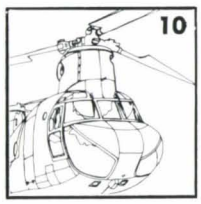
USAARL
SCI SUPPORT CENTER
P.O. BOX 620577
FORT RUCKER, AL 36362-0577

UNITED STATES ARMY
APRIL 1973

AVIATION DIGEST

UNITED STATES ARMY AVIATION DIGEST

APRIL 1973 VOLUME 19 NUMBER 4



Views From Readers 1

Advanced Army Aviation Training: Emphasis—Tactics! 2
CPT Andrew F. Scheidemantel

Ballistic Damage Tolerant Flight Control Systems 4
MAJ Llayll A. Fry

Aeromedic, LTC Nicholas E. Barreca, M.D. 6

Instrument Training In The Reserves 10
CW2 Christopher W. Ulsaker

The Answer To Your Question Is No! Hubert C. Pate, DAC 12

Tucson, Where Am I? LTC Donald J. Mascia 16

An Academic Overview, LTC Curtis J. Johnson 20

Universal: Aircraft Recovery Kit, Robert A. Matthews, DAC 23

Important Byproduct For The Commander 30

Turbine Engine Know-Why 32

Visualize The Invisible 40

Write To Right 43

Pearl's 45

USAASO Sez 48

How To Get The DIGEST Inside Back

A "New" Warning System? CW2 Peter J. Smith Back Cover

DIRECTOR OF ARMY AVIATION, ACSFOR
DEPARTMENT OF THE ARMY
MG William J. Maddox Jr.

COMMANDANT, U. S. ARMY AVIATION SCHOOL
MG Allen M. Burdett Jr.

ASST COMDT, U. S. ARMY AVIATION SCHOOL
COL Earl W. Fletcher

EDITOR, U. S. ARMY AVIATION DIGEST
Richard K. Tierney

ABOUT THE COVER

World War I reports indicate that the first attempts by aviators to protect themselves from small arms fire occurred when they stole stove lids and placed them in their aircraft seats. This form of "armor" protection has rapidly advanced from the stove lid concept and there also have been significant developments in aircraft design to protect aircraft flight control systems. See page 4

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.

The DIGEST is an official Department of the Army periodical published monthly under the supervision of the Commandant, U. S. Army Aviation School. Views expressed herein are not necessarily those of Department of the Army or the U. S. Army Aviation School. Photos are U. S. Army unless otherwise specified. Material may be reprinted provided credit is given to the DIGEST and to the author, unless otherwise indicated.

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

This publication has been approved by Headquarters Department of the Army, 1 September 1972.

Active Army units receive distribution under the pinpoint distribution system as outlined in AR 310-1. Complete DA Form 12-4 and send directly to CO, AG Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220. For any change in distribution requirements, initiate a revised DA Form 12-4.

National Guard and Army Reserve units under pinpoint distribution also should submit DA Form 12-4. Other National Guard units should submit requests through their state adjutants general.

Those not eligible for official distribution or who desire personal copies of the DIGEST can order the magazine from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402. Annual subscription rates are $8.00 domestic and $10.00 overseas. Single copies are 75 cents each.

VIEWS FROM READERS

Sir:

Hard times have indeed arrived at the Army aviation hangar, and CPT McKelvy's recent article ("The High Price of Experience," January 1973) ably expressed a growing awareness of the problem of the grounded aviator. Although flying restrictions have only recently affected us profession-wide, the problem is not new. Many aviators have been kept out of the air by administrative waivers or as a result of attendance in nonflight connected schooling for several consecutive years. They have long since come to appreciate the various barriers that can arise between the grounded or low-time aviator and the maintenance of even minimal proficiency. Not always the least of the problems is the indifferent or cool attitude taken by some aviation facilities and personnel toward nonassigned "poor cousins" who happen to care enough to ask for publications, annual writ guides, a little flight simulator time or even some hangar talk on the never-ending regulation changes.

Not only are such attitudes professionally bankrupt, but they do not even make sense from the selfish standpoint. Perhaps a partial remedy would be the contemplation of possible changes in one's own status with the arrival of the next set of PCS orders, or the possibilities of flying with a stagnant aviator in the next fracas down the international pike.

In the interest of lessening dependence on charity and in ensuring continued "official" contact and proficiency among grounded and nonprefix 6 or X aviators, I would suggest three actions in addition to those implemented by AR 95-1:

(1) Despite the current drive to reduce the extent of military publications, place the name of each grounded aviator on a direct mailing list to receive AVIATION DIGEST and other appropriate publications on operations and safety. If funding is not available then further paring of distribution to nonessential activities might be a solution.

(2) Place an official requirement on the nearest aviation facility to provide grounded aviators with simulator training and other support on a priority directly below that of assigned fliers.

(3) Allow grounded and low-time aviators to log unlimited flight time as copilots on essential service missions that would otherwise be flown with an empty seat at the controls. Unit commanders or operations officers could be required to countersign 2408-12s to prevent abuse of the authorization and the spirit of DOD directives.

Now more than ever the profession needs to pull together in the communal sense toward the goal of keeping the *total* corps of aviators as proficient as possible. The right combination of personal and professional motivation and support will do the job.

CPT Ballard M. Barker
Dept of ES & GS, USMA
West Point, NY 10996

• There is new criteria for obtaining distribution of the AVIATION DIGEST which can be found on inside back cover.

Sir:

Request two copies of the article entitled "The Tactical Map And You" which appeared in your October 1970 issue of AVIATION DIGEST.

CPT William M. Davis
357th Chemical Company (SG)
39th and Federal Streets
Camden, NJ 08105

• The copies you requested are in the mail.

Sir:

My compliments to Mr. Ted Kontos on his article "That Frigid Old Man" in the December issue. I hesitate to criticize such an informative and well-written article, but here I go.

Concerning inlet screen and inlet guide vane icing on turbine engines, Mr. Kontos cautions pilots to suspect such icing if EGT begins rising, and explains why. All true.

While flying in stratus clouds with light rime ice forming (CH-47A, L-7C engines), I've found that EGT, torque and rpm vary quite often. This is due to water droplet size and density variations within the cloud, which in turn causes large and instantaneous changes in density altitude, leading to a change in engine performance.

Moral: Should EGT rise during flight in icing conditions, *suspect* engine inlet icing, BUT DON'T GO INTO A PANIC! There is another explanation.

