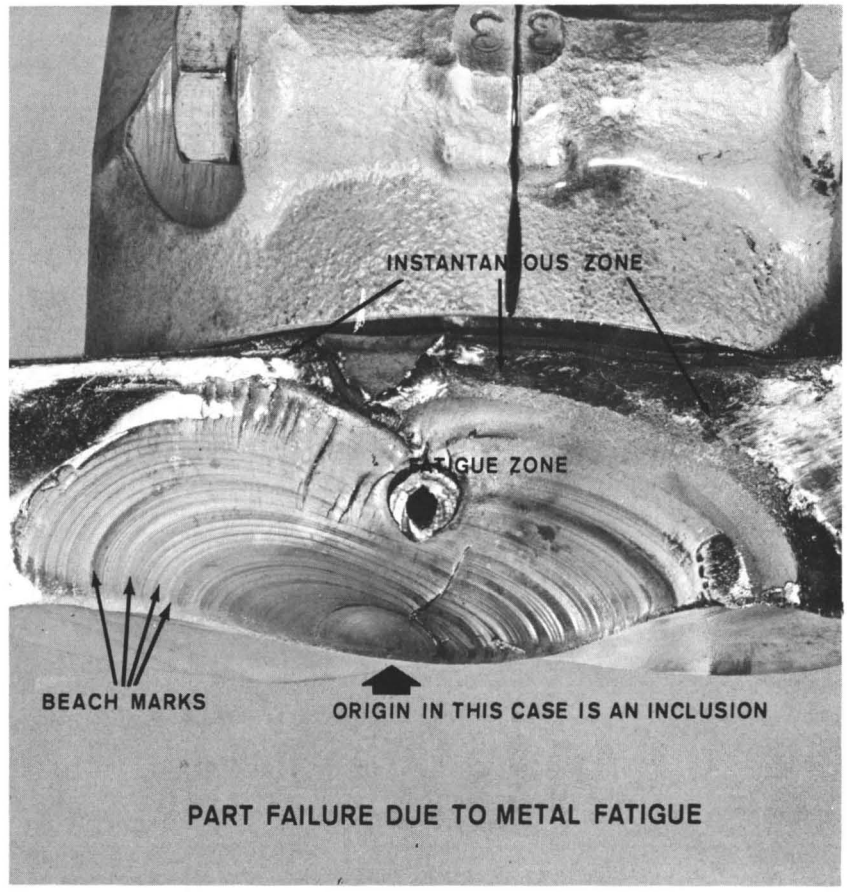


Figure 1

There are many reasons for broken parts so how can you recognize a fatigue fracture from any other break? This is not always easy but here are a few pointers.

You will find a fatigue fracture generally divided into two distinct zones (Figure 1). These are labeled the fatigue zone and the instantaneous zone. The fatigue zone will most often be very smooth since the crack took some time to form and the two sides usually have a chance to rub each other smooth. The instantaneous zone will be coarse and crystalline in appearance. The reason is the structure of metal is basically crystalline and when a fatigue fracture takes place it pulls apart all at once leaving clear outlines of the crystals which make up the metal.

Now to go back to the fatigue zone. Usually, you will see marks along the surface of the crack which looks similar to the marks the tide makes on a beach. For this reason they are called beach marks (Figure 1). As the crack forms it may move very slowly over a long period of time. As it

does it will move a little way until it hits fresh, unfatigued metal and stops. After a time this area becomes fatigued due to the high concentration of stress around the crack. The crack then moves through this area until it once again hits fresh material. Each time it stops it makes a beach mark.

Beach marks will form in a circular fashion, radiating away from the point of origin (Figure 1). An easy way to determine the starting point in a fracture is to look at the beach marks and determine where their point of origin is located. However, beach marks are often worn off near the starting point due to the sides of the crack rubbing together.

To compound the problem a break may result from a combination of several fatigue cracks. This type of break is called a compound fatigue fracture. Here, the same two zones exist but are often harder to identify. Breaks of this type are often found in overstressed splined shafts.

There is no foolproof method of detecting metal fatigue before damage to the part occurs. Often you may be able to see it but just as often it will go undetected until complete fracture occurs. This is one good reason for sticking strictly to the component replacement time limits and load limits placed on Army aircraft. Even this, though based on tests and more tests, is often not enough. For this reason constant inspections of both the aircraft, maintenance procedures and operating procedures cannot be stressed enough.

Early detection is highly important because the visible crack does not appear until some 60 to 80 percent of the fatigue process has been completed. For mechanics there are several good nondestructive test methods available. Among these are X-ray—sonic and ultrasonic, magnetic particle (Magnaflux) and liquid penetrant (Zyglo and Dy-Check). The liquid penetrant and Magnaflux methods are among the most common in the Army and probably the most reliable.

For visual inspection all areas of high stress should be checked as frequently as possible. The checklist (Figure 2) should be useful in reminding yourself of likely areas regardless of the aircraft.

Unfortunately some of the most likely areas are difficult to inspect. Don't be afraid to remove inspection plates frequently and use a light. In some cases a bore-scope similar to those used to check tank guns and artillery tubes will aid you in checking hard to see places. Visual inspections of this nature and preflight inspections will go a long way toward reducing complete fractures even if a crack develops.

Keep yours eyes open. When a crack develops or if you even suspect one report it. When a crack finally forms the part may have only 20 percent of its life left.

Figure 2

CHECKLIST FOR METAL FATIGUE INSPECTION

1. _____ **Corners of square holes—if sharp corners are not necessary a rounded or fillet corner will standing more stress.**
2. _____ **Sharp edges—Good craftsmen smooth off their edges. Again, it not only looks good but it reduces stress concentration. The notch effect will often cause stress concentration around these rough edges.**
3. _____ **Notches—Avoid these where possible. They are among the worst stress raisers.**
4. _____ **Tool marks—These often constitute a notch and will quickly start the fatigue process.**
5. _____ **Chewed up surfaces—All rough edges have a notch effect and will be likely fatigue areas.**
6. _____ **Excess material—This is especially important in checking field repairs. An excess of splicing material for example may not only add weight but also stress in an area which was not designed to withstand it.**
7. _____ **Hidden mistakes—These were not in the design, thus the area in which they are located was not designed to withstand the stresses they bring. Don't hide them, correct them.**
8. _____ **Stamped identification marks—These are actually notches.**
9. _____ **Splices—These are often not put on by experts and may be of poor design leading to failure of the splicing material and of the area which is spliced.**
10. _____ **Bad load distribution—This may be the result of poor cargo loading techniques or poor structural design placing too much stress on one support and not enough on another.**
11. _____ **Spotfacting—This is an area machined away around a bolt hole so that the bolt head or nut will fit flat against the surface. Often these are left with sharp or scored edges and result in metal fatigue.**
12. _____ **Thin flanges—May be too thin for the load they carry.**
13. _____ **Rough forged surfaces—Any rough surface, like one left on forged parts may be suspected since each pit in the surface will act as a notch.**
14. _____ **Threads—Any threaded surface such as a bolt may fail due to the notch effect produced by the threads.**
15. _____ **Corrosion—Remember the wedge effect causes a stress concentration as corrosive material fills a small crack.**
16. _____ **Susceptible components—Make an engineering evaluation of susceptible components to determine if they should be forged, cast or machined in the interest of inherent stress problems including fatigue.**

START WITH THE

Major John E. Feit

THERE MAY BE a few who don't agree, but I've always contended the best forced landing was made in the coffee shop over a cup of brew or maybe in the "hooch" with a cold bottle of soda. In short, the best forced landing isn't the one we make; it is the one we didn't have to make because we prevented it before we crawled into the bird.

How did you learn your preflight? If you are like me, you learned from your instructor. Where he placed his emphasis is where you place yours. Of course, the best preflight begins with a thorough knowledge of the dash 10, but over the years nervous experiences will cause you to modify your preflight to emphasize certain additional items.

That brings us to the crux of this article. What should the pilot be looking for on a preflight beyond the obvious cracks, dents and popped rivets? A group of us who are flying UH-1Ds and Hs every day got together and tried to distill a little of our experiences about those UH-1Ds and Hs, since they are about the most common aircraft in the Army inventory. We don't profess to know it all by a long shot for we are still learning.

I will not list every item on the preflight, just those items with which we have had a bad experience. Let us start around the aircraft as we do on the preflight.

• The forward battery compartment and radio compartment access door on the nose of the aircraft have two snap fasteners, both of which had better be working. If either one is defective, air pressure can push the door sideways enough to allow it to come open; and in

flight it may just keep going right up through the rotor system.

• Bent or rusty hinge pins in the copilot's door will make it unlikely that you can jettison the door. This usually is discovered about the time you are in a big hurry to get out of the aircraft.

• The landing gear, thought of as an integral part of the aircraft, is really a separate unit capable of standing all by itself. The aircraft fits on top of those skids and normally takes the skids with it via four skid suspension points. These suspension points consist of a heavy metal bar with a rubber pad on top of it to lift the skid cross tubes. If the metal bar is broken or missing, you would fail to lift the skids at that point; and conceivably you could fly away minus the skids. The missing or broken strap is pretty obvious, so generally not a great problem. But a missing rubber pad is also bad news. This allows the skids to fall away from the aircraft just a little bit, and the next time you set the bird down it just might fall off the skids. Basically, it works this way:

The stops on the aircraft body fit inside the stops on the skids. Now if for any reason the skids should drop away from the aircraft body and slip so as the aircraft stops get outside the skid stops, the aircraft will be able to slide down the cross tube to the ground. You may or may not have time and rpm to do anything about it. When you are checking, you'll discover there are two different types of stops on the cross tubes—the older type is like two small horns, the newer type a larger flat plate. The plate being larger makes this type of thing less likely to occur even if you should lose the rubber pad in flight.

The electrical compartment seems to be the crewchief's private goody box. This compartment also contains several electrical terminals. Any loose tools or oil cans can create a heck of a short and unwanted smoke.

The tail rotor drive shaft tunnel makes one of the poorest storage places for tools, rags and other foreign objects imaginable. Yet, people insist on storing items there, particularly just after they have been working on the tail rotor drive shaft. Avoid tail rotor drive shaft failure, remove all miscellaneous items.

With the cyclic full forward, the sync elevators should have no more than three-eights inch rotational play at the trailing edge; and the in and out play should not exceed .030 inch. The thickness of a dime is about .030 inch.

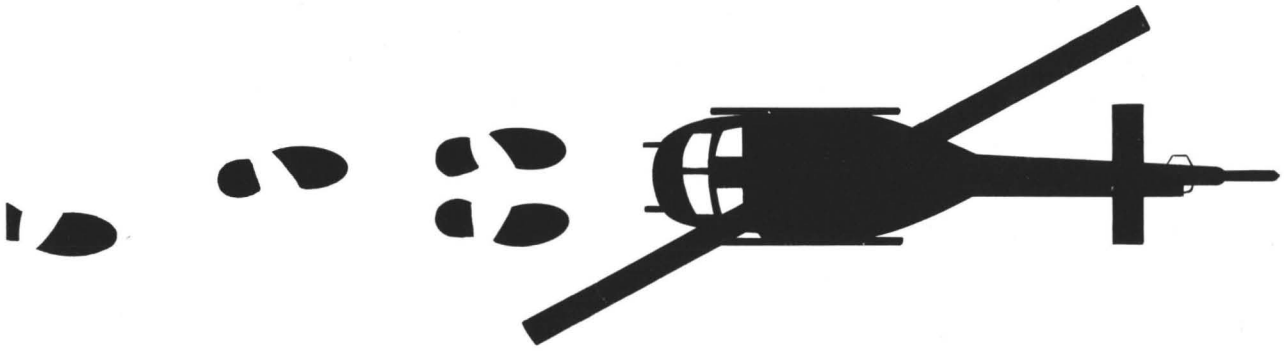
The tail rotor is way up there; and if you don't have a way up (that is without endangering your life and limb), the next best thing is to grasp the tail rotor blades and gently twist them in the direction of pitch change. If either blade will rotate more than one-eighth inch at the trailing edge, you may have troubles with the "T" head assembly or the pitch change links. You definitely should get up there and take a closer look—it might save you a tail rotor failure. Also, keep a sharp eye on the two "T" head/slider attach bolts for proper nut safety. Don't forget to inspect the tail rotor blades.

The fluid level in the 90 degree gear box should be to the full mark. The trick is to make sure what you see is fluid. Sometimes the glass becomes stained, and what you see isn't oil but stain. So shake the tail boom (the stinger is a handy place to grab) and see if you see the fluid move. If not you had best crawl up there for a closer look. Also, make sure the oil cap on the 90 degree gear box is in place.

The 42 degree gear box is the same, except you will have to get your nose right up to the cover to be able to see the oil cap. The magnetic chip detector plug should be secure. All the oil will leak out if the plug comes out and you may or may not know it until it is too late.

The inspection panels on the bottom of the tail boom (there are three) are structural panels. Missing bolts on these panels are the first cousins of popped rivets.

The compartment giving access to the aft battery position, oil



cooler, etc., has just inside the access door a tube that runs from your upper right to the lower left. Now this tube is extremely unhandy when moving the battery around, but is a structural member of the aircraft and must be present. If the crewchief has taken it out for convenience, make him put it back. The aircraft does not fly very good minus the tail boom.

The oil cooler has a fan visible on the top and you should be able to move this fan freely. Your bare fingers will slip in between the wires of the protective screen to spin the fan. Don't use foreign objects like a pencil for if you should just happen to drop it down in the oil cooler you will gain the undying hatred of the crewchief, maintenance officer and probably the old man. It is a long tedious job to remove the oil cooler to retrieve a pencil and the ship will probably be down all day.

Paint slippage marks should be on the tail boom attaching bolts and they should show no slippage.

The bearings in the control rods should be checked for freedom of movement, but with *only small, light movements.* If you use a strong right arm and bang the control rods from one side to the other, you may be the cause of bearing failure in the control rods. The tail rotor servo (all servos in fact) should show a little hydraulic fluid seeping. That is how the servo is lubricated—now I don't mean a leak with puddles of hydraulic fluid, but it should be moist.

The right side of the skids and pilots' doors should get the same attention as the other side.

Top side is an excellent place to be safety minded. The plexiglass above the pilots' compartment will not support your weight, and it is very easy to stray into this area as you crawl up. If you have a little oil on your boots, and a little dew on the deck, it is just about like ice skating. Don't let anyone be playing with the controls while you are top side or you may be suddenly without fingers. The filler cap for the transmission oil and hydraulic fluid should be firmly in place. The short shaft—there are two types, one with and one without cooling fins—clamps should be fastened by bolts saftied with cotter pins. The short shaft should rotate smoothly in the direction of the cotter pins. Rotation of the short shaft in the opposite direction should cause the main rotor blades to turn. Any roughness in the rotation of the short shaft is an excellent warning of impending engine problems. A word of caution: if your flight suit or fatigue pockets are open when you bend over to check the short shaft, you may spill change, tools, pencils, etc., down on the engine deck. This is terribly embarrasing, and it can make it extremely difficult to make your takeoff time. A check in this area will also contribute to eliminating engine failures due to foreign object damage (FOD).

The collective sleeve may be checked for play by placing your fingers through the holes in the collective assembly just under the swashplate. If you detect any play in the collective sleeve assembly, it should be checked out by maintenance. One way to aid in telling if you have any movement in the collective sleeve assembly is to move the mast gently back and forth until it starts swaying fairly well. Then, place your fingers on the collective sleeve assembly. If you feel a distinct click through your fingers, there is movement in the assembly.

The large rod end type bearing in the trunnions that connect the push-pull tubes to the swashplate have small tolerance on in and out play, approximately .020 inch. The bearings in the shank portion of the trunnion should have no apparent play.

All the bolts on the control head are supposed to be torqued tight enough that you should not be able to rotate the bolt with your fingers. Inspect bolts for excessive wear. Also look for the proper safety on *all* these control bolts.

The control rods from the swashplate to the mixing levers and stabilizer bar assembly all have very small tolerances in bearing wear. Any play in these bearings at or over .010 inch should be checked by maintenance.