CW2 James E. Grodhaus
4th Aviation Company (ASH)
APO New York 09025

• Your point on EGT, torque and rpm fluctuations while flying in clouds is well taken and is valid, but let us take it a step further. If flight is intended when temperatures are 40 degrees F. or lower and moisture is visible, the FOD screens should be removed because this combination of moisture and temperature is highly conducive to icing. Army helicopters are not equipped with de-icing systems, but the helicopter engines are equipped with anti-icing systems, which must be turned on prior to encountering icing conditions. Then, with the anti-icing system in operation, there is no reason for concern if you see transient EGT, torque and rpm fluctuations in clouds, but if you see a sustained increase in EGT, you have got a problem. This is the point of the statement concerning EGT increase. If you wait until you see icing conditions on the engine instruments, you are already in trouble, because if the anti-icing system does break the ice loose most of it will go into the engine and damage the compressor blades.

Advanced Army Aviation Training:

Emphasis—Tactics!

Now is the time to readjust and reorient individual aviator training programs. Aware that the Army must provide for possible future low-, mid- and high-intensity conflicts, the training of air cavalry scout and attack pilots should be integrated since they operate as a team

Captain Andrew F. Scheidemantel

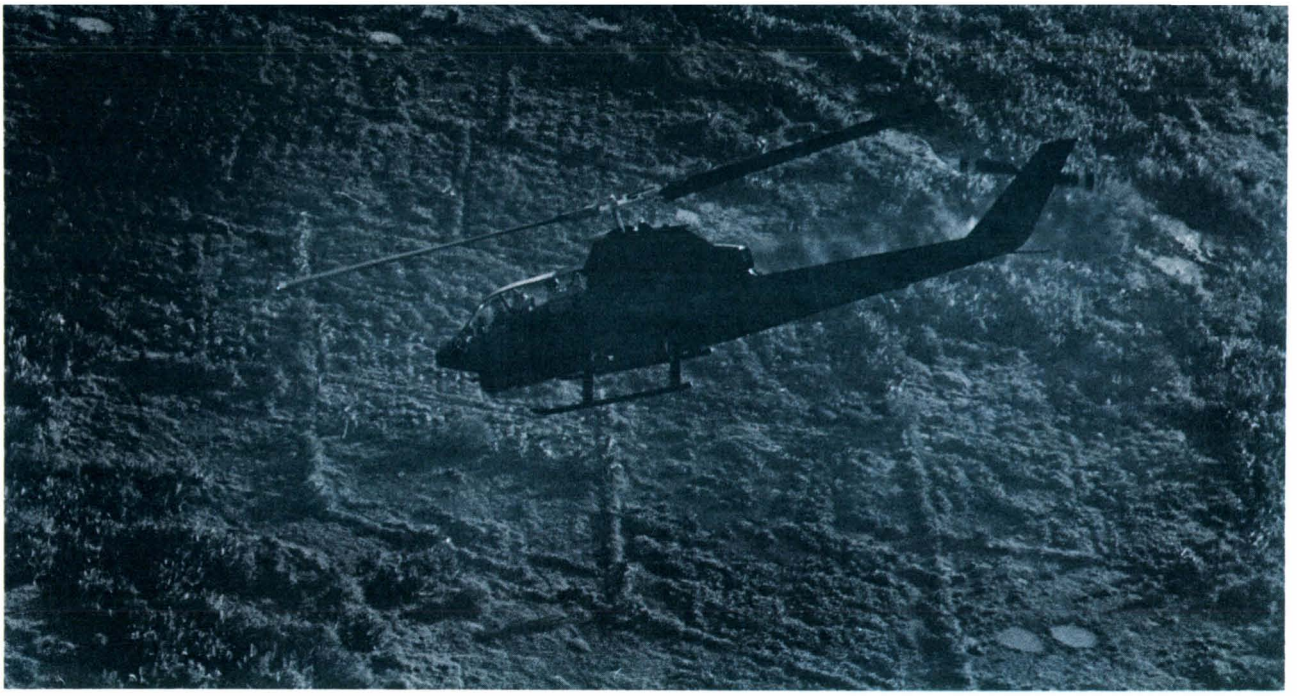
HISTORY proves that postwar climates are generally in a state of flux. There is much sifting of data, acquired by the blood and sweat of many men, in an effort to learn from mistakes. There has been success in many areas as is evidenced by improved equipment, organization and doctrine. But a comprehensive Army aviation *tactical* training system has not emerged within the training base. This is particularly true for the air cavalryman.

The air cavalry concept has been around for some time, but was not proven until hostility intensified in the Republic of Vietnam. With the greatly expanded need for aviators during this conflict, specialized air cavalry training had to wait for more settled days. It was generally recognized that air cavalry aviators were tasked beyond their training. But, due to the low intensity of the conflict there was sufficient time for additional in-unit training for the required skills demanded by air cavalry missions.

At present there is less of a drain on aviation resources and it is now time to readjust and reorient individual aviator training programs. Not only must the Army provide for similar low-intensity conflicts which may erupt in the future, but it also must provide for mid- to high-intensity warfare situations. Aviation training must become branch oriented where specialized skills are required to accomplish the mission, as is the case with air cavalry units. We need look no further than our own service to find the ideal model to emulate.

The reference here is to the method of advanced individual training which has worked successfully for so many years—both for officers and enlisted men. Why this procedure was abandoned for the Army's aviation flight training program is somewhat unclear to me. Perhaps I'm merely showing my ignorance of the situation, but it seems to have been because of the relatively unsophisticated equipment and tactics of the pre-Vietnam era and the desire to maintain a centralized training base for aviation due to the relative expense of aviation equipment and training facilities. Be that as it may, the situation has now changed and

OH-58 Kiowa helicopter lifts off helipad at Vung Tau, Vietnam. Scout missions are frequently a team effort with attack ships



On the prowl—deadly HueyCobra dives to check suspected VC position while supporting 9th Infantry Division troops in the Mekong Delta

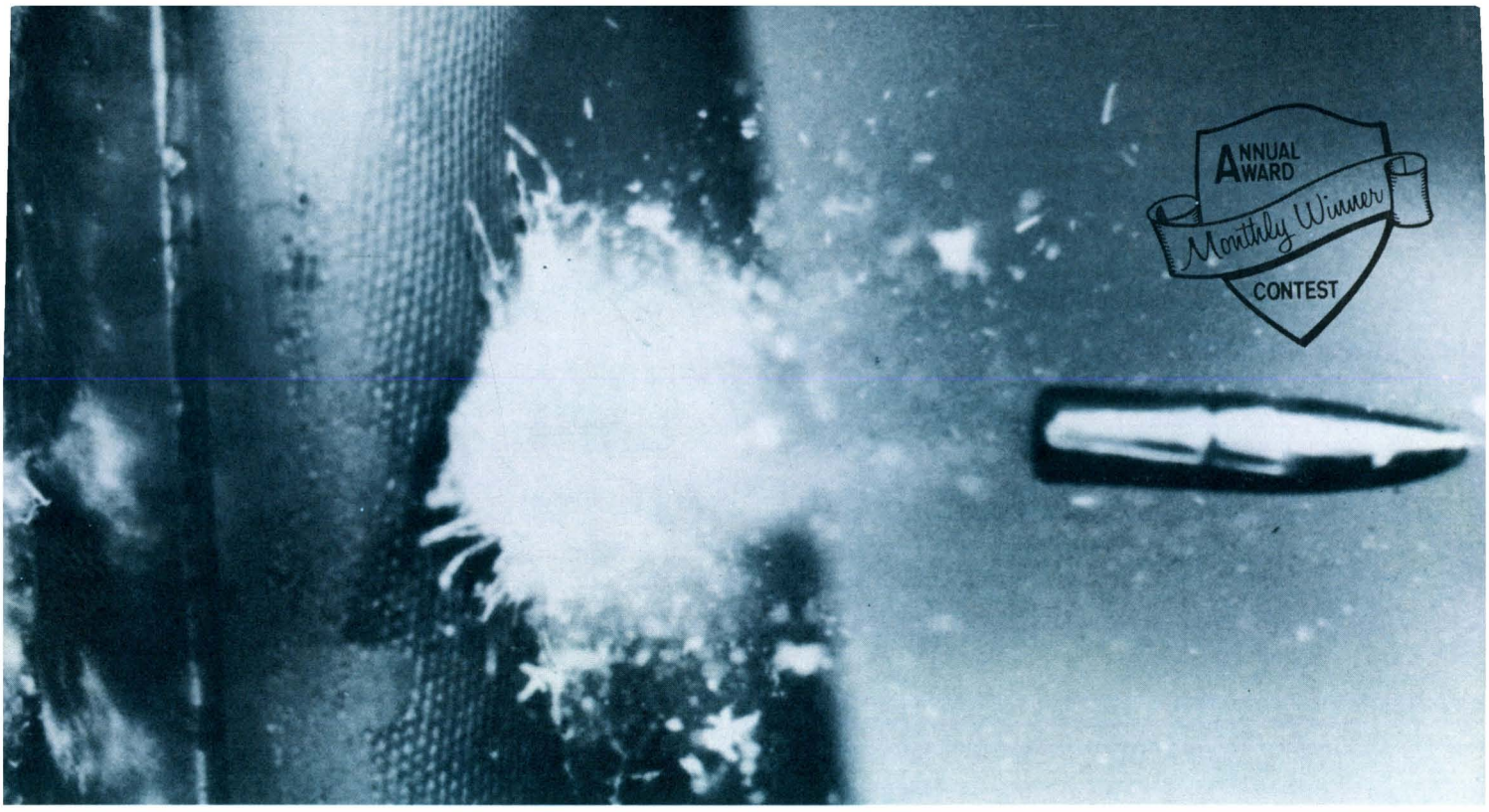
Army aviation training must adjust accordingly. The system outlined below is merely one of several approaches, all of which are feasible, but it seems to be the most logical and readily adaptable to the Army's needs.

Basic Army aviation flight training should be conducted as it is now by the U.S. Army Aviation School (USAAVNS) at Ft. Rucker, AL. Advanced flight training should be broken down into as many different specialized courses as necessary. These courses could be either controlled by the branches having proponency over them or by USAAVNS maintaining close liaison with the branch schools to ensure continuity and branch material subject matter.

Were it not desirable to maintain a centralized training fleet for aviation training, I would advocate moving these advanced courses to the branch schools concerned. However, financial and real estate problems preclude this, not to mention policy considerations. Then too, USAAVNS has all the necessary training facilities on hand and these should be used to the fullest.

Aviators assigned to various branch material units would attend the proper course of advanced individual flight training and receive a branch material MOS. For example, an aviator scheduled for assignment to an air cavalry unit would attend the Air Cavalry and Attack Helicopter Course. He would be awarded either a 61203 MOS (attack) or a 61204 MOS (scout). Warrant officers also would receive an appropriate MOS to identify them as air cavalrymen. The student would receive all of his tactical training in the aircraft he is to fly in his unit, thus producing an aviator well qualified in the normal operation of his aircraft as well as in its *tactical* employment. This method of functionalized aviation flight training could be conducted within the same time frame as the present course, with no additional aircraft qualification courses necessary after flight school and no additional funding required. Since the attack and scout pilots operate as a team in air cavalry units, the integration of tactical training for these aviators would result in more efficient teamwork. This would certainly reduce the unit's individual aviator training burden considerably, thereby enhancing the unit's combat effectiveness. The aviator would have more confidence in himself, his aircraft and his unit. More time and effort could be concentrated on teaching and practicing tactical skills and techniques for mid- to high-intensity combat environments and on new equipment operation and employment. The new requirement for all Army aviators to maintain standard instrument tickets will require considerable training time, thus pointing up once again the need for efficiently using all training time, whether it be in a service school or field unit.

Policy and financial considerations are likely to play a big part in determining the final shape and location of any course such as proposed here, but the courses should not be sacrificed simply for these reasons. The increasing sophistication of equipment and tactics, as well as the equipment and tactics of potential enemies, will require even more highly trained and proficient aviators in any future conflict. Waiting until the next war to institute these changes may be too late. The Army must train for future wars today or accept the prospects of fighting a major war with inadequately trained personnel and confronting the hazards that such a policy would involve.



Ballistic Damage Tolerant Flight Control Systems

Ballistic damage tolerance is a relatively new concept which is a prime consideration in all new aircraft structural designs. Aviators in the field may be interested in learning about the reduced vulnerability to small arms fire resulting from the use of some fabrication techniques such as fabric layup, filament winding, molded chopped fiber and Tetra-Core

Major Llayll A. Fry

EXTENSIVE SERVICE in Southeast Asia has shown that helicopter flight control systems are highly vulnerable to small arms fire. In general, existing components of these systems are designed with minimum dimensions to save space and weight, and they are often forged or cast from notch sensitive metallics. This approach makes these components highly vulnerable to ballistics and to catastrophic failure on ballistic impact with subsequent loss of aircraft control.