The rotor head is secured to the mast by the main mast retaining nut ("Jesus Nut") and a set of split cones. The Jesus Nut keeps the head from coming off the mast in flight, and the split cones keep the head from coming down the mast at rest. The split cones are placed around the mast so that the halves don't touch. The head is placed on, then the Jesus Nut is torqued down. The Jesus Nut should be saftied by a locking device with tongs fitting into its grooves. The locking device bolt should then be safety wired to the head. Looking up under the head, the split cones appear as split rings around the mast, between the mast and head. If the cones are touching each other on one or both sides, call maintenance to evaluate. This indicates improper torque on the Jesus Nut or sloppy maintenance procedures and should be checked out further. CAUTION: The main rotor blade has to be untied to be able to check both sides of the split cones. If any aircraft are hovering in the vicinity, flapping blades can give a nasty headache, or if your fingers are in the way, a new look in hands.

Leaking from the blade grips occasionally does occur. The limits are: the blade grip reservoir to go dry in a two-hour flight or a 24-hour static period. A reminder: halfway up the glass, about the bolt, is the full mark.

The rotor blade pitch change links are allowed quite a bit of play, .015 to .020 inch. The limiting factor is does the play give a 1 to 1 vertical vibration, or does the play exceed .020 inch? If either condition exists a change is necessary.

The rods between the hydraulic dampers and the stabilizer bar can have some play, but do make sure the oversized safety washer is on the outside of the bearing. Then in case of total bearing failure, the rods won't come completely loose. Now look at the general condition of the top and bottom of the main rotor blades. Sharp scratches in the blades require the attention of your maintenance personnel.

The air inlet filter screens make a very handy place for laying small tools when the crewchief is working up top side. These tools can cause damage if they get down into the short shaft in flight.

The cowling that runs around the front of the transmission and over the generator is supposed to have a gasket around the bottom to help hold it fast and eliminate vibrations. This gasket has a way of coming off after a little hard service and allows the whole cowl to vibrate up and down. If the gasket is completely missing those vibrations can jar the latches loose and then allow the whole affair to start peeling off from the front and go up through the rotor system.

These have been the areas where we have had problems. If you found just one from this list that saves you a forced landing at the controls, we are well pleased. If you have found a problem area we haven't mentioned, write: Editor, AVIATION DIGEST, VFR Department, Ft. Rucker, Ala. 36360. Here's to you and hoping that all yours will be the "Best Kind of Forced Landings."

Aviation Returns . . . . . to the Cow Pasture

Autorotations to sod, although not much different from hard surface landings, demand extra care in pilot planning, judgment and technique

Major Bobby F. Thomas

. . . and that's no bull

HEY, HAVE you heard the latest? There's a new warrant officer in our unit who says that at Ft. Rucker and Hunter Army Airfield students are being taught minimum ground run autorotations and they are doing them in cow pastures! Why couldn't they have done that while we were in flight school? If they had, maybe we wouldn't have had to learn the hard way that there is a difference between shooting an autorotative landing to a hard surface and an unimproved field or paddy."

Perhaps you too learned the hard way. To answer your question, until recently a demand for this type of proficiency had not been voiced. Then letters from aviation units in Vietnam to the Commanding General at Ft. Rucker mentioned that there was a definite deficiency in most pilots' ability to make a successful zero ground run forced landing. These letters prompted a staff study which resulted in the recommendation that this maneuver be standardized and incorporated into the syllabus of instruction for the contact stage of training. Immediate action was taken to determine

necessary and proper procedures for touching down on unimproved terrain. Once the maneuver outline was completed and suitable areas selected (in some instances, cow pastures), standardization pilots from both Rucker and Hunter were trained. They in turn started giving checkouts, and soon all contact instructor pilots were "ready and raring" to teach.

As for practical application of the maneuver, we must remember that minimum or zero ground speed autorotations are used for more than touchdowns in fields. Ditching in water and landing in trees also require as little forward speed at impact as possible. The key to achieving this is deceleration and the proper aircraft attitude during initial approach and a cushioning pitch application just prior to touchdown.

Autorotations to sod are not much different than to a hard surface, if handled properly. Pilot planning, judgment and technique are the determining factors for either a good or bad autorotation.

Picture yourself in a basic autorotation to a hard surface lane in the UH-1. You've reached a safe entry point, collective is lowered, throttle reduced to flight idle, aircraft in trim and cyclic eased rearward for a 60-knot attitude. At 50 to 100 feet the deceleration is put in with rearward pressure on the cyclic, slowing the forward ground speed and placing the aircraft in a landing attitude. At 10 to 15 feet, initial pitch is applied to load the rotor system and slow your rate of descent. Of course, you are still maintaining the cyclic in a position that initiated your deceleration. Now you apply cushioning pitch to smoothly set your aircraft on the lane with no more than two helicopter lengths ground run.

If you would, imagine yourself in an autorotation to sod, fairly smooth, but unimproved in the same type aircraft. When the entry point is reached, simultaneously lower collective, roll off throttle to flight idle, trim aircraft and adjust cyclic for a 60-knot attitude. At 50 to 100 feet, rearward cyclic is applied to assume a decelerating attitude, which, if held, will result in zero ground speed at the point of intended touchdown. At 10 to 15 feet apply sufficient collective pitch to slow rate of descent and assist deceleration. To effect a smooth touchdown you utilize remaining pitch, while continuing to hold aft cyclic. Do not lower collective to prevent or stop forward slide.

That wasn't so hard, was it? Both autorotations were completed with successful touchdowns, but on two different types of surface. When touching down on a hard surface, you can allow a ground run of considerable distance with little chance of damage. This type of surface is not afforded by unimproved terrain such as sod, rice paddies or trees; therefore, any amount of ground speed at touchdown is undesirable and possibly disastrous.

How do we achieve a minimum or zero ground run at touchdown? First, certain factors must be considered. These are: wind, pilot planning and judgment, aircraft deceleration and use of pitch.

To take them in order, we will start with a discussion of the effects of wind. Experience has shown that minimum ground run autorotations are difficult to safely perform without the assistance of a headwind component. Therefore, without this headwind component, the pilot should be prepared to accept a minimum ground run touchdown in lieu of a zero ground speed.

Next in order is pilot planning and judgment. Autorotations into unfamiliar areas are made difficult by the aviator himself. He does this by not taking into consideration such things as tall grass, water and trees. These items are observed by the aviator's peripheral vision as the autorotation proceeds. From this information the pilot must determine the amount and point of deceleration and the amount and point of initial and cushioning pitch.

The critical portion of our successful touchdown, with minimum ground run, begins with deceleration. How does deceleration in this maneuver differ from a basic autorotation? It is very simple. The deceleration is adjusted to reduce your forward speed as much as possible just prior to ground contact.

Now we are ready to discuss pitch application. At the point of initial pitch application, further aft cyclic is applied to counteract the natural tendency of the nose to drop. This aft cyclic provides the maximum possible decelerating effect during initial and final pitch application. With the aircraft in a decelerating attitude, our pitch application not only reduces our sink rate, but further assists in reducing forward speed. However, in a high gross weight and density altitude situation all pitch application possible would be primarily used to reduce the last 10 to 15 feet of vertical motion. The pilot would not want to use this available pitch simply to reduce forward motion. Finally, by holding the aircraft off the ground as long as practical and touching down on the heels of the skids, we attain zero or minimum ground run.

In summary, operations on unimproved terrain vary little in their basic concepts from operations on improved landing areas. The points worthy of note are the finite and correct use of deceleration and pitch application.

Proficiency in this vital maneuver will increase an aviator's confidence in his ability to make a successful forced landing—regardless of the terrain.

A New Look For Army Aviation

It's time to consider overhauling aviation unit structures

Increased technology in the hardware field has created a need for revisions which will provide commanders with the streamlined organizations required to accomplish their missions

Lieutenant Colonel Bruce B. Campbell

The Air Cavalry Squadron concept

IT'S TIME FOR A CHANGE in Army aviation—a change in the structure of aviation units to make them more efficient in their use of new technology, more capable of utilizing their aircraft properly and more efficient in the area of personnel management.

The need for a change in the structure of these units has been prompted by the dynamic and ever-changing application of Army aviation as well as by rapidly increasing technology.

Ten years ago there were no air cavalry squadrons, airmobile divisions, surveillance airplane companies, heavy helicopter companies nor attack helicopter companies. Today in the Republic of Vietnam these organizations not only exist, but are carving a niche in the annals of warfare. Each Army aviation organization has been structured to accomplish a mission, even though this mission may be so broadly stated that it is difficult to define in precise terms.

More powerful and dependable aircraft have made missions easier to accomplish and have added a greater capability to an already powerful punch as both a supporting force and a devastatingly efficient fighting force. The UH-1 Iroquois, which has replaced the UH-19, CH-21 and CH-34, is smaller, requires less maintenance and is more reliable. The CH-47 Chinook has increased the capability of the assault support helicopter company when compared to the CH-37. These are but two examples of how increased technology has improved the capability and efficiency of Army aviation.

But what about the structure of Army aviation units? Have they progressed along with technology in order to make the most efficient use of this increased capability? The original CH-21 and CH-34 companies contained 21 aircraft, whereas the current UH-1 companies (non-divisional) have 31 aircraft (USARV MTOE). Commanders of the original companies had problems in controlling their organization, in maintaining an acceptable availability rate and in keeping the accident rate down. Proper and efficient utilization of

s the most modern of the Army's aviation structures

their aircraft was one of the things which had to be ignored since in many cases the ground commander did not consult the aviation company commander with regards to employment and utilization and he, the aviation commander, did not have time to teach the ground commander employment. All of these problems existed in peacetime when stability of personnel was the rule rather than the exception.

If the original CH-21 and CH-34 company commanders had problems with 21 aircraft under stable conditions, picture the UH-1 company commander in Vietnam with 31 aircraft and complete instability. Due to the 12-month rotation policy, the commander's training program is continuous. Training under combat conditions has and will continue to result in a high accident rate. Since ground commanders are continually changing, aviation commanders must continually strive to educate them. But, these are not problems which can be totally corrected by a new organization. They will exist to some degree in any company regardless of size. But as the size of the company increases the problems encountered by the commander will also increase and he will have less time to devote to the primary mission of the company—providing support to the ground commander.

The size of the current aviation company and the aviation battalion is creating a monumental problem for commanders—the problem of being required to work for more than one master. There is a passage in the Bible which states that man cannot serve two masters, but this is being expected of the aviation personnel in Vietnam.

The aviators assigned to the platoons of an assault helicopter company are authorized and justified on the basis of cockpit seats. In other words, for each cockpit seat in the UH-1 one aviator is authorized. The company is not authorized a motor maintenance officer, an assistant operations officer, a unit standardization officer (aviation training), a safety officer nor an awards officer. All of these tasks have proven to be near full-time jobs in Vietnam. Some of the personnel assigned to the flight platoons are required to spend the main part of their time accomplishing these non-TOE tasks and thereby serving a second master. This system is producing results in Vietnam and the jobs, in most cases, are being accomplished. But are the tasks being accomplished in an efficient and economical manner? Is an excessive price being paid for these jobs? A price in the form of excessive accidents perhaps?

The question may be raised as to whether there is a need for full-time jobs in such areas as administrative officer, safety officer and standardization officer. Even before Army aviation was committed in Vietnam, the need for a full-time safety officer was recognized. Most major commands directed that one officer in each company-size aviation unit would be given the primary duty of an aviation safety officer. It has been demonstrated time and again that an active safety program can assist in reducing aviation accidents. But what about the administrative officer? If a hard look is taken at the size of the aviation company it will

become immediately evident that the normal company orderly room administrative section cannot possibly accomplish the load imposed by the unit personnel. The assault helicopter company, as currently organized in Vietnam, has 219 personnel authorized. This strength figure does not include the normal attachments of a 72-man TC Detachment (KD) and a 9-man SC Detachment (RL). Modified Tables of Organization and Equipment (MTOEs) have been submitted by USARV to absorb these detachments in the aviation company. Approval of the MTOEs will result in the company having an aggregate strength of approximately 280 personnel. No other combat company approaches this strength.

The unauthorized staff—the administrative officer, safety officer, etc.—of the aviation company does, in reality, have two masters. They spend a great deal of their time working for the company commander or executive officer and the remainder of their time working for the platoon leader or section leader accomplishing their TOE jobs.

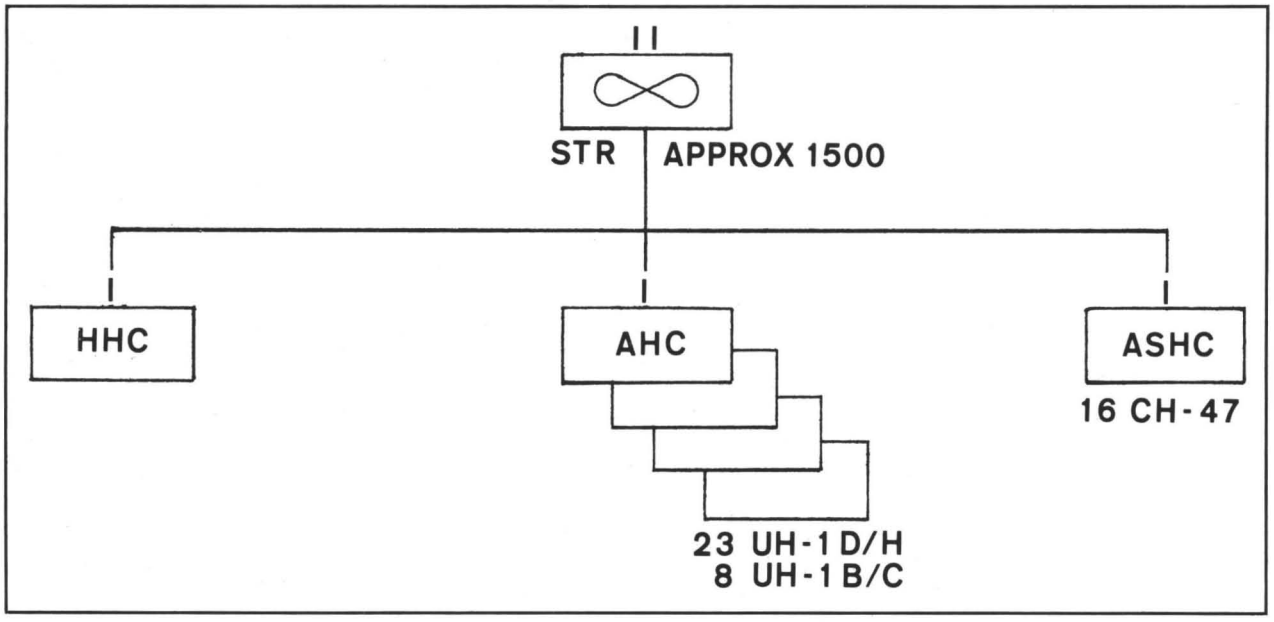
As for the company commander, this individual is working for many masters. He is not only responsible to the aviation battalion commander but also to the supported commander for the actions of his company.

To illustrate the point let us look at a typical day for an assault helicopter company. The company will be given a mission of supporting an infantry brigade. The first lift of the morning will possibly, if they are lucky, be a company-size lift which will be accomplished by 0800 hours. Following the lift the aircraft will be sent in all directions; a lift platoon plus a light fire team may be broken off to support an infantry battalion of a brigade which is 20 to 30 kilometers from the previous lift. The other platoon may be used for resupply of the inserted company or may be returned to strip alert for employment elsewhere. Thus, the company is spread over an area as large as Ft. Knox, and the company commander is responsible to two different battalion commanders, an infantry brigade commander and, as always, to the aviation battalion commander.

If one studies the employment of the assault support helicopter company or the reconnaissance airplane company, he will find that these units rarely work as a company. The aviation battalion commander has the same problems that the company commander has except he has an authorized staff to assist him in solutions. The battalion may be structured as shown in Figure 1, but when it comes to responsibility he may be working for three or more masters during the course of a day's activities. He may have a company supporting a brigade of the 25th Division, a company supporting a brigade of the 9th Division, a company in general support of the Corps and a CH-47 company spread over the entire Corps sector.

The question is, Why have we structured the aviation company and battalion to their present size and configuration if they are seldom employed as a unit? Many people will answer by saying that an assault helicopter company must be able to lift the combat elements of a rifle company, thus coordination is held to a minimum.