To improve ballistic behavior, both new design concepts and new materials are required. This requirement has led to studies at the U. S. Army Air Mobility Research and Development Laboratory, Ft. Eustis, VA, and the development of the concept of ballistic damage tolerance and to components made from fiberglass-reinforced composite material.

The concept of ballistic damage

The author is with the Corps of Engineers as Research and Development Coordinator, Structures Division, Eustis Directorate, U. S. Army Air Mobility and Development Laboratory, Ft. Eustis, VA. He has a B.S. in Civil Engineering and a masters degree in Aerospace Management. In addition, he has completed the Engineer Advanced Course, Command and General Staff College, fixed/rotary flight schools and the instrument examiner school and has over 5700 hours of flight time.

tolerance, however, is somewhat contrary to old established means of defeating ballistics. Undoubtedly, the first attempts by aviators to defeat small arms fire were made in World War I, when pilots stole stove lids from the kitchen and placed them in their aircraft seats (see figure 1, cover). This approach was probably not too effective, but it did show two things: First, it defined a fundamental human concern of all aviators to protect their own behinds; and second, it showed that the intuitive approach to defeat ballistics is the brute force approach: armor plate. But what happens when we indiscriminately apply armor plate to aircraft, particularly helicopters? We simply cannot afford the weight penalty.

The ballistic damage tolerance concept, on the other hand, is a design approach wherein components are designed specifically to accept ballistic penetration, even in the most critical area, yet remain functional so that the aircraft can return home safely from a mission. Examples of this concept are shown in figures 2 and 3. Figure 2 (see page 4) shows the minimal damage after impact of a fiberglass tubular specimen. The bell crank shown in figure 3 had been impacted eight times with fully tumbled .30 caliber projectiles. Even so, it was still able to withstand maximum static loading without further degradation.

Flight control system vulnerability: At this point you are probably wondering: Just how vulnerable is a flight control system? Figure 4 shows a UH-1 connecting link which was impacted with a tumbled .30 caliber projectile. Figure 5 shows the extensive and complex CH-47 control system. There are over 130 separate components in this system. A hit on a number of these components could cause loss of aircraft control.

The next question, then, is: How can we improve the system and reduce vulnerability? This can be done by a number of methods, such as armor plate and dual mechanical systems. One study has shown that a fly-by-wire system would provide the best results for the least weight. However, several additional factors must be considered, such as cost, reliability and maintainability. The capability exists for fly-by-wire but these systems are still experimental when applied to helicopters.

A dual mechanical control system, on the other hand, would provide redundancy but also would double the system requirement for weight, space and cost. A severed component in one circuit would not prevent function of the other. However, damage that jammed one circuit could also jam the other unless a complicated release system was used.

Of the methods available to reduce vulnerability, the ballistic damage tolerance approach is most attractive for several reasons: First,

Continued on page 26

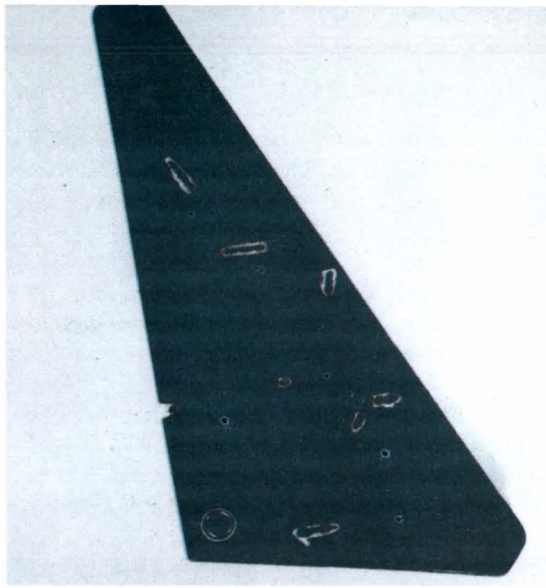


Figure 3: Bell crank was impacted eight times with tumbled .30 caliber projectiles and still withstood maximum static loading

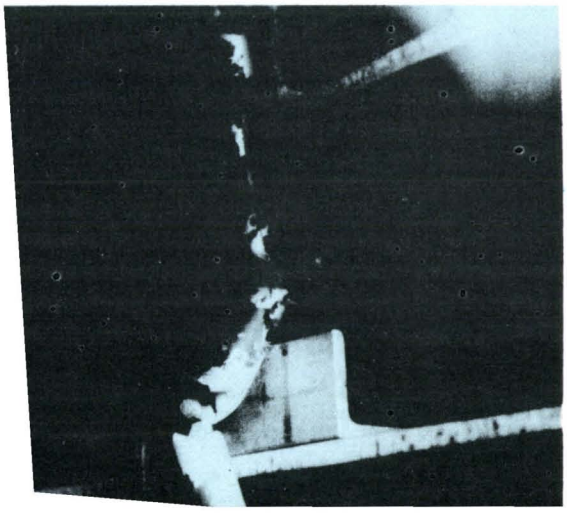


Figure 4: A UH-1 connecting link being impacted with a tumbled .30 caliber projectile. Note the severe damage to the tubular link

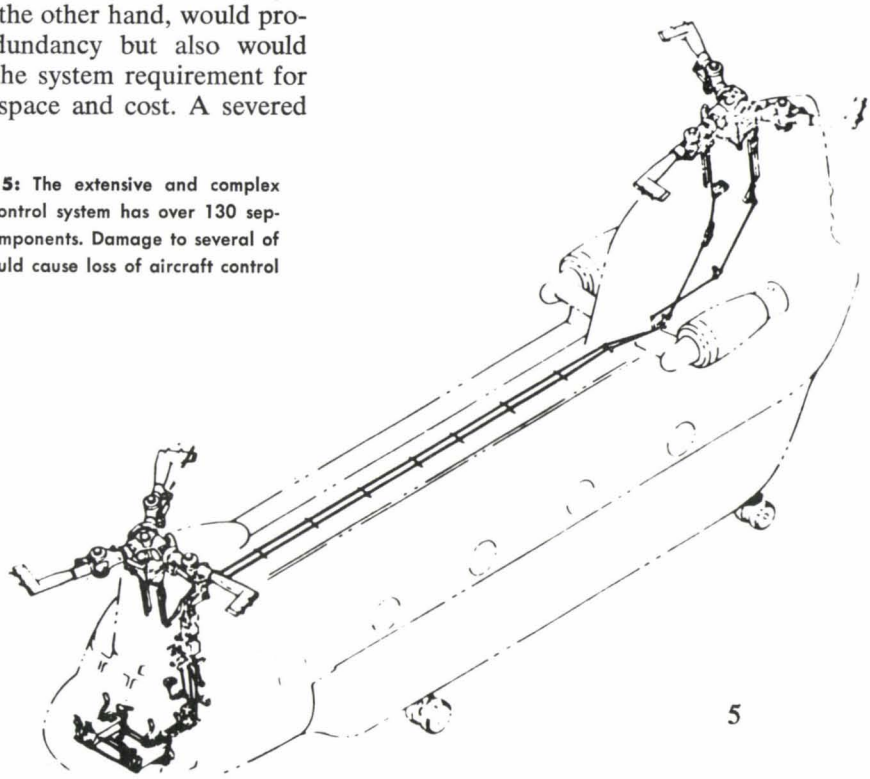


Figure 5: The extensive and complex CH-47 control system has over 130 separate components. Damage to several of these could cause loss of aircraft control

Tips To Healthful Living: Part II

Formula For A Long And Useful Life

LTC Nicholas E. Barreca, M.D.