Figure 1



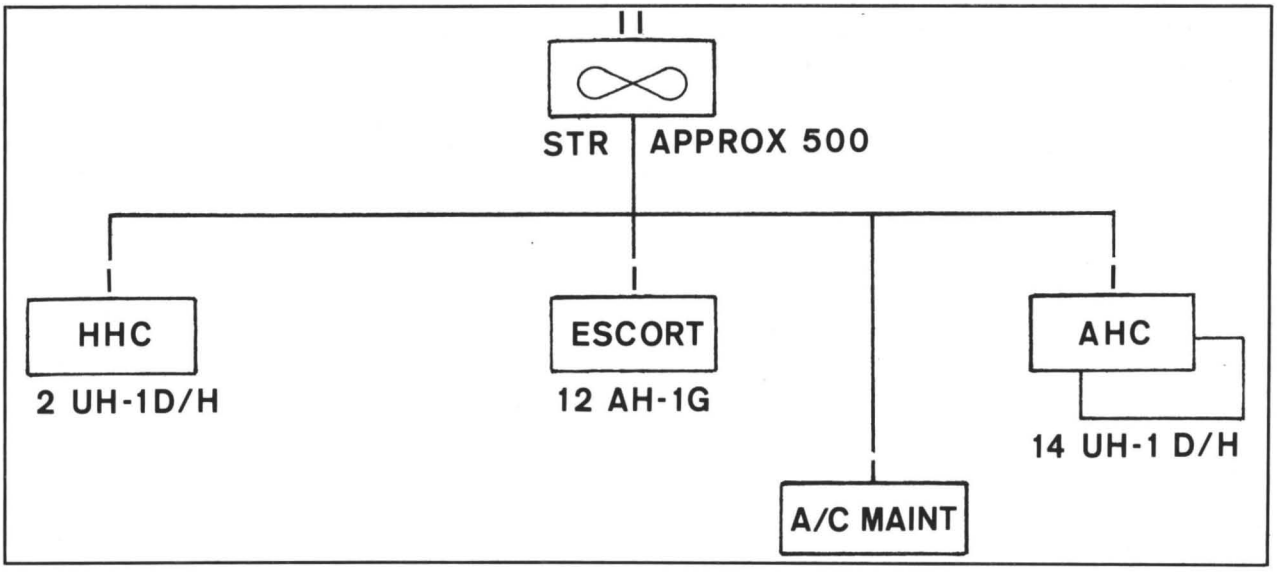


Figure 2

But, does it really matter whether the coordination is between an infantry company commander and an aviation company commander or between an infantry company commander and an aviation battalion commander as long as the mission is accomplished?

It could be argued that Vietnam is a special situation and the requirements generated there may not be valid in other areas. This is true but Vietnam is real. It is the least costly type of conflict for the enemy to wage and indications point to this type warfare in the future. Therefore, why disregard the lessons learned there?

The aviation company and the aviation battalion should be structured along the lines of division artillery, that is, an aviation element comparable to division artillery should support an infantry division. The aviation element should be made up of four battalions, one for direct support of each brigade and one for division general support. As for the total number of aircraft in each battalion, it would seem prudent to investigate the normal support required by an infantry brigade and so equip the battalion. The exact figures are not available at this time but let's say the brigade normally received the assets of a current assault helicopter company plus five UH-1D helicopters from the division's organic airmobile company. Additionally it may receive a light fire team from division's organic general support company. Thus the total is 28 UH-1Ds/Hs and 10 UH-1Bs/Cs or Cobras being provided from three different companies which are elements of two different battalions. This same support could be placed in one battalion which habitually supported an infantry brigade. The organization would be as shown in Figure 2.

The battalion would be slightly larger than the current assault helicopter company but benefits gained by this increase would be tremendous. The span of control of the company commanders would be within their capability. The company would normally be employed as a company and not fragmented over the entire division area of operation. Coordination for mission support would be simplified, reduced and more effectively accomplished by the aviation battalion through its staff. The aviation battalion commander, who would be responsible for providing the required support, would also be responsible for the maintenance of the aircraft. In essence, the number of masters would be reduced to an acceptable number.

An added benefit of this organization would appear in the area of personnel management within Army aviation. Utilizing this proposed reduction in company strength would make it possible to have captains as company commanders. Majors could then be released for tours of duty with their basic branch; they could attend service schools and be available for advanced civilian degrees.

Many appear to be reluctant to make such a change. This is normal since one of the basic fears of individuals is fear of change. But fear of change should not be permitted to impede progress, and progress is synonymous with change. The proposal submitted here is a big change from our present organization. This structure would create a sound organization, one that would improve the efficiency of Army aviation and result in better support to the ground commanders.

crash sense

the following 28 pages prepared by the U. S. Army Board for Aviation Accident Research

SAFETY

This is the second article of a three-part series adapted from a three-hour USABAAR presentation made to the Command and General Staff College and Army War College. Presentations were made by COL Russell P. Bonasso, director; LTC Jack D. Peavy, chief, Aircraft Accident Review and Analysis Department; LTC Howard L. Collins, chief, Education Department; and LTC Henry E. Dreher, chief, Plans Division.

While rated aviation personnel may find some of this information elementary, remember that it is intended for nonrated commanders. You can help the aircraft accident prevention program by directing these articles to their attention.

DURING WORLD WAR I, an Army unit could move about 4 miles an hour, or about 20 miles a day. During World War II, except for some special units, we still averaged about 20 miles a day. Korea produced very little improvement. Today, a Chinook company of 16 helicopters can move the firing batteries of a battalion of 105 howitzers 20 miles and have the first round on the way in 20 minutes. This is the impact of Army aviation on combat effectiveness; it is achieved through the proper use of Army aviation resources.

Knowledge is power—the more we know about the capabilities of any system, the more efficient we become in its employment. Army aviation has proven its value in Vietnam, but have we learned all that we can in order to employ it wisely and effectively? Noncombat accidents say no.

The purpose of this article is to focus attention on aircraft capabilities and limitations as they impinge on mission accomplishment. These aspects will be presented in a manner that will give commanders a better idea of what can be expected from supporting aviation units. Atmospheric conditions, aircraft performance, aircraft operations and maintenance will be discussed.

What do we mean when we speak of aircraft capabilities? Some of us immediately think of all the useful things that aircraft can accomplish, as reflected in glowing accounts published by industry. We have all seen pictures of helicopters carrying tremendous slingloads. There are documented reports of record-breaking range, speed and altitude flights. If you do not understand the many variables in aircraft operation, you might be led to believe that a certain aircraft can take off at its maximum gross weight, fly to a record-setting altitude and then cruise at high speed to a destination at the

for Combat Readiness

Aircraft Capabilities

maximum distance of its range at any time on any day.

Some factors that affect aircraft performance are:

Load
Distance
Weather
Terrain
Type aircraft
Condition

Obviously, all record-setting accomplishments did not take place at the same time. Many tradeoffs can be considered to complete any given mission. Let's discuss some of these.

All of our aircraft are designed to certain military specifications. Our helicopters and powerplants must perform to certain standards. However, the atmosphere in which they operate is so variable that it would be impossible to arrive at exact performance figures without some kind of base line.

Engineers decided to evaluate performance based on a standard day with a temperature of 59 degrees, sea level pressure at 29.92 inches of mercury and no wind. This makes sense because when we test the performance of our aircraft, we now can mathematically calculate the performance against variables encountered during testing.

A term that involves temperature, pressure and moisture content is *density altitude*. Density altitude is exactly what the term implies. It tells us how dense the air is at a given altitude. The density altitude at sea level on a standard day is zero.

Air density directly affects the performance of powerplants and lifting devices of our aircraft. The air grows less dense or thinner as altitude increases. This decreases the efficiency of wings, rotor blades and engines. Lower temperatures and higher pressure variances can bring improvements in density altitudes, but this does not mean we can carry greater loads than on a standard day. Although powerplants and lifting devices will perform more efficiently, there are structural limitations to the aircraft. What this really means is that, under these conditions, engines and lifting devices have an easier time lifting the maximum weight for which they were designed.

Knowing and considering density altitude, a commander can plan for its effect on aircraft performance and obtain maximum use for existing atmospheric conditions.

Another factor that commanders need to know about is aerodynamics, particularly the phenomenon known as *ground effect*. Helicopters habitually fly missions where the performance variance caused by ground effect *must* be taken into consideration during mission planning.

Aeronautical engineers discovered long ago that the performance of the lifting devices changes when an aircraft is in close proximity to the ground, as in landing or taking off. Research brought about the conclusion that when an aircraft is operating at an altitude of less than half its wing span or its rotor diameter, more lift is generated.

This phenomenon becomes critical to helicopter operations *only* during the hovering phase of flight. Once forward flight reaches a certain speed, the airflow over the rotor creates enough lift to keep the helicopter flying. If a helicopter is to be landed in an LZ where it will come into ground effect, we can plan to carry a certain amount of weight. If it will be required to hover higher, out of ground effect, as when supplies are dropped, for example, we must plan for a lesser amount of weight.

Now that we recognize the variables of atmospheric conditions and the position of our aircraft relative to the ground, let's see what all this means to commanders. FM 101-20, the Army Aviation Planning Manual, tells us that the UH-1D helicopter can fly with a gross weight of 9,500 pounds on a standard day. You must remember that the performance figures in FM 101-20 are based on a standard day.

Aircraft gross weight is the weight of the aircraft, ready to go with fuel, crew and cargo. Operating weight is the weight of the aircraft with a crew

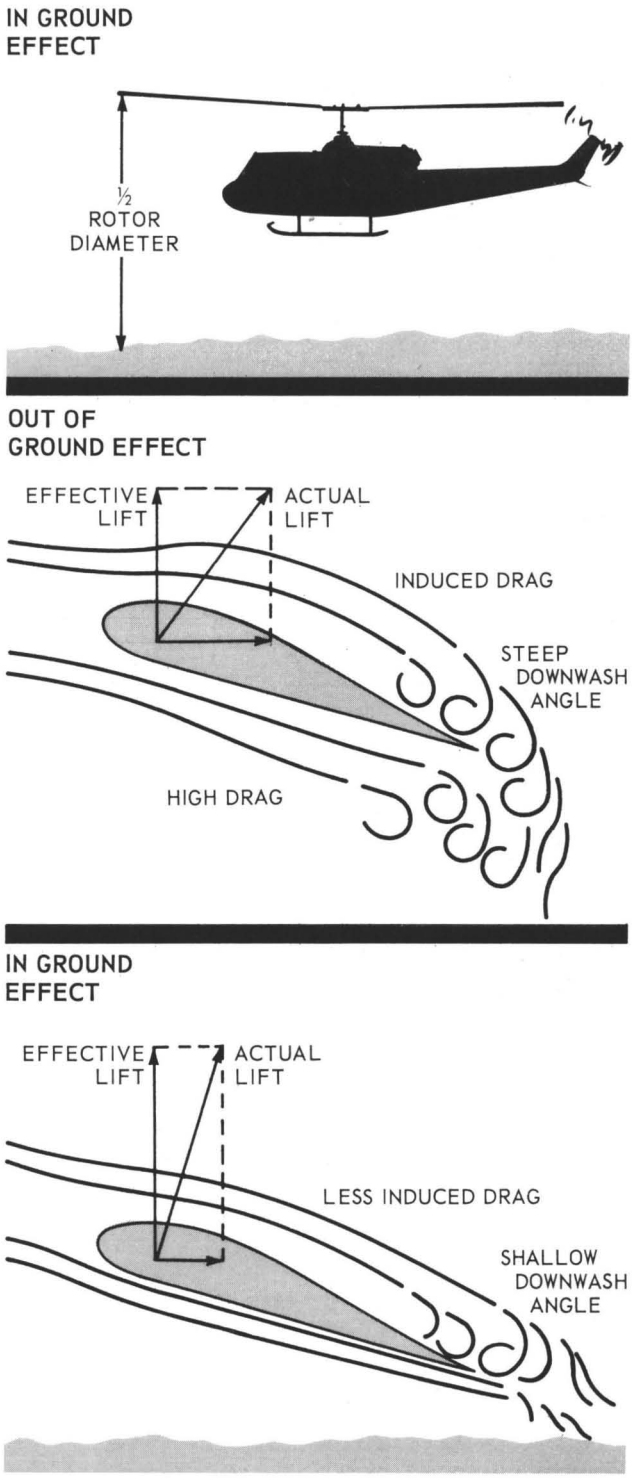
aboard, but without fuel or cargo. Payload is the amount of weight differential between gross weight and operating weight.

You can understand the difference in aircraft capability when a mission requires a landing in ground effect or a high hover out of ground effect. A 1,300-pound differential is the equivalent of six American soldiers and 100 pounds of rations. Bear in mind this differential is for a standard day.

Now let's go to a location in Vietnam where we might find an average daytime temperature of 105 degrees. Our density altitude could be 4,000 feet. The combined rotor and powerplant performance of our UH-1D can only lift 8,900 pounds gross weight if we are to hover in ground effect, or 7,000 pounds if we are to hover out of ground effect. Atmospheric conditions have cut 600 pounds of weight from our standard day performance of 9,500 pounds if we are to take off and land in ground effect, and 2,500 pounds if our mission requires hovering out of ground effect.

Now let's go up into the mountain country around Ahn Khe where the temperature is 85 degrees F and the pressure altitude is 5,000 feet above sea level. The density altitude now computes at 8,000 feet and we are getting into some extremely thin air. Our gross weight capability in ground effect has been reduced to 8,300 pounds, a reduction of 1,200 pounds, or six American soldiers that we cannot carry. Operation out of ground effect has now become marginal.

How do we compute the payload for a given situation? Let's say it's an average day in RVN and we plan for our UH-1Ds to land in an LZ. The maximum gross weight capability is 8,900 pounds. How many troops can we put aboard? First, we have to know how much the helicopter weighs in its operating condition. FM 101-20 tells us this is 6,600 pounds with crew. This is without fuel, because this is one of our tradeoffs. Suppose we want this aircraft to fly 25 minutes out from a strip, unload and return for a second similar mission without refueling. This



Drawings show aerodynamics of ground effect

Aircraft Capabilities

is 1 hour and 40 minutes of flying time. We will also need fuel for groundtime and reserve. We allow 30 minutes for this. Our fuel will permit us to fly no longer than 2 hours and 10 minutes. The performance charts in the operator's handbook tell us this requires 1,100 pounds of fuel. Now the aircraft weighs 7,700 pounds. We subtract 7,700 from 8,900 and find we have a payload of 1,200 pounds, the equivalent of six American troops, or about eight or nine ARVN troops.

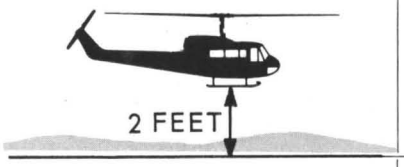
This may sound a little odd when the manufacturer tells us this aircraft is designed to carry 11 people. That is true for a standard day—which you will never find in RVN.

These are physical laws that affect aircraft performance. We must not violate them, for when we do the penalty is usually far more drastic than a court-martial would hand out for a gross violation of Army regulations.

A case in point is that of a UH-1D which was performing a command and liaison mission. It took off in the heat of the afternoon with 10 passengers, a crew of four, and 1,400 pounds of fuel aboard. During the climb, a loss of rotor rpm was caused by the fact that the engine could not deliver enough power to maintain rotor rpm at the pitch angles the blades required to maintain flight in an overloaded condition for the existing density altitude. When rotor rpm is reduced to a point below that required to maintain flight, the helicopter descends rapidly and lands considerably harder than planned. The cost to repair this one was $50,000. The only serious injury was a dislocated shoulder suffered by one of the passengers. However, the loss of mission capability cannot be measured.

This accident was the result of an attempted takeoff with overgross weight for the atmospheric conditions. The pilot, a 26-year-old WO1, was directed, over his objections, to carry the load on board. The fact that there are vacant seats in an aircraft does

GROSS WEIGHT CAPABILITY

UH-1D L-11 ENGINE	STANDARD DAY	RVN AVERAGE DAY	RVN EXTREME DAY
	TEMPERATURE 95° F PRESSURE ALT 0 DENSITY ALT 0	TEMPERATURE 105° F PRESSURE ALT 1,000 FT DENSITY ALT 4,000 FT	TEMPERATURE 85° F PRESSURE ALT 5,000 FT DENSITY ALT 8,000 FT
IN GROUND EFFECT 	9,500 LBS	8,900 LBS	8,300 LBS
OUT OF GROUND EFFECT	8,200 LBS	7,000 LBS	6,400 LBS

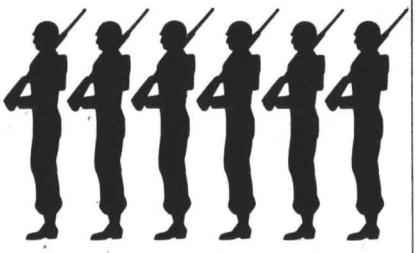
There are physical laws that affect aircraft performance. We must not violate them, for when we do the penalty is usually far more drastic than a court-martial would hand out for a gross violation of Army regulations

not necessarily indicate that more passengers can be carried.

Another UH-1D was on a resupply mission with water and rations to a long-range patrol. Two passengers were carried to offload the supplies. En route to the LZ, the aircraft commander was informed that he could not land as planned in the LZ because of stumps and tall vegetation. He elected to continue his mission and the helicopter was brought to a hover out of ground effect over the LZ. Because of low rotor rpm, he had control difficulty and the tail rotor struck a tree. The helicopter crashed into the landing zone. Investigation revealed that the weight of the helicopter was 800 pounds overgross for hovering out of ground effect.

While it is true the aircraft commander could have aborted the mission, responsibility for this accident must be shared by the ground commander who failed to clear an adequate LZ or advise in his mission request that a landing would not be possible.

AVERAGE DAY RVN	4,000 FT DA
MAXIMUM GROSS	8,900 LBS
OPERATING WEIGHT	6,600 LBS
FUEL 2:10 HOURS	1,100 LBS
	7,700 LBS
	PAYLOAD
	1,200 LBS
	6 TROOPS



Had this been done the pilot could have made allowance for the requirement to hover out of ground effect through adjusting the load, or making two trips if necessary.

The reasons for the loss in rotor rpm were exactly the same as in the previous accident. The aircraft was asked to do more than it was capable of performing.

While discussing flight characteristics, let us address one more facet of this subject. It is true that helicopters can climb and descend vertically and hover at altitude—unless the powerplant fails. At this juncture, we are faced with a well known law—what goes up must surely come down—in this case, rapidly!

All of you know about helicopter autorotations when engines fail. But did you know there are certain conditions under which this maneuver can't be performed with any degree of success? Experimental test pilots, armed with certain engineering data, go out and fly the helicopters to determine these conditions. Then they make a chart. Skid height above the ground is plotted vertically and forward airspeed is plotted horizontally. If the powerplant fails at any point in the shaded area of the chart, a safe autorotation cannot be made. Autorotations are a function of altitude and airspeed. Behind the curve, it's a crash and not an autorotation. The official name for this chart is the height-velocity curve. Aviators call it the *dead man's curve* and it's one of the reasons they draw flight pay.

Note that we didn't say that helicopters will not operate in the shaded area. It frequently is done in RVN, particularly on medevac missions where the hoist is used. This is one of the accepted risks. Just remember the exposure when operating in this regime. Help the aircrew pray that the engine keeps running while they are in the danger zone. If it fails, you will have a helicopter and its occupants in your lap in a hurry.

Let's say the skid height is 75 feet above the ground and the helicopter is hovering at zero airspeed while hoisting wounded troops out of the jun-

gle. So long as the engine continues to function and gross weight for density altitude and wind condition is not exceeded, the crew will be in fine shape. But a loss of power will usually result in a severe crash and fatalities.

If the helicopter is at 100 feet and cruising at 70 knots, it is out of the danger zone. If the engine stops, it can be autorotated. The success of this maneuver will depend on the terrain, the pilot's skill and some luck. If he goes into the jungle or on a mountainside, he'll crash, hopefully soft enough for the occupants to survive. If he goes into a rice paddy and doesn't hit a hidden dike, they'll be okay. If he lands on Tan Son Nhut Airport and goofs, he'll still break up the helicopter, with chances of injury. When missions require operation in the shaded area, be sure the reasons are valid.

There are some other things commanders should take into consideration during mission planning. Rotary wing aircraft are very sensitive to wind. Where possible, every takeoff and landing should be made into the wind. A helicopter taking off into a 2-knot wind can clear a 50-foot obstacle in one-third the distance required had it taken off downwind. Put another way, it requires three times the distance to take off downwind and reach 50 feet as it does to take off into a 2-knot wind.

Wind conditions often make the difference in successful landings and takeoffs in tight LZs. It can even make a difference in the amount of weight the helicopter can carry while hovering out of ground effect. If it is to slingload supplies into a special forces camp where it must hover out of ground effect, knowing the wind conditions at the expected time of arrival would permit maximum use of the helicopter's capability.

The reason that we obtain better performance by operating into the wind is because the windspeed adds to the speed of the air moving over the lifting devices. This produces *more* lift for the same power requirement. Downwind situations complicate matters because the windspeed subtracts from the speed of the air moving across the lifting devices. This produces *less* lift for the same power requirement. The difference in performance is significant.

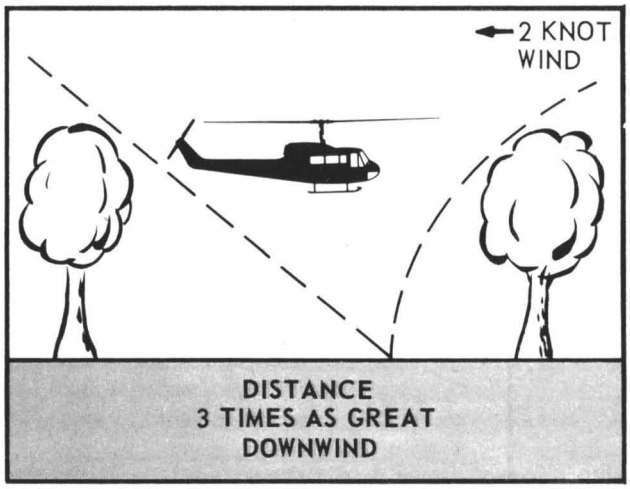
It is a known fact that the terrain and the tactical situation will often dictate the direction of aircraft operation. Sometimes this requires downwind operation. If the aircrews know this ahead of time, they can plan the loads and the approaches to remain within the operating limits of the helicopter.

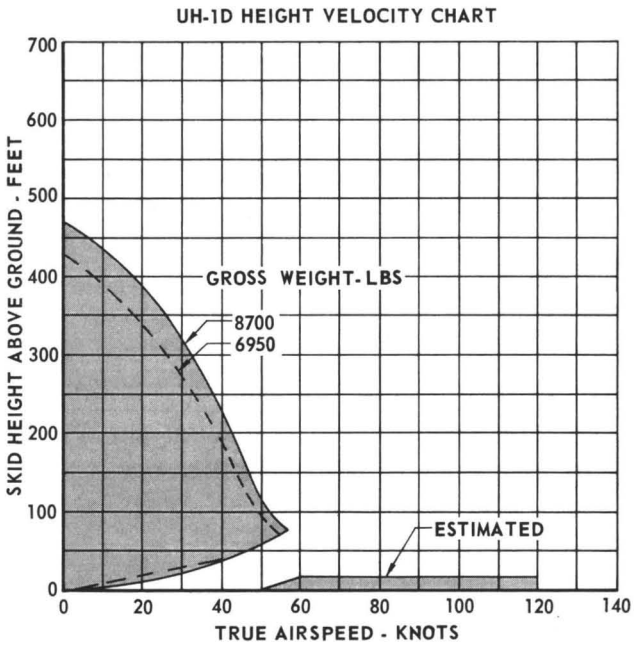
There are times when plans get changed, with some drastic results. A UH-1D was on a troop lift mission from a secure loading area. The pilot computed his load for a takeoff into a 7-knot wind and loaded seven troops aboard. Later he was placed as number three in formation for the takeoff. A request for a check-fire of local artillery was refused, necessitating a downwind departure, without adequate time to readjust the loads. The lead helicopter took off successfully. The second had difficulty, but finally limped off. The third did not make it and crashed, rolling on its side. Investigation revealed that the adverse effect of the downwind takeoff was the sole reason for this accident. One soldier was pinned under the helicopter when it rolled over and was seriously injured. The helicopter was destroyed, at a cost of $228,544.

After the accident, the helicopters remaining on the ground offloaded two troops each, made successful takeoffs and completed their mission.

Wind also has a very definite effect on fixed wing aircraft. The U-6 takeoff performance chart shows the effects of temperature, wind and loads. At 23 degrees and zero wind, it will require 600 feet for takeoff at a gross weight of 4,100 pounds. With the same temperature and weight, only 150 feet are needed if there is a 30-knot wind on the nose. When the airplane weighs 5,100 pounds at 23 degrees and no wind, 755 feet are needed for takeoff. For the same weight at 95 degrees and no wind, 975 feet are needed.

As temperature and weight increase, a longer strip is needed. If there are headwinds which speed up the





airflow over the wings, the airplane can get off in shorter distances. This is valuable information for mission planning, particularly for short strips in the back country.

The terrain from which we operate also affects aircraft capability. In the delta country, hidden dikes are a real menace. They are very difficult to see from the air. USABAAR files contain many reports of accidents where helicopters landed on what appeared to be level ground covered with tall grass, only to have one skid come down on a dike and the other sink into 3 feet of mud and water. This results in overturns, lost helicopters and casualties.

In the Montagnard country, the problem is more clearly identified because of the sloping terrain of the hills and mountains.

Commanders must give consideration to terrain when selecting LZs. Helicopters are designed with a great deal of maneuverability. However, there must be limits to movements of the controls or we would chop up our helicopters with their own rotor blades. An example can be seen in lateral control. To pick the helicopter up from a slope we must compensate with lateral control. If we exceed an angle of 10 degrees, we do not have enough lateral control to bring the aircraft level and it will roll over.

One accident occurred because the pilot failed to correct with cyclic control in order to level the main rotor with the horizon prior to liftoff. How much slope can a pilot compensate for? In a no-wind condition, he can only correct for a 10-degree slope. If he has a crosswind blowing downslope, he can't correct for a 10-degree slope *plus the wind.*

Helicopters must remain at a hover during loading and unloading in terrain where the slopes are too steep. This can also cause the aircraft to be out of ground effect. Aircrews need this information before they try to land loaded helicopters on slopes exceeding their helicopters' capability. The terrain in which you select your LZs has a decided bearing on the helicopter operations.

There is one more important subject to which commanders must direct their attention if they are to have continuous support from their aviation resources—*aircraft maintenance.* The only differences in aircraft maintenance and maintenance of other equipment is a high degree of technicality and the fact that you can't get out and walk when an aircraft stops functioning.

It is easy to become mission oriented to the point that maintenance fades into the shadows of unimportance. We must guard against this pitfall. Operating beyond established inspection limits or failing to provide the downtime required for the replacement of worn parts, dirty filters and other required main-

Aircraft Capabilities

tenance is the surest and fastest way to deplete aviation resources.

Failure to program and foster good aircraft maintenance is disastrous. Accidents which have resulted from improper maintenance or a lack of maintenance contain some valuable lessons. We can learn by understanding the mistakes of others.

When maintenance is rushed and mechanics or inspectors overlook important small items, the results are catastrophic.

A CH-47, down for an intermediate inspection, was scheduled for a resupply mission that had to be flown early the following morning. The maintenance crew worked all night and had just finished the last item of work on the aft rotor head prior to the scheduled takeoff time. The crewchief standing on the ground asked the technical inspector who was inspecting the work to safety a bolt on one of the controls at the lower attaching point while he was up on the work platform. He apparently did and signed off the work.

One and a half flight hours later, the helicopter broke apart in the air and crashed, killing five people. This tragic accident can be traced to a failure to safety one nut on one bolt. It was also determined that a technical inspector signed off the work, but he could not remember actually inspecting the safety of the upper nut, *because he had been so intent on safetying the lower one.*

We called this maintenance error, but was it really? Does haste still make waste? You bet your life it does and that's exactly what you are betting if you don't allow your aviation support adequate maintenance time.

A great deal of effort has gone into the development of the maintenance systems of various aircraft. These systems have proven to be sound guidelines. When followed, they will serve the command well by producing a high percentage of flyable machines.

With proper planning, a predictable amount of serviceable equipment will be available on a day-to-day basis. Noncompliance with regulations pertaining to maintenance of aviation support equipment will produce catastrophic results and reduced combat effectiveness.

We have discussed the capabilities and limitations of aircraft and described the results of failures to comply with requirements for safe operations. Your application of this information will improve the effectiveness of your aviation resources by reducing noncombat losses and thereby increasing mission capability.

WEIGHT	TEMP	WIND	FEET
4,100	23°	0	600
		30K	150
	95°	0	810
		30K	235
5,100	23°	0	755
		30K	205
	95°	0	975
		30K	295

This is valuable information for mission planning. Particularly for short strips . . .

LOW LEVEL LESSONS

ACCIDENT NUMBER ONE

A UH-1H WAS on a resupply mission.

Copilot: ". . . I was flying and approaching the resupply point. Near the end of the approach, one of the passengers advised me not to land. I aborted the approach and made a right descending turn down to the river. I had to turn right because there was a bridge to my left and personnel on the ground in front. I was in the left seat and could not clearly see out the right side. I put the nose down to gain airspeed. The turn was into the wind and I assumed the river would have the least number of obstacles for the aborted approach.

"As I straightened out, I saw a small boat directly in front of me. I did not see it until I had stopped my turn. I immediately pulled collective, but could not clear the boat. I then pulled aft cyclic and the next thing I knew we were hitting the water. I believe the tail rotor hit the boat when I flared and caused me to lose control of the aircraft."

After hitting the boat, the helicopter crashed into the river and sank. Two persons on the boat were killed and three crewmembers of the helicopter had minor injuries.

Investigation narrative: "There was some question as to whether or not the aviators involved were completely certain about who was in command of the aircraft at the time of the accident. Although the copilot was at the controls, he was not the AC. He was acting as pilot and was unable to see clearly out the right side of the aircraft while making the right turn. He had the responsibility of clearing the turn, and it is evident that he failed to do so, as he did not see the boat until rolling out of the turn. Both aviators used poor judgment in making a descending turn. . . .

"The pilot, without justification, allowed his aircraft to reach so low an altitude that it hit the boat no more than 2 feet above the surface of the river.

"Contributing factors were confusion about who was in command of the aircraft and failure to adequately clear for a descending right turn."

Recommendations: "That the operations officer, platoon commander, or other individual assigning missions designate a pilot in command of those aircraft flying without an AC and insure that he understands he is responsible for the aircraft.

"Reemphasis on the importance of crewmembers clearing their side of the aircraft in turns. This includes the crewchief and gunner. . . ."

ACCIDENT NUMBER TWO

OH-13H pilot: "I was flying to build time during transition. I took off and remained in close traffic for two approaches, then departed to the northeast. After flying about 30 minutes, I turned and began flying toward a river. Arriving at the river, I turned and began flying up the valley at 2,000 feet. After 20 minutes, I realized it was time to return to the airfield.

"Because of the uneventful flight up to this time, the way the aircraft was functioning and the complete absence of turbulence, I elected to contour fly down the river. After about 2 minutes of contouring along the river at 60 to 70 knots, the bubble seemed to explode. The next thing I noticed was a wire just ahead. I started a cyclic climb to miss the wire, then began to look for a place to land. I was not really aware of what had happened or how seriously the aircraft was damaged.