Provided by the Society of U.S. Army Flight Surgeons

Aeromedic

IN FEBRUARY 1964 the late President Lyndon B. Johnson launched a war against heart disease, cancer and stroke with the appointment of a commission of famed medical and economic scientists and administrators. Why? Because heart disease, cancer and stroke were and continue to be the major causes of death among Americans. In 1963 they were responsible for 71 percent of all deaths . . . nearly one million from heart disease and stroke combined, more than one-quarter million to cancer alone. But that only reveals the tip of the iceberg. It doesn't reflect the many millions who are, and have been for many years, disabled and miserable from these diseases.

Death, we all agree, is inevitable but does it have to be tomorrow . . . prematurely . . . rather than after a *long* and *full life*? Notice . . . there was no mention of living to "old age." The phrase "our old age" has come to imply recurrent illness, disability, discomfort, burden and uselessness. . . . Something more than a vegetable existence. Need this be so?

The formula for a long and useful life is within our grasp . . . if we're not too lazy or careless to reach for it. The major burden of these dreadful diseases is largely preventable. Last month the health consequences of smoking were discussed. By eliminating smoking alone many of us could realize useful longevity simply by our genetic heritage.

Certainly we could elude many cancers as well as chronic obstructive pulmonary disease and a large proportion of the risk of coronary heart disease. Coronary heart disease, however, is one of the major causes of morbidity and mortality among our compatriots. How can we elude this apocalyptic curse to man's vigor? Only by avoiding those factors which are known to increase the risk of development of this disease and to a large extent that of stroke as well.

The three *major* risk factors associated with coronary heart disease (CHD) are hyperlipidemia, hypertension and smoking. Hyperlipidemia means the overabundance of cholesterol and other fats in our bloodstreams that frequently results from dietary excess of these foodstuffs. In addition to these there are many *minor* risk factors . . . diabetes, lack of physical fitness or physical inactivity, certain personality characteristics and family history of CHD. The solution to our problem . . . control of a majority of all these risk factors. The determined result of all this effort will be a longer, more useful life.

No doubt some will claim that such a life of control and denial will merely seem longer. The reason it will seem longer is that its adherents will be more vigorous and productive at both work and play for a larger proportion of their total lifetime. True living is *doing*, not merely existing. To this end then let's examine the means one has of reducing the afore-

Stop Smoking

mentioned risks.

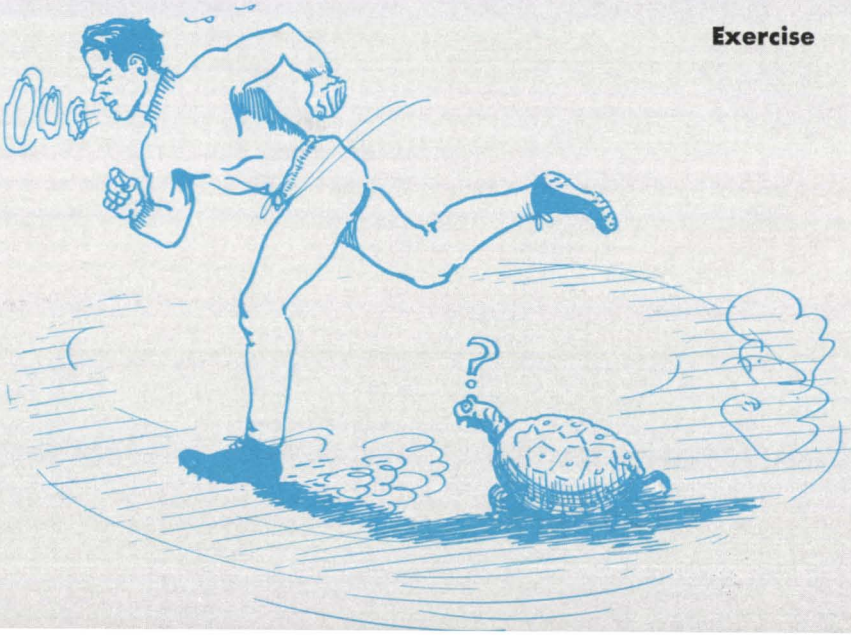
A very definite major risk was dispensed with last month . . . that of *smoking*. However, control of this factor can also be affected by our approach to the control of other factors such as diet, overweight, diabetes and inactivity.

Hypertension is a condition that has long been known but largely neglected in many people until its effects were obvious . . . and disabling. Hypertension is *high blood pressure*. It has many causes but the greatest proportion is termed essential . . . meaning medicine hasn't as yet identified all the specific causes. However, effective therapy is simple and available. With early diagnosis and adequate treatment much of the risk and complications of the disease can be avoided. Not infrequently though, the diagnosis of this disease is postponed or avoided by patients and physicians as well . . . particularly among air crewmen. Hypertension is disqualifying for flying duty. However, among trained and experienced flying personnel a waiver can be granted if the condition is controlled by diet, exercise and/or certain diuretic medication.

Until very recently borderline or mild hypertension was thought to be of questioned consequence. Today, it is more commonly thought that *any* hypertension is potentially harmful in terms of later heart or kidney disease and stroke. The lower the blood pressure the better, provided blood flow is sustained for normal activity. Several years ago air crewmen would go to great lengths to ensure that their blood pressure remained falsely low at the time of a flight physical examination. They would rest for several days, avoid cigarettes, coffee, alcohol and stress, then report for the physical hoping for the best. Sometimes well-intentioned flight surgeons would permit patients to rest or sleep with a sedative to demonstrate that this hypertension was not significant or sustained. All of this is false security though. We don't live quietly or without certain physical or psychological stimulation. Thus, the best reflection of our blood pressure is those readings taken in proximity to our normal activity.

If you have hypertension accept its presence and seek specific therapy. Sometimes the use of diet for weight reduction and limited salt restriction will control the condition; others require this in combination with a seriously considered and medically supervised program of lifelong vigorous physical exercise. Still others require the help of specific medication. One way or the other the objective must be the reduction of blood pressure. Early hypertension in the absence of com-

Exercise



plications should not be looked upon as a stigma to those pursuing a flying career. Once under therapy they are no less capable of outstanding performance than their unaffected associates. Thus, air crewmen shouldn't shrink away from identification of their high blood pressure but realize the benefits of its early discovery and specific treatment. They should further see that their loved ones also receive the benefit of periodic blood pressure determinations to identify the development of hypertension early and ensure its prompt treatment. With hypertension controlled another risk factor for coronary heart disease and stroke will likely be eliminated.

Diabetes mellitis is another condition that is associated with an increased risk of circulatory disorders. One form of this disease begins as we get older and are less likely to control our intake of carbohydrate. This inability to tolerate carbohydrate in foodstuffs can be recognized early with a screening laboratory test for blood glucose (sugar). This type of test can be incorporated into flying physical examinations for those who are at greatest risk . . . individuals over 30 to 35 years of age, particularly if overweight and with a family history of the disease. Once identified as having a tendency toward this disease, definite dietary counseling can be undertaken. This in combination with medically supervised exercise can control many early risks of this disease.

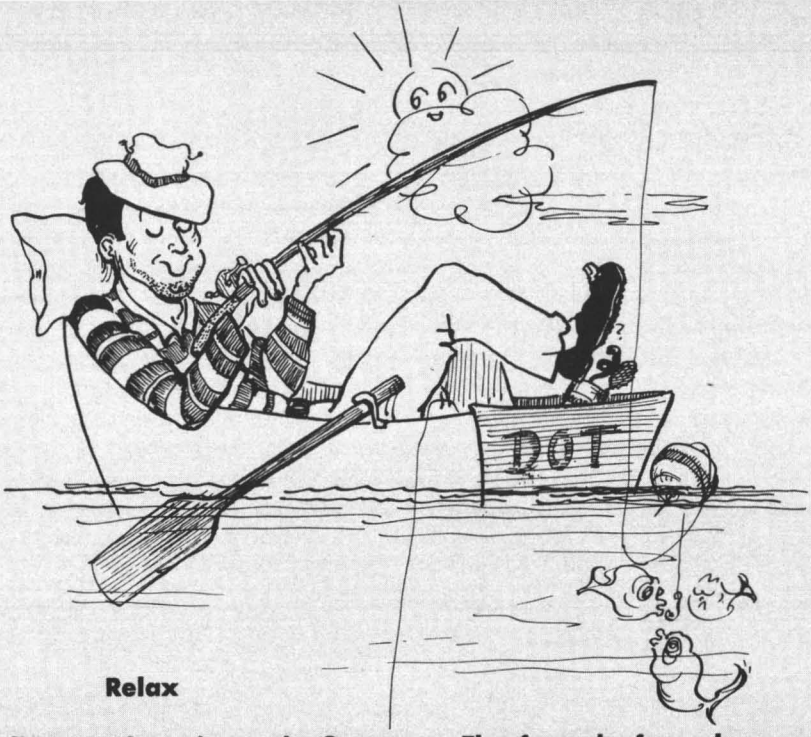
In both hypertension and diabetes then exercise can play a beneficial role. What about the other risk factors . . . hyperlipedemia, obesity, smoking, perhaps even personality and family history? Recently, the American Heart Association Committee on Exercise* wrote the following:

"Current knowledge points to high blood pressure, elevated serums lipids [cholesterol, etc.] hyperglycemia [high blood sugar] and cigarette smoking as factors of primary concern in reducing the risk of coronary heart disease. In the hope of reducing such risk in all individuals, the committee advocates physical activity as an adjunct to the elimination of cigarette smoking and the control of blood pressure, serum lipid levels and obesity. . . . We do . . . encourage the widespread adoption of exercise programs *tailored to the capacity and interests of individuals,* because of the probability that they will enrich the quality of life and, in combination with other measures, help reduce coronary risk."

Control Weight and Diet

Lack of physical activity and lack of physical fitness are associated with a higher risk of coronary heart disease. Whether or not exercise in and of itself will prevent heart disease is presently unknown although there is evidence pointing in that direction. One thing is for sure . . . exercise and physical fitness do promote a reduction in the other risk factors.

It is very difficult to continue smoking when one is earnestly trying to progressively work up to a 1½-mile run, vigorous bicycling, many laps of swimming, or a reasonable squash or paddle ballgame. If as part of a fitness program, one risks the daily tipping of accurate scales to assess his weight reduction, he or she will find it difficult not to be more careful at the dining table. This is especially true if one gets a



Relax

glimpse of one's portly figure in a strategically placed mirror. Thus, obesity and smoking could fall victim to well-organized and consistently practiced physical activity.

If, in addition, you become more health conscious by eliminating saturated fats and cholesterol from your diet, you will be well on your way to increased longevity. Even limited substitutes like margarine, low-fat milk, corn or peanut oil, chicken, fish (excluding shellfish) will help. Exercise tends to lower blood cholesterol and other fats as well.

The formula for a long and useful life becomes very apparent then. One must adopt a *completely new lifestyle*. This new lifestyle must be lifelong in its application. The steps in adoption of this rebirth must proceed as follows:

• *Stop smoking*. Use any device, method or assistance to accomplish this end.

• *Embrace a program of aerobic exercise*. The U. S. Army is now sponsoring a program entitled "Run for Your Life" (see DA Pamphlet 350-46). Such a program should be medically recommended and supervised on an individual basis for individuals over 30 years of age. This is particularly true if an individual has been leading a rather sedentary existence. Seek your flight surgeon's advice prior to participation.

• *Control weight and diet*. Eat a well-balanced diet . . . not a fad diet. Merely limit the number of calories till you reach that delicate balance where you no longer gain weight (provided you have reached your desired and healthy weight). Avoid saturated fats and cholesterol and substitute polyunsaturated fats whenever possible.