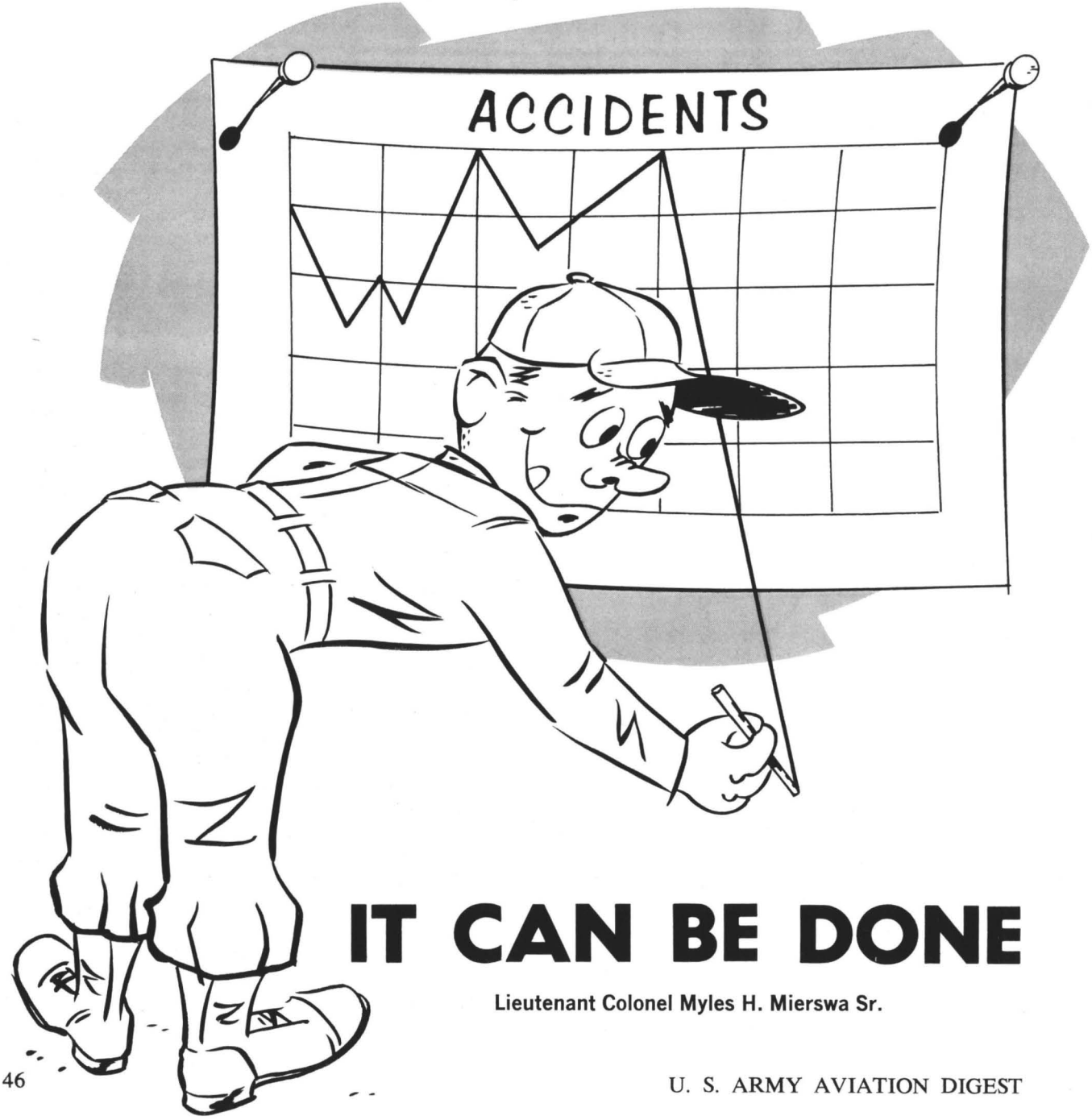
"I made a running landing and skidded approximately 235 feet. After coming to a stop, with the engine still running and what seemed to be normal control responses, I shut the engine down and tried to establish radio contact, but failed. I got out to inspect the damage. After inspecting the damaged components, I ran up the engine, checked the control responses while light on the skids and picked up to a hover. I hovered downstream about 3 minutes and made radio contact, then landed and shut down."

Analysis: "The pilot elected to contour fly in an area with which he was not familiar, and the aircraft struck a wire rope, causing extensive damage."

Flight surgeon: "The pilot had his helmet on with the tinted visor down. This undoubtedly altered his visibility. The sun was shining and he did not believe that the degree of decreased visibility was enough to be significant.

"When the cable hit the plexiglas, it exploded and many small pieces were thrown back into his face, but the visor protected him and he was not injured."

LTC Mierswa entered the Army as a private in 1946, graduated from Fordham University with a BS degree in 1951 and was commissioned in the Regular Army after being designated distinguished military graduate by Fordham. He is a graduate of the Command and General Staff College, a dual rated Senior Army aviator, and has served three tours in Vietnam. His decorations include the Silver Star, Legion of Merit, Distinguished Flying Cross, Air Medal with 11 oak leaf clusters, Army Commendation Medal with one oak leaf cluster and the Purple Heart with one oak leaf cluster. He is currently serving as instructor in the Department of Joint, Combined and Special Operations at the Command and General Staff College.



IT CAN BE DONE

Lieutenant Colonel Myles H. Mierswa Sr.

"MAN, THIS IS the greatest outfit with the best safety record in all Vietnam! You'd better believe it!" What the aviator who said this really meant was that he and the other members of his battalion were extremely proud of their safety record and professional team.

No matter how they say it, most Army aviators are proud of their units. And a good safety record can be as important a morale factor as a good combat record. Unfortunately, too many units don't emphasize the safety aspects in combat, and aviators think the rule book is thrown away as soon as they cross the 180th Meridian. But wise commanders will incorporate strong safety policies in their plans, implement them in day-to-day operations, and personally supervise them.

Come now, you mean to tell me battalion commanders in combat have time to supervise safety programs?

Yes, believe it or not, it is very easy to put a handle on the safety program. As you walk around the airfield checking operations, maintenance, airfield police or any of the other tasks of a commander, all you have to do is keep your eyes and ears open. Ride along as an AC or pilot in one of your ships during an operation. What you see and hear will astound you.

During my first walk-through tour of the battalion area I found no less than three major safety hazards, all potential killers. Yet, all required only minor corrective action.

The first thing I saw were two gunships bouncing through the parking area, struggling to get to the runway. Reaching the runway four bounces later, they wallowed off the ground and away on their mission. I asked, "Tell me, Major, is it normal for your gunships to struggle so to get airborne?"

"That was an easy takeoff, sir!" he answered. "You should see the way they have to struggle later in the day."

I knew the density altitude was about 6,000 feet, but I felt we should be getting better performance than that. "Let's take a look at one of your gunships."

The young crewchief reported and began to show me his helicopter. He was proud of it and, believe me, it was well armed and equipped. In addition to the normal load of rockets and 7.62 minigun ammo, each door gunner had a full box of linked 7.62 for the door guns, an M79 grenade launcher with a box of ammo and each carried his M16 with six clips of ammo. The pilots were also well equipped with sidearms and an M15 rifle.

A box of fragmentation grenades and two boxes of various colored smoke grenades were aboard. Each crewmember had a chest protector, plus a flak vest. Down below the pedals in the chin bubbles were two additional flak vests to protect the pilots from any rounds coming up through that area. As any good crewchief is prone to do, this lad carried his complete toolbox, an ammo can with gun cleaning equipment, four or five quart cans of hydraulic fluid and engine oil, and a grease gun. In case they were forced down, each carried a personal survival kit. Also aboard were a large aircraft jungle survival kit, two cases of C rations, five gallons of water and other assorted items. Stowed in the rear radio compartment were two sleeping bags, several sets of fatigues, some rags, paint brushes, cleaning compound and wax.

Most of this extraneous gear was made up of nice-to-have items. The crew would never have a chance to use most of it. If they were forced down, they could not carry it. If they crashed in the mountainous jungle area in which we operated, the aircraft would probably explode on impact. If they were lucky and were able to land on a road or cleared area, their wingman or a nearby slick would probably land and immediately evacuate them. As a matter of fact, during the next 6 months, each of these probabilities occurred.

To cure this hazard, a checklist of essential items was drawn up by the gunship platoon leaders and reviewed by the company commander, the safety officer and myself. It was posted in each gunship and nothing else was permitted to be carried. Several unannounced followup inspections were conducted by the commanders and the safety officer. It worked. The gunships were 800 pounds lighter and the load factor was greatly reduced, with a substantial gain in takeoff capability. In fact, we were able to increase the normal mission fuel load to allow an additional 15 minutes of flying time.

The next obvious hazard I saw consisted of junk, trash, brass, and grass cuttings in the helicopter revetments. Every time a helicopter came to a hover, rags, grass, bits and pieces came flying through the rotor blades, swirled through the air and settled back down to await the next helicopter. That is, most of it settled back down. Some gathered in engine intake manifolds.

Immediately a foreign object damage (FOD)

IT CAN BE DONE

SOP began to form in my mind. After it was published, disseminated and enforced, this hazard was reduced and, eventually, almost eliminated. It wasn't as easy as most safety measures and required full cooperation from pilots, crewchiefs, mechanics and commanders. However, after a few compliments from high ranking visitors on our nice neat heliport, you could hear members of the battalion reminding transient crews to keep our revetments clean.

Before reaching the operations building on that first day, I heard the early morning mission returning to the base field. As a new commander, it really stirred my heart to see a line of helicopters from my assault helicopter company flying toward the field. Moments later, my stirring heart was in my mouth. The company flew over the field, peeled off in a tight turn to a low hot base over the fence, flared one behind the other and, after much bobbing, weaving and Yo-Yo type hovering, settled into a cloud of dust near the refueling area. I asked the leader, "Tell me, Captain, why the wingover and the hot approach?"

"It's good practice for combat assaults, sir. We always make assault type landings. Good training, and it separates the men from the boys."

"How big is the largest LZ in this AO?"

"Not very big. I'd say not much bigger than two or three-ship size. But they're real bears to get into and out of, with high trees on all sides. We don't get too many opportunities to practice those real hot approaches, so we do them here where we have plenty of room."

Before I could reply, our conversation was interrupted by the noise of a platoon of choppers scrambling for an LRP extraction mission. Here again, I saw an unnecessarily dangerous technique. They literally jumped off the ground to a high hover, immediately rolled off their ground cushion and, with their noses pointed at the ground, charged forward. At about 10 feet and 80 knots, the noses pulled up and they climbed like a group of homesick angels.

"I suppose that's the normal takeoff technique for a quick scramble, right, Captain?"

"Yes sir, it's good for the morale. And since we don't let pilots with less than 300 hours make those takeoffs, it's a good chance for the old pros to show the new guys what they can do."

Needless to say, this practice was corrected immediately. *All,* and I mean *ALL* takeoffs and landings to the base field or any other secure area would be Fort Rucker type departures and approaches. This was enforced even with transient aircraft. On several occasions, pilots were invited not to come back if they couldn't comply.

After this, there were no tail rotor or blade strike accidents. In fact, we had no accidents at all for 108 straight days.

That sounds great, but how are you going to prevent accidents? They're going to happen and there's not much you can do about it.

As a commander there is a lot you can do about it. You must see all, know all, and be willing to do something about it. You must use every member of your staff and every commander to prevent accidents. You must convince them and every aviator, crewchief, mechanic and door gunner that there is no such thing as an unavoidable accident. Make them safety conscious and make them alert for any practices, techniques or areas which could contribute to accidents. The best way to acquire laurels for your combat prowess is to have combat-ready aircraft to accomplish your mission. The only way to attain the required availability of helicopters is to have a good maintenance program *and no accidents. And the only way to have no accidents is to prevent them.*

You're being unrealistic. You've got to accept a certain number of accidents. It may be one a week or two a month, but to say you won't accept any is unreal.

It is amazing that every commander I've ever known who has been willing to accept a certain number of accidents per week, per month or so many flying hours filled their quotas. Most of the time, they exceeded their quotas.

Remember, there are only three people who can directly cause accidents—the man who manufactures the equipment, the man who maintains the equipment, or the man who operates the equipment. You, as the commander, have direct control over two of these three people. Incidentally, the two you have control over cause more than 90% of all accidents.

When your unit starts setting safety records, every man in the unit will strive to keep the record going. No one wants to be the first to have a record-stopping accident. Pretty soon, you and your safety officer will be getting suggestions from your people on how to keep your accident-free string going. You'll hear your safety problems, accomplishments, and records discussed in the line shack, ready room and even at the bar. It will be discussed in bull sessions as much as your combat achievements. The end result will certainly improve your unit's combat capabilities, aircraft availability and morale.

Don't tell me it can't be done. It has been done. WE DID IT!

Emotional Stresses Lead to Cockpit Anxiety

PILOT OF LIGHT HELICOPTER: ". . . I saw a large open field away from homes and livestock and decided to practice a tactical reconnaissance. I descended to about 300 feet and began a high reconnaissance. I did not intend to land. I was only going to practice looking for obstructions at a strange field from a safe altitude, not a true low reconnaissance.

"I passed along a treeline at about 40 knots, gradually descending to about 300 feet. I saw no obstructions or obstacles and made a short climbout. I then descended in a wide turn along the treeline for a low reconnaissance. I leveled off and turned for a second pass over the field at about 100-150 feet and 40 knots. I was making a gentle left turn.

"I had turned my attention from in front of the aircraft to the field when suddenly I felt something was wrong with the aircraft. I was quite apprehensive, but unaware of any loud noises or unusual vibrations. As I was lined up on the field at this time, I decided to descend into the field which I could see was clear and safe. I descended toward the approximate center of the field, intending to land as soon as possible and find out what was wrong. The flight path to touchdown was near a normal descent angle, but was more a direct flight to a spot rather than a deliberate landing approach.

"I remember no violent control movements. My intention was to get down as smoothly as possible. I did not violently alter the flight path or speed, but continued in the general path. I started a flare to stop forward motion and the next thing I remember is contacting the ground with a slight bounce and twist. I immediately shut everything off . . . I didn't think there was any damage because the bounce was slight, then I heard a grinding sound and thought, 'I got the tail rotor!' I looked out and saw the damaged tail boom, checked to make sure everything was off, got out and disconnected the battery. . . ."

Investigation board analysis: ". . . the angle of descent was approximately 22 degrees, at or about 40 knots. While terminating, the pilot flared in a tail low attitude, causing the tail skid to make first contact. The combination of flight path, tail low flare, airspeed and lack of sufficient pitch in the main rotor blades caused a hard landing, and the main rotor blades severed the aft tail boom section and component parts. . . . The aircraft continued forward, bouncing and twisting on the main skids, and came to rest upright. The pilot did not apply sufficient pitch and power to stop the sink rate. . . .

"The pilot had not flown a helicopter of this type and model for a period of 50 days before the accident. He had not been given a currency ride, as required by AR 95-4. The aircraft was on loan to the pilot and the owning unit failed to ascertain whether the pilot was current in this type and model, in accordance with the current unit SOP.

"All systems and controls of the helicopter were inspected and found operational. There was no failure or malfunction involved."

Flight surgeon: "There were a number of psychological stresses in the pilot's recent past. Two of his close relatives died during the previous 5 months. For the past 2 years, his wife had suffered recurrent infections, which culminated in an operation about a month before the accident. She had a stormy postoperative period . . . They decided that work might help her recuperation and she took an apartment near her job in order to conserve strength, leaving him with the major responsibility for their children for an extended period. During this time, he and his wife became increasingly estranged. At the time of the accident, he probably had his alarm mechanisms aroused by this estrangement and was predisposed to the sudden onset of anxiety.

"Four years before this accident, the pilot was flying a fixed wing aircraft which developed a strange noise in one engine. He landed at the nearest field and remained overnight while a minor repair was made, then flew back to his home field without difficulty. During his next flight in the same aircraft several days later, the engine disintegrated because of a stuck valve which caused a hole to be burned in a piston. He felt that this sequence of events may have raced through his mind when he had the feeling that his helicopter wasn't flying well and this perhaps influenced his decision to put it on the ground as soon as possible. I personally doubt that his action would have been so precipitous had his alarm mechanisms not been aroused by his family stresses. In this preoccupied state, his flying technique was adversely influenced and he made a hard landing."

PEARL'S
personal equipment and rescue/survival lowdown

Dear Pearl:

In reading your article in the November 1968 issue of the AVIATION DIGEST on the subject of survival gear, I note that you request questions on the subject.

My present activity with the ROK Army involves this area and I would like to request your assistance. I work with UH-1H helicopters and request FSN, PN and cost of body armor for aircrewmembers for this helicopter. Also request same information for seat armor other than pilot seats. Source code, procedures and related information in the area of armor for this activity would be much appreciated.

G. M. Perry, DAC
Hq KMAG TC
APO SF 96302

Dear Mr. Perry:

The nomenclature (NOMEN) and Federal Stock Number (FSN) of personal body armor appears in Supply Bulletin (SB) 700-20. The costs were extracted from the Management Data List of the Federal Supply Catalog. The information on the armored seats was furnished by the U.S. Army Aviation Systems Command, St. Louis, Mo., commodity managers. The only seats in the UH-1H that are considered armored are the pilot's and copilot's. The other crew and passenger seats are not armored, but there is a UH-1 gunner seat armor that can be temporarily strapped on any crew or passenger seat.

There is some armored seat information on page 163, TM 55-1520-210-35P-1. During a conference at USAAVSCOM on 4 April 1969, it was proposed by USABAAR and agreed upon by USAAVSCOM that armored seat data would be provided in the next revised publication of TM 55-1520-210-10 and -20.