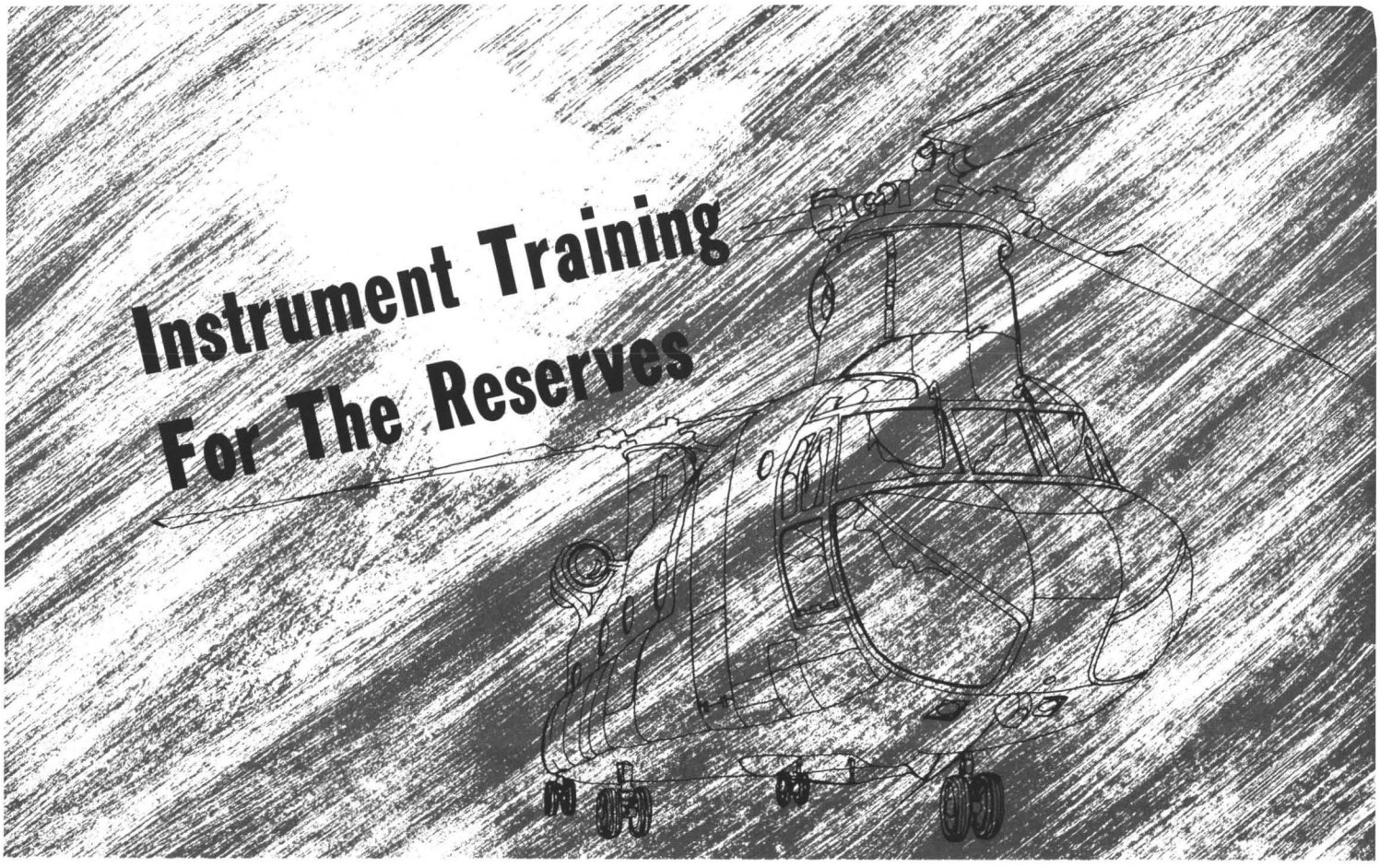
• *Seek relaxation and recreation*. This will alter your personal and emotional responses to many daily activities. Often vigorous exercise is psychotherapeutic. It takes the edge off many of our daily frustrations and hostilities and frequently permits sound and restful sleep.

• *Cooperate in periodic health examinations*. Assist in the treatment of identified hypertension, diabetes or other ailment by reinforcing your new lifestyle.

The benefits that will be realized from the adoption of this new lifestyle are many, not the least of which includes the ultimate enjoyment of your federal or other generous retirement income plus the vitality to embrace many other endeavors. You will likely live longer, enjoy fuller, be more productive, have a better self-image and relative peace of mind.

Cooperate

*American Heart Association Pamphlet entitled "Exercise Testing and Training of Apparently Healthy Individuals: A Handbook for Physicians."
©1972. New York



Instrument Training For The Reserves

The program discussed by the author is an *upgrade* program designed for the 195th Aviation Company to make maximum use of limited time. Each of the pilots to be trained had at least 4 years of previous flying experience. With the publication of AR 95-1, dated 20 December 1972 which was effective 1 January 1973, it is now necessary that instructor pilots be qualified by a DA approved course of instruction and/or an evaluation by a USAAVNS standardization instructor pilot

CW2 Christopher W. Ulsaker

THE ARMY'S requirement that all aviators become instrument rated presented the Reserve Components with a challenging and demanding training objective. The prime problem in organizing an effective program concentrated enough to rapidly produce standard instrument ratings at an acceptable rate was the nonavailability of pilots for additional training due to occupational time conflicts.

For the pilots of the 195th Aviation Company (ASH) at Ft. Meade, MD, the need for instrument rated aviators was immediate because our unit SOP requires at least one instrument rated pilot in the cockpit for all flights in the unit's CH-47 Chinooks due to the high density area in which we operate. With this requirement in mind, the unit set up a training program which would best work in with the aviators' free time. We requested and received a complete set of rotary wing standard instrument course programed texts from the U. S. Army Aviation School, Ft. Rucker, AL, for every pilot in the unit. Once distributed the texts were to be completed prior to actual instrument flight training.

The first group of pilots to be trained consisted of six students and three instructors for a period of 30 days. None of the students had ever possessed a standard card, although all had at least 4 years experience flying. Except for one former basic instruments instructor, none of the instructors had any qualifications other than a standard instrument rating. We were fortunate to have the supervisory services of a unit instrument examiner, although he was not available as a regular instructor.

The first class was largely experimental and several approaches to effective training were tried—largely as a result of a gathering of opinions from the unit instru-

ment examiner, the instructors and the students. The syllabus which finally proved most effective included an introductory flight to establish each student's current level of proficiency with flying under the hood, several hours of basic instrument maneuvers, and the remainder of the program a progressive perfection of the knowledge and skills necessary for the successful completion of the final checkride.