PERSONAL BODY ARMOR

NOMEN	SIZE	FSN	COST
Body Armor,	Short	8470-935-3183	$111.00
Small Arms	Reg	8470-935-3184	120.00
Protective (Front w/Carrier)	Long	8470-935-3185	134.00
Body Armor,	Short	8470-935-3192	202.00
Small Arms	Reg	8470-935-3193	215.00
Protective (Front and Back w/Carrier)	Long	8470-935-3194	248.00
Insert, Small	Short	8470-935-3174	91.00
Arms Protective	Reg	8470-935-3175	95.00
Body Armor (Back)	Long	8470-935-3176	103.00
Insert, Small	Short	8470-935-3177	88.00
Arms Protective	Reg	8470-935-3178	97.00
Body Armor (Front)	Long	8470-935-3179	111.00
Vest, Small Arms	Short	8470-999-1473	24.50
Protective Body	Reg	8470-999-1474	24.50
Armor	Long	8470-999-1475	24.50

ARMORED SEATS

Pilot—FSN 1680-947-3440, PN 178061-3, Cost $484.00

Copilot—FSN 1680-947-3441, PN 178062-3, Cost $484.00

UH-1 Gunner Seat, FSN 1680-067-8208

Pearl

Dear Pearl:

Request information on individual survival vest and/or individual survival kit (leg type). If survival vest or kits are not authorized for units within CONUS, we request information on day/night flares, penguin gun type flares, strobe lights and URC-10 emergency radio.

CW2 Daniel L. Britt
Supply Officer
D Troop 3rd Sqdn 1st Cav
1st Armored Div

Dear Mr. Britt:

Survival Kit, Leg Holster, Individual (FSN 8465-935-4728) was classified "Standard A" in April 1968 and is authorized CONUS units. A production contract has been in the process of negotiation since the item was type classified, but never concluded. This does not, however, preclude you from requisitioning the item. Although the item has not yet been included in the publication, CTA 50-901 will be the authority. A list of the contents is attached (see page 53, December 1967 issue of the AVIATION DIGEST). Since this kit is not readily available in supply channels, I am providing the other information you requested also:

Signal, Smoke and Illuminating (FSN 1370-309-5028). Programmed for and procured like any munition.

Signal Kit, Personnel Distress (FSN 1370-926-9387). Authority: CTA 50-901.

Light, Marker Distress Type SDU-5/E (FSN 6230-067-5209). Component of lightweight survival kit. Authority otherwise: TOE.

Radio Set, AN/URC-10 (FSN 5820-858-5721). Authority: TOE.

Pearl

Barbara Eden
starring in NBC's
"I Dream of Jeannie"

Said this beauty to the airmen,
Who fly in a far off land,
"I hope you'll wear the kits, friends,
Survival may demand.
Though you find it clumsy and hot,
And would much prefer to stow it,
Believe me, unnecessary it's not!
And guys you'd better know it!
We'd love to have you back with us,
When your tour is done.
So wear your kits without a fuss,
And hurry home for fun!"

SEPTEMBER

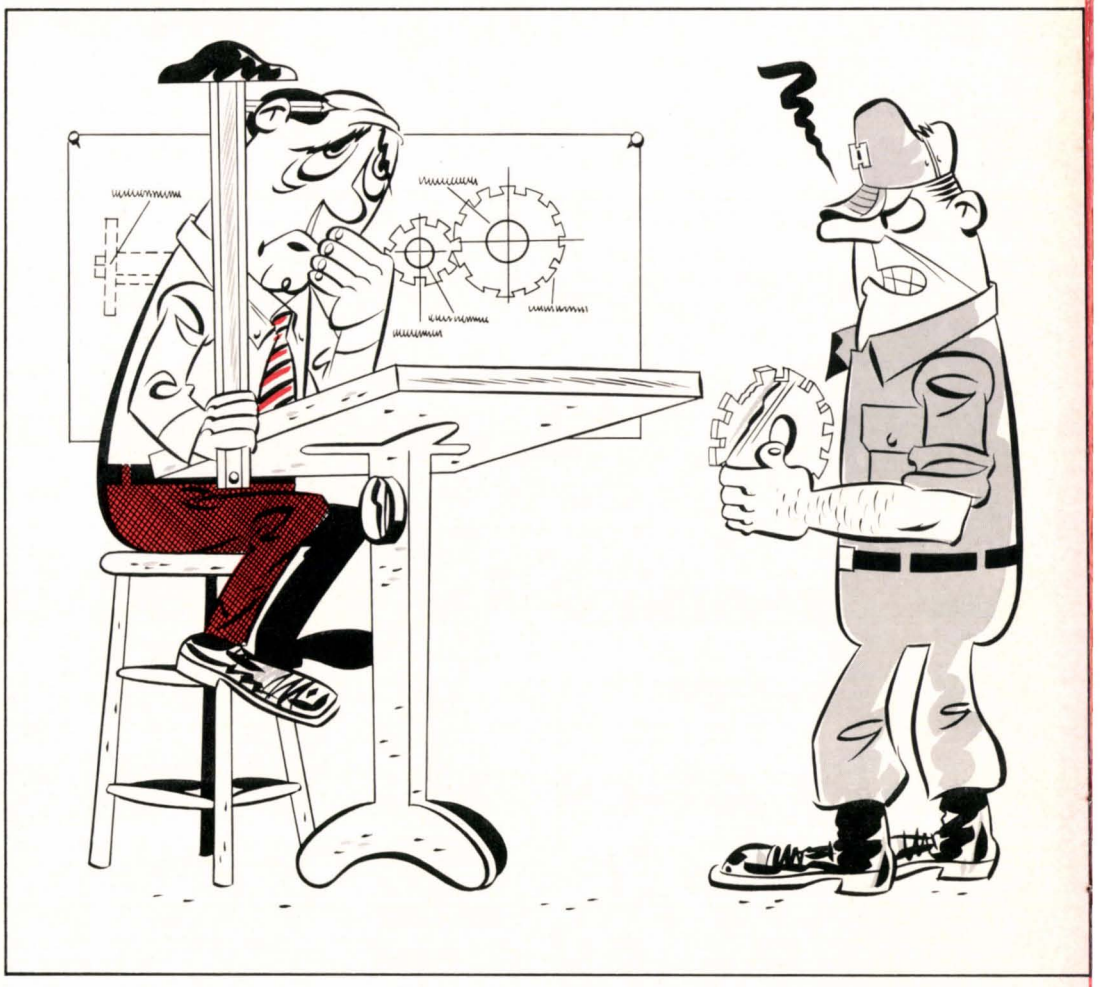
SUN	MON	TUES	WED	THU	FRI	SAT
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

PLEASE CUT ALONG LINE AND DISPLAY IN PROMINENT PLACE

It is most difficult to explain to a maintenance officer the failure of a gear designed to take more than the load limit that would ever be applied

THIS ARTICLE WAS written to provide Army aircraft field maintenance personnel with a better understanding of fatigue analysis and causes of in-service fatigue failures. It was also written to provide component designers with a better understanding of field maintenance problems in maintaining and repairing critical life components of helicopters.

The majority of in-service fatigue failures of rotary wing aircraft components comes from deficiencies in or lack of attention to detail design, faulty production techniques and quality control, and inadequate direct and support maintenance of finite life components. Time and again, teardown analyses of failed components have revealed failures caused by undercuts in material, sharp machine radii, faulty material (based on specification requirements), notches, nicks, scratches, etc., on highly stressed components. Many of these failures could have been avoided by more concentrated effort on detail design, better control of production processes,



better quality control and more attention to quality maintenance.

The common approach to solving deficiencies or failures of components or structures, believed caused by fatigue, has been to beef-up the structures or select new materials with better fatigue properties and submit Engineering Change Proposals as the *cure-of-all-evils*. There have been many instances where such an approach has not solved problems and extensive qualification testing and failure analyses were required before solutions were found. When three or four Engineering Change Proposals are required before a problem is resolved, there is convincing evidence that little attention was given to detail design or production techniques in making the modifications.

One problem that causes neglect of detail design is that designers of mechanical systems subject to complex operational conditions are caught in two conflicting cross-currents of design philosophy—conventional design by criteria based on seemingly factual safety factors, and the purely statistical concept of reliability based on a mean time to failure. For example, it is most difficult to explain to a maintenance officer who just discovered a gear failure in one of his helicopter transmissions that the margin of safety of that gear was 1.5, 1.7 or 2.0 over the limit load that would ever be applied. To the maintenance officer, the gear failed so he should rightly think it had a minus margin of safety. This becomes even more frustrating when the report responding to his Equipment Improvement Report (EIR) says he has an isolated case, or that a teardown analysis will be required to determine the cause of failure.

On the other hand, if the designer turns to engineering references for guidance in calculating allowable loads, he will find frustrating discussions concerning load ratios and safety factors on strength (for ultimate load design) or on finite life (for fatigue design), with frequent references to such vague terms as *normal operating conditions, reasonable safety margin, extremely remote risk,* etc. If he turns to reliability references for design factors, he will be overwhelmed by complex statistical theories related to oversimplified models with little relation to the system and its operating environment. Or he will be faced with crude statistical methods based on nothing more than an assumption.

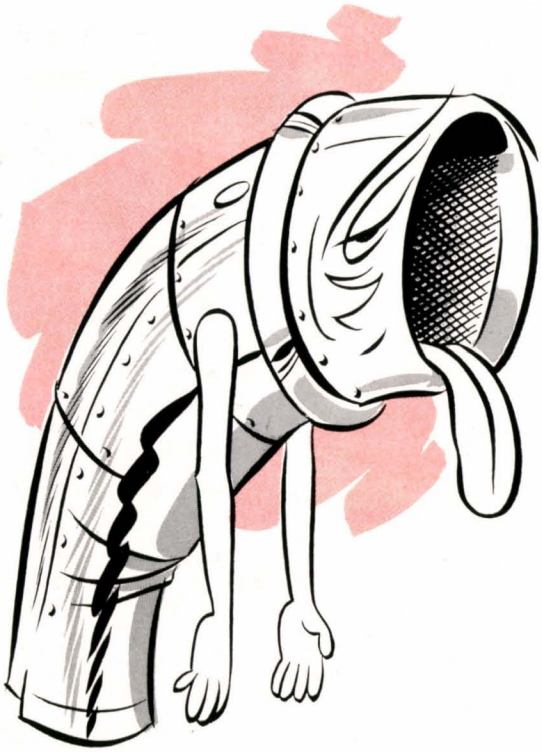
The increased complexity of redundant mechanical structure with seemingly factual safety factors, as well as unknowns of operating loads during peculiar operating conditions, reflects the fact that modern systems cannot, in general, be designed for infinite or a confident finite life. When you add to this the possible faulty in-process or production techniques of manufacturing and the possibility of substandard maintenance of fatigue (finite life) components in service, it becomes even more convincing that there is no such thing as an infinite life component on a helicopter.

This puts the component designer, as well as maintenance personnel, in frustrating positions. The designer is aware of the inadequacy of the conventional engineering design approach, with respect to design for a specified operational life. But he is unable to use a purely statistical reliability approach because reliability measuring techniques are not appropriate for the design of structures or parts that can be tested early enough in development, in sufficient quantities, with built-in environmental deficiencies, to make reliability predictions, based on tests, accurate. Maintenance personnel expect finite life components to last for a specific period of operational life. But when they fail at one-fourth, one-half, etc., of that life, a precautionary attitude of early

Factors Contributing to Fatigue Failure of Aircraft Components

William H. Barthel
U. S. Army Aviation Systems Command

The extent to which structural parts and components are designed for fatigue is determined by the fatigue sensitivity of the component



replacement for any cause increases the replacement rate and makes the problem even more complex.

It appears that one of the most urgent tasks of component designers, for improved fatigue life and reduced premature removal, is development of an integrated approach to structural design, qualification testing and in-service environmental conditions that combine the useful features of safety factors (engineering), a reliability (statistical) approach to failure rates and substandard maintenance conditions that can exist in field operations for designing and qualifying components for operational use. As a starter, this could be a procedure for estimating mean service lives of components, based on actual operational conditions, with a little Murphy's Law thrown into the estimate. This assessment of service life would include factors covering materiel and tolerance deficiencies, marginal quality components and marginal maintenance. For primary structures, including all finite life components, in addition to the conventional safety margin (safety factor or margin of safety), there would be a predicted in-service flying hour life for such components. This life would be based on a specified critical operational load spectrum, marginal critical dimensions, in-service wear tolerances and materiel conditions that include certain less than satisfactory field maintenance inputs. Such an in-service flying hour predicted life would improve the ability of using activities to predict and logistically support in-service fatigue and materiel failures and provide field maintenance personnel with a more realistic safety factor.

While all aircraft structures, such as transmissions, rotors and control systems, down to the simple sheet metal brackets, are subject to fatigue and in-service materiel failures, the nature of loading the structure, servicing it, repairing it, and overhauling it makes the structure or component more prone to failures at a life level below that considered compatible with the complete weapon system life. As a result, the day is now here when fatigue integrity, ease and simplified maintenance, minimum close tolerance components, and minimal moving parts are major factors in the selection process of competitive weapon systems. The quantity of moving parts in a transmission, gearbox, etc., the number of bearings in power trains and control systems, the number of seals in hydraulic systems and the complexity of a rotor system all affect the complexity and risks of systems evaluated.

Better consideration of lessening these factors in preliminary design, as well as providing reliable estimates of mean service life of such components, with a reasonable confidence level, would increase confidence in accepting complex subsystem designs and reduce the calculated risk factor of such designs.

Fatigue design of complex systems is really a problem of reliability analysis, rather than of stress or strength analysis, after the safety factor is determined and adequate bench testing has been performed. Fatigue design differs from ultimate load design by the complexity and resulting vagueness of the correlation of load, stress, carrying capacity, in-process or in-production developed deficiencies, and field maintenance deficiencies that can be built into the component during servicing and operation. A designer may say he has no control over the last two, but he does have a control during initial design of lessening the probability that they will occur.

The extent to which structural parts and components are designed for fatigue is determined by the fatigue sensitivity of the component or structure. Fatigue sensitivity is defined as a measure, at a specified service life, of the probability to fail in fatigue rather than under a single application of the ultimate load. In other words, fatigue design is not just based on a load-life cycle at various stress levels. It is, from a practical standpoint, based on tolerances, quantity and stress level of moving parts, wear rates and complexity of production, as well as maintenance. These probabilities, plus many others, depend on operating conditions and the expected service life.

The fatigue sensitivity of a component cannot be specified independently of such conditions. The same system may be fatigue insensitive under one set of conditions and fatigue sensitive under another. Under conditions of low fatigue sensitivity, it is necessary to design only for a specific operating life in fatigue. Fatigue design may simply be the elimination, by constructive means, as well as a designer's experience, of the most obvious sources of crack initiation and sharp edges—design that will reduce subpar maintenance, etc., to a minimum, to avoid a possible reduction of the expected fatigue life to within the range of the expected life of the total system. Detail design for fatigue, supplemented by extensive fatigue testing, is necessary only for medium and high fatigue sensitive components for which fatigue failure is the expected type of failure. Tests of full scale systems are an integral part of fatigue design.

Fatigue design for finite life must be concerned with a rational measure of reliability, considering production processing deficiencies, as well as possible subpar maintenance. A speed-up measure is provided by the probability of failure-free operation during a specified service life under ideal conditions. With respect to the effect of operating loads on fatigue life, the relation between operating and design load ranges and fatigue life must be based on a rule of accumulation of fatigue damage in materials, the validity of which has been justified by experimental tests. This is referred to as "The Accumulative Damage Theory."

With the aid of such a theory, fatigue lives associated with load ranges, specified by measures of intensity of stress amplitudes, of mean stress, and of dispersion and shape, can be predicted for different materials. The effect of any change in fatigue design criteria, or in operating conditions, can be expressed in terms of the order of magnitude of the change in fatigue life. Any time an aircraft takes off in an overgross weight condition and enters one of the critical stress conditions, the fatigue life of certain critical aircraft components is reduced.

The significant factors that jointly determine fatigue life and performance are:

1. Operating loads
2. In-production quality processing
3. In-service quality maintenance
4. Fatigue performance of material
5. Structural forms and connections
6. Residual stress
7. Fretting and corrosion

Each of these factors should be considered in component design in terms of its effect on fatigue life and premature failures, based on comparative fatigue tests on material specimens or representative connections, and on suitable analytical procedures. If comparative test data are not available, the effects must be estimated on the basis of full-scale test or performance records. A more critical and more complicated factor to predict is the effect of the program of maintenance imposed either in the form of periodic inspection and repair, or automatic periodic replacement of fatigue senstitive parts without inspection.

Comparative fatigue performances of materials must be evaluated by fatigue tests under identical stress spectra on notched specimens or, preferably, on representative models of connections of the respective materials, from which the effect of the material on fatigue life and scatter is directly obtained. The result of constant load amplitude tests is less relevant than those of randomized spectrum tests and neither results are as reliable as fatigue tests under actual operating conditions.

Consideration of the basis of structural design involves two principal aspects: (a) the relation of the design stress intensity for ultimate load and that for maximum fatigue load, and (b) the degree of redundancy. While the maximum fatigue load is usually specified as the load intensity that is expected to occur between 10 and about 100 times during the design service life, the ultimate load is specified in terms of an extreme load that the system should be able to sustain in the case that operation under unlikely extreme conditions cannot be avoided.

In other words, the cumulative damage theory is based upon the assumption that fatigue damage is proportional to the ratio of the applied cycles under some condition, if cycling was continued to failures. The statement of the theory in that failure corresponds to the conditions:

$$\frac{n.}{N.} + \frac{n_2}{N_2} + \frac{n_3}{N_3} + \ldots . ni = 1$$

where n equals the number of applied cycles at some condition and N equals the number of cycles to failure if the part is cycled to failure under that condition. Tests of the validity of the theory show that the predicted life of a part under a variety of loads may be in error as much as $\pm$ 50%. Adding the probabilities of in-production processing deficiencies and in-service substandard maintenance could even increase the error of fatigue life prediction even more.

In summary, both laboratory tests and service experience have shown that any manufactured part will fail after repeated application of a stress substantially lower than the stress at which failure would occur under continuously increasing load. Lack of attention to detail design, faulty production or quality techniques, and inadequate direct and support maintenance of fatigue components will increase the failure rate of such components at low stress levels.

The problem of the designer is not just one of designing a component to a hypothetical safety factor, but to design a component in such a way that minimum in-production and in-service handling and servicing will be required. To estimate the fatigue life of a production part on the basis of the performance of laboratory specimens may introduce considerable error if other uncontrollable factors are not considered. Therefore, it is wise for a designer to realize the limitations of fatigue theory, operational maintenance effects and production processing errors possible on complex components and maintain an adequate ignorance factor.

In those cases where fatigue problems exist or are predicted to exist, the best approach to the problem is to subject an actual part to a test in which the loading used and the number of cycles required give reasonable assurance of adequate service life. Even then, an "ignorance factor" of 1.5 or more should be added to the service life margin.

Even though aircraft field maintenance personnel are not trained to recognize finite life components, concentrated effort in performing maintenance on such components will, in the long run, reduce premature failure rates. Every man who works on a highly stressed part should try to remember the following: "Prevention is always the best cure and dirty hands maintenance is not good preventive maintenance." Whether it is in the design caused by lack of attention to details, whether it is on the production line where poor production processing or poor quality exists, or whether it is in-service subpar maintenance, an induced defect on a finite life component carries a red flag which means danger. This danger could cause a premature failure or premature removal which both contributes to in-service maintenance headaches and reduced availability of a weapon system.

the type, quality and quantity of lubricants are matters of increasing importance

when a lubricant is **NOT** a lubricant

PERHAPS ONE OF the oldest principles in dealing with machines is that a drop of oil in the right place makes a very great difference in operation. Earlier machines did not seem to object much to the type of lubricant, but responded gratefully (for a time at least) with reduction of squeaks, friction, and wear. However, as time passed, the simple machine was compounded for greater performance. The environment changed too, with extremes of temperature, speed, and load not uncommon. Obviously then, the type, quality, and the quantity of lubricants (greases, oils, preservatives, etc.) became a matter of increasing importance to meet the needs of the machine. For example:

High speed bearings require a relatively low viscosity lubricant. Heavy lubricants produce excessive heat which can induce premature bearing failure.

Some hydrocarbons absorb moisture, causing corrosive attack of the wetted metals. While this is not an important point on some applications, serious failures can be produced on intricate, close-tolerance devices such as jet engine control components by the use of lubricants with excessive entrained moisture.

The type and amount of lubricant must be compatible with all of the materials with which it comes in contact. It does little good to lubricate a bearing perfectly if the adjacent seal is destroyed by the lubricant. Similarly, it does not make sense to use unnecessarily large quantities of lubricants which will contaminate and jeopardize the operation of another system vital to the machine. Hence, the amount of lubricant is often as important as the type. (There is a basic fallacy to the phrase, "If a little is good, a lot is better!")

The lubricant must be capable of withstanding the temperature of its operating environment and still remain a lubricant. A good low-temperature lubricant is seldom, if ever, a good high-temperature lubricant. Improper use of lubricants with respect to temperature requirements has resulted in carbonization of the lubricant, producing seizures, heavy wear, and system failures. Several of the current high-temperature lubricants feature a molybdenum disulfide additive in a silicone vehicle or carrier. These lubricants do not carbonize or break down within their rated temperature. However, if such a lubricant is diluted (or "thinned") with a hydrocarbon oil such as Mil-L-6081, the effective temperature rating is lowered considerably. As a result, the lubricant may carbonize or break down during service, with consequential bearing failure or other damage.

These are just some of the factors which must be considered prior to the selection of a lubricant to meet a specific need. The moral of the story:

Use only the specified type and amount of lubricant. If the type required is not available, obtain the necessary authority before substituting.

Do not use unauthorized mixes, thinners, preservatives, or additives. The results could produce bearing failure or other damage.

Be sure to check specifications and stock numbers on new containers.

Be sure that secondary containers (such as oil cans) are clean, guarded against contamination, and are well marked for content.

—*GE "Jet Service News"*

ACCIDENT NUMBER ONE

A UH-1D WAS on a maintenance test flight. Pilot: ". . . I hovered for about 10 minutes, checking out the pedals. The controls were normal and I went to the pad and took off. I climbed to 1,500 feet and flew to the test flight area. I made autorotation and maximum power checks and was in straight and level flight at about 1,200 feet when I felt a vibration in the pedals. I mashed the pedals and found that the tail rotor had failed. I called the tower, told them that I was going down and gave my approximate location.

"I flew for a short distance until I was over an open area, lowered collective and started a descent into a marshy area, with about 60 to 80 knots airspeed. The aircraft was still handling OK.

"I decided not to make a running landing because the skids would sink in the mud and the aircraft would nose over. I flared and as the airspeed reached about 30 knots, the aircraft began to turn right. I closed the throttle to flight idle and the turn seemed to stop, but we were moving in a path along the ground to the left. I held it off as long as I could and moved the cyclic full right, but could not stop the left movement. The aircraft touched down gently, then tipped over on its left side. The rotor blades struck the ground and stopped almost immediately. The engine was still running, so I turned off the fuel and battery. . . ."

"What made you decide to land there rather than return to the airfield?"

". . . I thought of going back, but I didn't know what was wrong in the tail rotor, so I decided to land where I was. I was afraid something might break the pylon. If this happens, you have c.g. problems. That's really why I decided to land there."

"Did you enter autorotation?"

"I reduced collective, but I didn't reduce power."

"Were there any unusual vibrations after you had confirmed tail rotor failure?"

"No. I got a vibration for about 5 seconds in the pedals, then it smoothed out."

Mechanic: ". . . The pilot said he felt a vibration, but I felt a slight jerk. The tail started to the left and went down. . . . As soon as the aircraft hit, it turned over on its side. I hit my head against the side and was real dizzy. . . ."

"Where were you riding?"

"Left front seat."

"Was there any fire?"

"No. A lot of fuel seemed to be coming out and there was some smoke. We got the fire extinguisher out."

"Did you have your helmets on and did they stay on?"

"Mine stayed on. It has paint on it where it hit the side and it hit hard. That helmet does help!"

Questions asked maintenance section leader: "Were you there when this aircraft was pushed out for the test flight?"

"Yes."

"Did you perform an inspection and button it up before the test pilot arrived?"

"Yes. We pull our own inspections, then get the technical inspector (TI)."

"Did the test pilot ask you to open up the cowling or doors during his preflight?"

"We keep the engine cowling open, check for leaks and look down the transmission."

"How about the tail rotor drive shaft?"

"It's closed. The TI won't stamp off for cowlings unless everything is closed."

"Is any open cowling considered a red X condition?"

"Yes."

"After the TI checks everything and is satisfied that the torque is correct, what do you do?"

"I go with the TI, then somebody starts closing the cowling. We try to get this done as fast as possible."

"When you're buttoning up, are you always there or is the TI there?"

"The TI isn't always there, but I am."

"After the TI has looked at it and is satisfied, what is the procedure to make sure everything is cleared?"

TOOLBOX

"I have my men go through it and button it up. Then I check it and double check it."

"What about foreign objects?"

"I check for that all the time."

"You personally supervise the closing of all work area cowlings?"

"Yes, I don't stand right over them and make them do it, but I check to make sure nothing is in there."

"How do you account for tools and special tools? What procedure do you have? How are you sure nothing is left in there?"

"We don't check the tools. Special tools are turned back in."

"How soon do you turn them in?"

"Usually as soon as we finish."

"If you miss a special tool, how do you go about finding it?"

"I look for it until I find it. I look for it in places where I have worked."

"Do you use any special tools in the tail boom?"

"We use a spanner wrench on the tail rotor and we use a 3/8-inch adapter on the couplings and drive shaft."

"What about torque wrenches?"

"Each mechanic has his own."

Questions asked mechanic: "Do you remember replacing the tail rotor hanger bearings on this aircraft?"

"I'm pretty sure I replaced most of them."

"Did you torque them down?"

"I did most of them."

"After you finished torquing the clamps, do you recall putting the wrench away?"

". . . The last one I torqued was on the transmission coupling. I always put the torque wrench back in the box. Usually, when I work on the tail rotor drive shaft, I lay my tools on the cowling."

"Do the mechanics have a tendency to lay tools around this tunnel?"

"Yes."

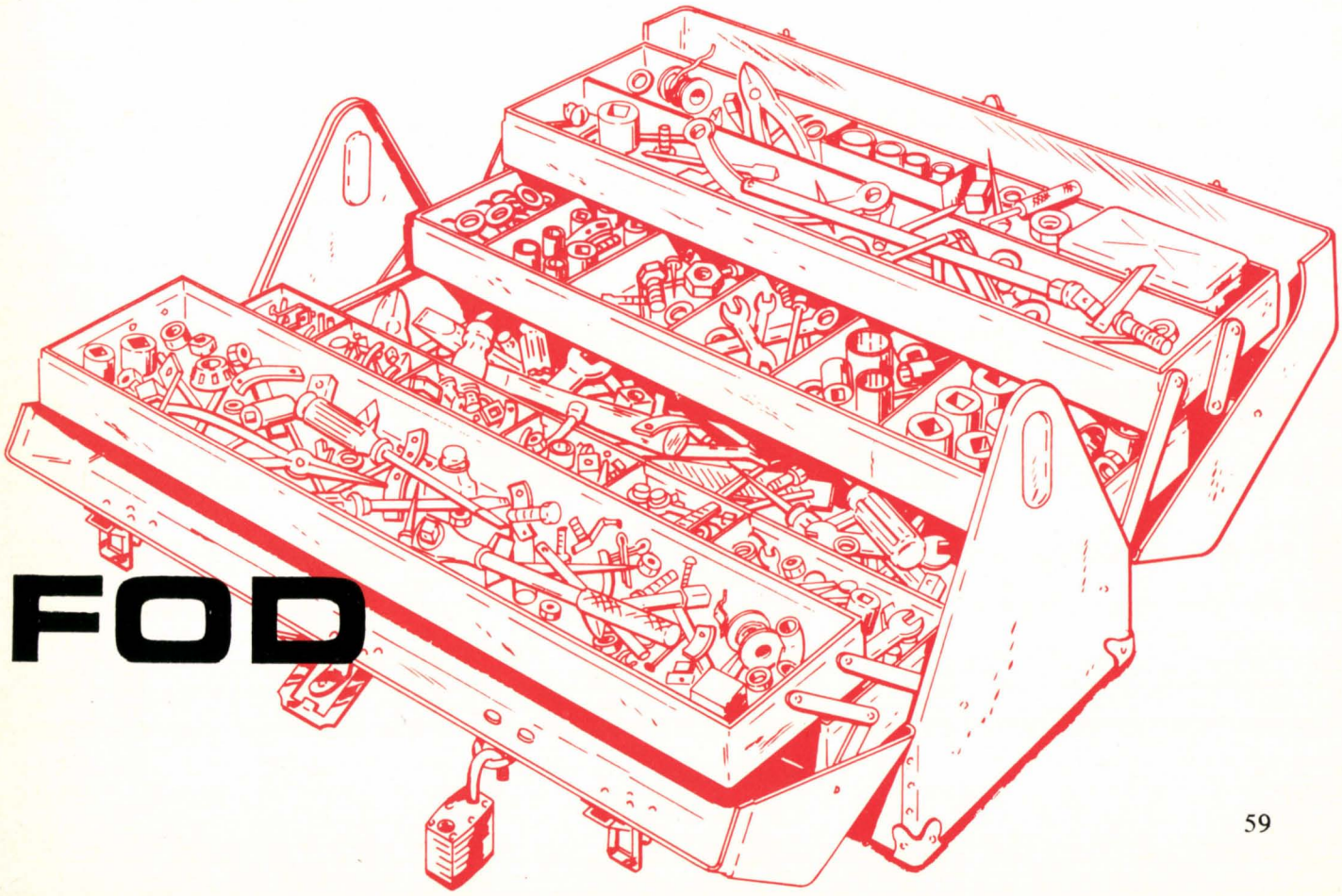
"Were you there when the aircraft was pulled out?"

"Yes. But I didn't work on it yesterday. The last time I worked on it was day before yesterday."

"Was the cowling closed sometime yesterday afternoon?"

"Yes."

Analysis: ". . . The fourth section of the tail rotor drive shaft was worn in two by a foreign object



which jammed between the shaft and the deck or the shaft and the cover. One-half of a bent and distorted torque wrench box was found in the immediate vicinity. The cause of a hole torn in the drive shaft cover directly above the coupling was not definitely established. However, a complete torque wrench box was missing from a toolbox belonging to one of the unit mechanics who had worked on the PE inspection team. The board is of the opinion that the missing half of the wrench box caused the hole torn in the drive shaft cover. Antitorque failure was established as the cause of the accident. . . .

"The aircraft records revealed no major discrepancies. There were a few minor irregularities in the forms and records, but overall maintenance, procedures, inspections, and records-keeping were excellent. The TI had inspected the reinstallation of the drive shaft on the previous day and paid little attention to this area during his final inspection prior to the test flight. It is the PE crew leader's responsibility to insure foreign objects are not present before replacing the drive shaft cover. The PE crew leader stated he had inspected this area, but it was obvious that the torque wrench box was overlooked.

"It is common practice to lay tools on the flat surface on the topside of the tail boom or in the curved surface of the drive shaft cover. Such tools can be easily overlooked when the cover is closed. This could account for the crewchief's failure to detect the torque wrench box during his inspection before closing the cover. . . .

"Due to this pilot's extensive experience (800 flying hours and 5 years in maintenance and test flights), it is inconceivable that he would not perform a more thorough preflight on an aircraft which had just been through extensive maintenance. The board concluded that failure to perform a thorough preflight inspection was a serious error in judgment and a factor in this accident."

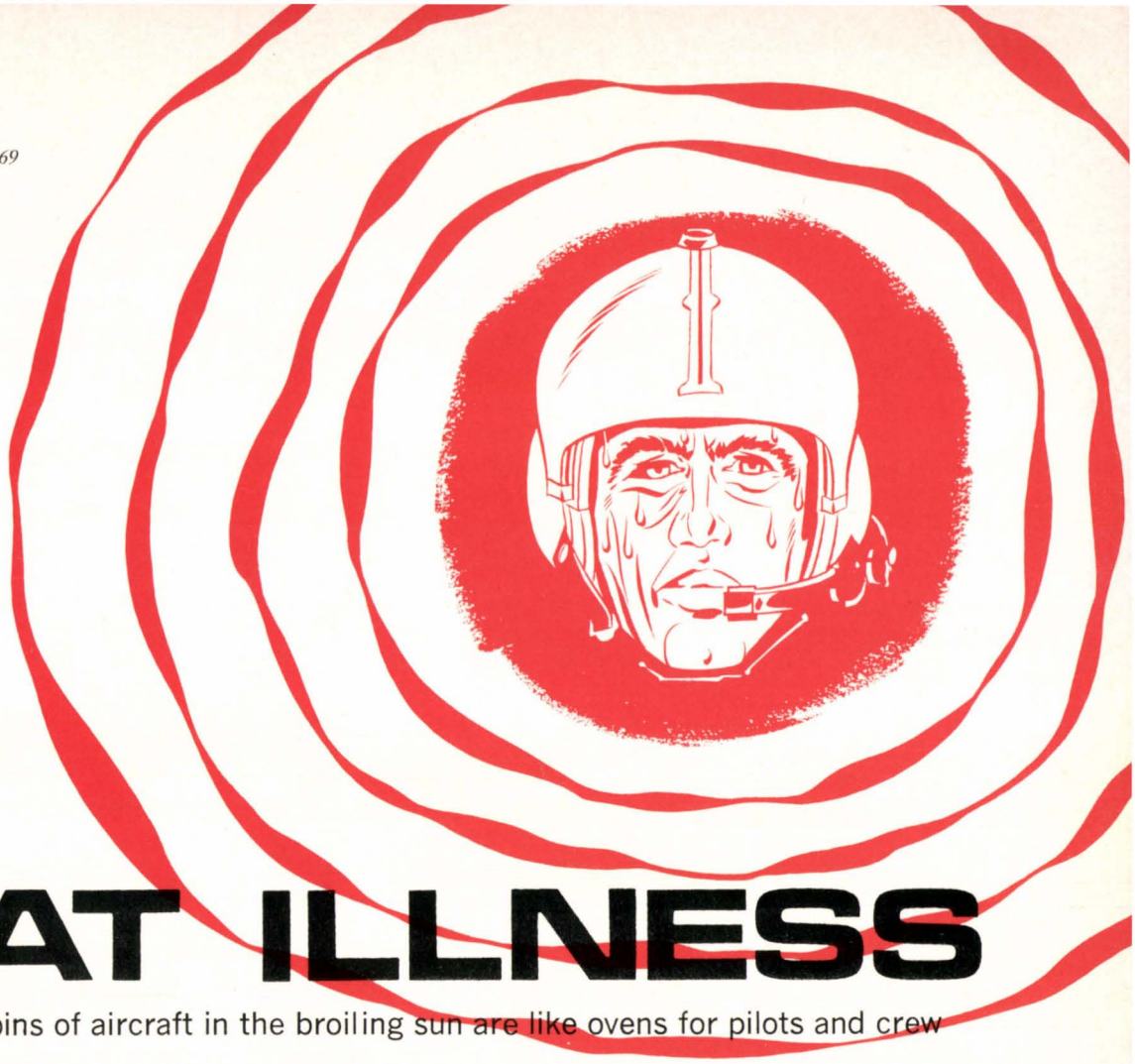
ACCIDENT NUMBER TWO

Approximately 3 months later, a UH-1H was on a training flight. The IP rolled off throttle to start a forced landing and the pilot turned downwind. He failed to get the collective down, causing a loss of rpm and the IP took control. He continued a right turn into the wind and flared to terminate at a hover with power. At approximately 400 to 600 feet and 30 to 40 knots, he rolled on throttle and applied collective and left pedal. There was no response to the left pedal and the helicopter began turning right, continuing to descend.

The IP attempted to lower the nose and gain airspeed. This increased the right turn, so he zeroed the airspeed and autorotated from about 15 feet. The helicopter touched down on the left skid while turning right and rolled on its left side.

When the wreckage was inspected, it was found that the tail rotor drive shaft had been sheared. The center access panel was removed and a 3/8″ x 7/16″ open end wrench was found lying in the tail boom below the damaged area. The wrench was worn and shiny on both ends and the severed drive shaft showed evidence of shearing or cutting. One tail rotor drive shaft weight was sheared in half and the fastener receptacle located next to the severed drive shaft was damaged.

from APPROACH, June 1969



HEAT ILLNESS

Cockpits and cabins of aircraft in the broiling sun are like ovens for pilots and crew

. . . HEAT IS PART of the working environment in many areas, both ashore and aboard ship. Cockpits and cabins of aircraft in the broiling sun become like ovens for pilots and crews awaiting takeoff. Ground crews working in the sun any time of year in tropic or semi-tropic areas or during the summer months in normally cooler parts of CONUS can encounter very high temperatures and humidity. Aboard ship, men working in such compartments as the bridle arrestor room, the aviation gasoline pump rooms or the arresting gear engine compartments have to adapt to hot working conditions.

For the benefit of readers to whom heat injury is a potential hazard and for those who have the responsibility for the well-being of such persons, here is a simplified discussion of the three main kinds of heat injury symptoms, their treatment and some preventive measures.[1] It should be emphasized that especially in the case of heatstroke, prompt professional medical treatment is essential for recovery. Your squadron flight surgeon or shipboard medical personnel can answer any questions which might arise in your mind as a result of this article, as well as elaborate on the basic material offered here.

Three Categories of Heat Injury

Generally speaking, there are three categories of heat injury: (1) heat cramps, (2) heat exhaustion or heat prostration and (3) heatstroke. In heat cramps depletion of sodium chloride (salt) and water due to excessive sweating is a primary factor. In heat prostration the heat-dissipating mechanisms of the body are overactive. In heatstroke they are completely overwhelmed.

Heat Cramps

As stated above, heat cramps result primarily from excessive loss of salt from the body following exposure to heat. These cramps are painful, sometimes very severe and usually involve the muscles of

[1]Material in the following discussion is drawn from BuMedInst 6200.7, Heat Casualties; prevention of, and TB Med 175, The Etiology, Prevention, Diagnosis and Treatment of Adverse Effects of Heat. A new TB Med 175 is to be distributed this summer.

the extremities and the abdominal wall. Body temperature is normal.

Heat cramps are promptly relieved by replacing the salt lost from the body. Saline solution (0.1 percent) by mouth or intravenous physiological saline solution should be administered. A 0.1 percent saline solution is prepared by dissolving two 10-grain plain salt tablets in a quart of water or adding one-fourth teaspoonful of table salt to a quart of water.

Heat Exhauston

Heat exhaustion occurs under conditions of heat stress as the result of excessive loss of water and salt from the body. The mortality rate is extremely low and, as a rule, the removal of the patient to a cool environment, rest and the administration of salt solution will result in a prompt recovery.

Symptoms of heat exhaustion are headache, mental confusion, vertigo, lack of coordination, drowsiness, extreme weakness, loss of appetite, dizziness, visual disturbances and nausea or vomiting. Occasionally cramps of the extremities or abdominal muscles occur. The victim rarely loses consciousness. His skin is usually cool and he perspires profusely. Oral temperature may be subnormal or slightly elevated but the rectal temperature is usually elevated. Pulse rate is rapid (140 to 200 per minute) and the blood pressure may be lowered.

The individual should be removed to a cool place where he can rest. Any factor that promotes the return of blood to the heart will tend to relieve heat exhaustion; elevation of the feet and moving or massaging the extremities are helpful. The deficit of water and salt should be made up by the administration of large quantities of salt solution (0.1 percent saline solution) by mouth as freely as the patient will take it. If water is not available, salt tablets or salt in other forms should *not* be administered alone. In the presence of severe collapse, medical personnel should administer physiological saline solution intravenously.

Heatstroke

Heatstroke is a very serious condition with a high mortality rate. It is characterized by extremely high body temperature, usually with profound coma.

The development of heatstroke represents a breakdown of the body's heat-regulating mechanism and is particularly apt to occur in individuals who are not acclimatized to heat. Physical exertion, alcoholism and diarrhea may predispose to the development of heatstroke.

After the disturbance of the heat-regulating mechanism occurs the individual may absorb heat from the ground or the surrounding air. In the great majority of cases there is absence of sweating, indicating that failure of the sweating mechanism is at least partially responsible for the high body temperature. In other cases the skin surfaces are cool, suggesting that the main defect is in the transport of heat to the body surface as a result of circulatory deficiency.

During the early stages of heatstroke, after sweating has stopped and the temperature has risen, the individual may be exhilarated and unaware of the dangerous condition which is developing.

Symptoms of Heatstroke

Warning symptoms of heatstroke are headache, dizziness, mental confusion, weakness, nausea, urination and diminished or absent sweating. Usually, however, the onset of heatstroke occurs with dramatic suddenness with collapse and loss of consciousness. Profound coma is usually present and convulsions may occur. In the early stage the patient's skin is usually hot, red and dry and there is absence of sweating. Pulse is full and rapid and blood pressure is normal or elevated. Respirations are rapid and deep. The temperature is usually markedly elevated —in excess of 106° F.

The most important objective in the treatment of

heatstroke is lowering the patient's body temperature *as rapidly as possible*. The longer the elevated temperature continues, the greater the threat to life.

TB Med 175 states: "Measures to lower the individual's body temperature should be initiated at the earliest possible moment. In the field the patient's clothes should be removed. If there is any source of cool water nearby the patient should be immersed in water, otherwise water should be sprinkled over the patient and its evaporation hastened by fanning. In addition to these cooling measures the attendants should rub the patient's extremities and trunk briskly to increase circulation to the skin. The patient should be removed to a hospital immediately and measures to cool the body should be continued until the hospital is reached. During transportation the passage of air currents through the opened door of an ambulance will aid cooling. When the patient reaches the hospital further cooling measures should be carried out immediately . . ."

One attack of heatstroke predisposes to a second attack and care should be taken by the individual to avoid a second exposure to the precipitating condition.

Preventive Measures

Measures to increase resistance to heat injury are threefold:

- Replenishing water and salt losses from the body as they occur.
- Maintenance of optimum physical condition and avoidance of undue fatigue.
- Gradual acclimatization to hot environments.

Replenishing water loss: The human body is highly dependent on water to cool itself in a hot environment. A person subjected to high heat stress may sweat more than a quart of water an hour. This loss must be replaced or there is a rapid decrease in the ability to work, an increase in body temperature and heart rate, deterioration of morale and heat exhaustion. The ideal way to replace water loss is by drinking small amounts of water periodically throughout the work period. If activity is moderate and heat and humidity conditions are moderate the water requirement will be one pint or more per hour per man, preferably drunk at 20 to 30-minute intervals. As activities are stepped up or working conditions become more severe, water intake should increase accordingly.

Replenishing salt loss: Although the diet ordinarily contains an adequate amount of salt, if you are unacclimatized you should take additional salt during the first few days of exposure to heat. An acclimatized person will need additional salt under heavy heat stress when sweating is excessive.

The salt tablet issued by the Navy is a 10-grain impregnated salt tablet (FSN 6505-754-2828). Impregnated salt tablets have a membranous structure which prolongs disintegration in the digestive system. About half the tablet is dissolved after 45 minutes and the remainder over a period of some 2¼ hours. Thus, one such salt tablet provides more or less even availability of 10 grains of absorbable salt over a 3-hour period. Plain salt tablets, such as used to make the 0.1 salt solution mentioned above in connection with the treatment of heat cramps and heat exhaustion, have cornstarch as a disintegrating agent and dissolve within 2 minutes. Salt in such concentrated form is not readily absorbed and can cause gastro-intestinal upsets. Extra salt at mealtimes, in the cooking and on the plate, will meet most usual requirements.

Physical condition: The general physical condition of a person has a significant bearing on his reaction to heat stress. The risk of heat injury is very much higher in overweight persons than in those of normal weight. Other conditions which increase susceptibility to heat include acute and chronic infections, reactions to immunizations, heat rash, acute sunburn, use of alcohol and fatigue. (Your flight surgeon can discuss with you the comprehensive list given in TB Med 175.) Once you have had an attack of heatstroke you are more vulnerable to a second. This is not true of heat cramps and heat exhaustion.

Acclimatization: A period of approximately 2 weeks should be allowed for acclimatization with progressive degrees of heat exposure and physical exertion. A period of acclimatization is necessary regardless of your physical condition although the better the physical condition the quicker acclimatization is completed. Acclimatization begins with the first exposure and is usually fairly well developed by the end of the first week. Persons who are unusually susceptible to heat will require additional time for acclimatization.

For your own sake and that of the men working or flying with you, you should be aware of the symptoms and treatment of heat injury and how you can prevent it in the first place. Forewarned is forearmed.

USAASO Sez

The U. S. Army Aeronautical Service Office discusses

Requirements for an alternate airfield

Changes and additions to FAA publications

On Alternate Airfield: Paragraph 3-10, AR 95-2, details the requirements for an alternate airfield. It is the purpose and use of the alternate airfield that is discussed in this article.

The purpose of an alternate airfield is simple. It is to provide a landing site when weather prevents an aviator from executing a landing at his destination airport.

When weather prevents a landing from being executed at the destination airport, an aviator is expected to request clearance to his alternate from ATC. The request for clearance should include, among other things, the route of flight and altitude desired. Should the aviator be unable to contact ATC, he is expected to use his own best judgment as to what action he should take. For example, an aviator experiencing lost communications may elect to execute another approach, provided he can reasonably assume to "break out." Another option the pilot has is proceeding on to his alternate.

When an aviator elects to proceed to his alternate and is unable to contact ATC, he is again expected to proceed by the most direct route by airway. Too many variables exist for FAA to provide specific guidance; however, it would not be considered unreasonable for an aviator to proceed to his alternate by the most direct airway at the MEA.

An aviator is expected to turn up all radio receivers in a situation as described above, since ATC has the capability of transmitting on navigation as well as communication frequencies. ATC clearances received in this manner are considered as valid as those received and acknowledged in the normal manner.

When all else fails, the aviator still has two options: One, he may bail out; or two, he may throttle back, set up a slight rate of descent, and say in a loud and quavering voice, "Our Father. . . ."

On FAA Publications: In February, the FAA renumbered and renamed FAA Handbook 7300.7, "Aeronautical Communications and Pilot Services." It is now known as FAA Handbook 7110.10, "Flight Services." The new designation will appear in AR 95-14, "Army Aviation Flight Information" which is currently being revised.

***Army Subject Schedule 1-4, AR 95-37 and TM 95-200:* Army Subject Schedule 1-4 (Terminal Air Traffic Control Facilities) dated 3 April 1969, is being distributed. This Subject Schedule is used in conjunction with AR 95-37 and each Airfield should receive five copies. The document provides guidance for standardization of Air Traffic Controller training. One printing error has been detected in para 3a(2) which reads, "The VFR Control Tower/GCA Program covers Blocks A and B of the Master Schedule." It should read, "The VFR Control Tower/GCA Program covers Blocks A, B and C of the Master Schedule."**

AR 95-37 (Army Air Traffic Controller Certification Rating and General Operating Rules) and Subject Schedule 1-4 have been long overdue. They are out—let's use them!

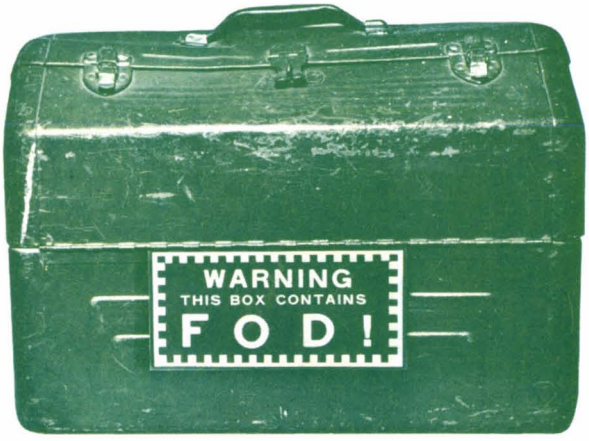
Stand by for a new TM. Finally, TM 95-200 (Air Traffic Control Facility Operations Manual) has gone to press. Shouldn't be too long—"Will advise."

Specialist 4 Gary G. Wetzel became Army aviation's first Congressional Medal of Honor winner while serving as a doorgunner in Vietnam with the 1st Aviation Brigade. SP4 (then a PFC) Wetzel single-handedly repelled an enemy onslaught by manning a machinegun aboard his crippled helicopter despite the serious wounds he had received.

Army Aviation's First Medal of Honor Winners

Chief Warrant Officer Frederick E. Ferguson, the first Army aviator to receive the Congressional Medal of Honor, was presented the award on 17 May 1969 by President Richard M. Nixon. His courage and skill as an Army aviator enabled him to save five men from a downed aircraft by flying his own helicopter through heavy anti-aircraft fire.

"...It is common practice to lay tools on the flat surface on the topside of the tail boom or in the curved surface of the drive shaft cover. Such tools can be overlooked when the cover is closed..."



See TOOLBOX FOD, page 58