Primary flight training consisted of continuous cross-country IFR flights with an instructor as copilot until the final few flights were conducted with two student pilots and an instructor in the jump seat. Students riding jump seat planned and followed identical flight routes as the student pilot and worked with him in computing time estimates or looking up necessary information when he was otherwise occupied or at a loss for proper direction. As training progressed there was a gradual elimination of the pilot's dependence on his fellow student, until during the final portion of the program each student was entirely on his own except for normal utilization of a copilot.

It was found that little time was required for mastery of basic maneuvers except for partial panel compass turns and fixed card ADF approaches, which appeared to present the most difficulty. No attempt was made to match our syllabus with the training schedule of the instrument course taught at the Aviation School due to our emphasis on a successful checkride within 30 days. All students were encouraged to progress as quickly as possible and training was geared accordingly on an individual basis. The primary and most important emphasis throughout the 30-day program lay with a maximum effort by the individual student to rapidly assimilate the knowledge presented through programed texts, study of Army regulations and Federal Aviation Regulations, and a thorough study and understanding of enroute charts, approach plates and flight planning for IFR flights. In short, it was quickly discovered that flying under instrument conditions was the least difficult portion of the program and that without a thorough knowledge of the rules and procedures prior to flight training any attempt to file and fly practice IFR was a futile exercise.

Another important obstacle we faced was the availability of aircraft and, in this instance, aircraft capable of instrument flight. With four UH-1Ds comprising the "fleet" and seldom more than one or two available at one time, meaningful flight training was often frustrating at best. Several students received the benefit of additional basic instrument training because that was the only form available. However, through a commendable effort on the part of maintenance and one aircraft's remarkable stamina, each student averaged about 1 hour and 30 minutes of pilot time per day, plus an additional 1 hour and 30 minutes jump seat time for 3 of the 4 weeks of training.

A large proportion of the training flights was filed IFR whenever weather permitted. Army regulations prohibit flight into known or forecast instrument conditions without an instrument rated copilot but because there is no stipulation against filing IFR in VFR weather, we made the most of every opportunity to acquaint the students with flight planning and procedures necessary for successful instrument flight.

Another factor in favor of IFR flight plans was the guaranteed airspace and constant radar advisory service available in the northeast corridor. The high density air traffic present in the Washington area is a constant hazard to practice instrument flights, and we found the additional safety of flight following to outweigh the occasional inconvenience of time delays or route restrictions. As a matter of fact, the air traffic controllers were most cooperative in allowing practice holding on the airways and practice approaches into local airports except during peak density traffic. Most important, we found that regular association with the controllers placed additional pressure on the students to progress rapidly in learning correct procedures if for no other reason than to avoid embarrassment over mistakes.

With an average flight time of about 18 to 20 hours spaced over 3 5-day weeks, all six students passed checkrides with an instrument examiner and were found to be competent instrument pilots with only minor discrepancies which were understandable considering the short time frame of their training. The graduation of the six students plus the unit examiner and three instructors now provides the unit with a solid nucleus around which to expand. A continuation of the program is expected to produce another four to six instrument rated pilots prior to the end of the summer. All told, the newly rated pilots combined with several pilots who need only a renewal of their standard card will have brought the 195th from about 4 percent current instrument rated pilots to more than 35 percent in a period of several months. Although it is not expected that the 30-day intensive training program will be viable other than during the summer months due to the restriction of civilian occupations, it seems fair to assume that a combination of the newly instrument rated pilots with the remaining VFR pilots during regular drills and additional flight training periods throughout the year will provide a valuable impetus to achieving the desired goal of 100 percent.

The Answer To Your Question Is NO!

NO! NO! NO! NO! NO! NO! NO!

IT IS SOMETIMES said that we are given just enough factual information to enable us to form our own *confusions*. This can be particularly true in some aspects of aviation.

There is no one publication that contains all of the rules and regulations which govern flight. ICAO, FAR, AR, Supplement, TWX, FLIP, TM, AIM, Dash 10, Advisory Circulars . . . heck, most of us can't even remember all of the sources. In many cases we take an isolated bit of information and form a misconception. These misconceptions often are passed on to others who use them to form other misconceptions.

With several years' experience as a ground instructor I have encountered many misconceptions in the form of student questions or in response to my questions. I have selected 45 of these which have been repeated most often and offered corrections as answers to questions. If you read the answers carefully, I am sure you can figure out the questions.

1. No! You cannot legally [illegible] to procedure turn altitude anytime you are inside the 10-mile circle on an instrument approach procedure chart. Minimum altitudes are published in the procedure and must be flown exactly. The significance of the 10-mile circle is that everything within the circle is drawn to scale. The procedure turn altitude provides obstacle clearance within the turn area whether it is inside or out of the circle. Reference: TM 11-2557-26.

2. No! The controller does not have to state "cleared straight-in" in order for you to make a straight-in approach when being radar vectored to the final approach course; it is automatic. When being radar vectored to the final approach course, you are prohibited from making a procedure turn unless you request to do so and receive a clearance from ATC. Reference: TM 11-2557-29, paragraphs 23 and 1360.

3. No! You are not required to comply with nonstandard takeoff minimums published at civilian airfields. Your legal takeoff minimums are those required by AR 95-1 for your instrument rating. But, when nonstandard takeoff minimums are published, they should be given careful consideration as a safety factor. Reference: AR 95-1.

4. No! The controller does not have to give you a runway number in all cases when issuing an approach clearance. If there is only one approach of a particular type at an airfield, the approach clearance does not have to include a runway number. However, if the aircraft is to land on a runway other than that to which the approach is flown, the term "circle to runway (number)" must be included. [Example: " Cleared ILS (instrument landing system) approach circle to runway 18."] Reference: TM 11-2557-29, paragraphs 1020 and 1022.

5. No! Your off time is not automatically relayed to FSS when you depart a civilian field. It is automatic at military airfields, but it is the pilot's responsibility to give his off time to FSS when departing civilian airfields. Reference: DOD FLIP (Department of Defense

NO! NO! . . . (If Field Grade or Above "NO SIR!")

Hubert C. Pate, DAC Academic Instructor, U.S. Army Aviation School

NO! NO! NO! NO! NO! NO! NO! NO!

INSTRUMENT CORNER

Flight Information Publication), section II, Pilot Procedures.

6. No! You are not required to read back all ATC clearances. "Roger" means that you have received and understand the transmission. However, if there is any doubt on any part of the clearance, it is a good idea to read back for clarification and to ensure that no mistake is involved. Reference: AIM, part 1.

7. No! It is not necessary for the controller to give all items required in the initial clearance to amend a previous clearance issued. The amended clearance changes only that portion of the original clearance to which it refers, and all other items remain unchanged. Reference: FLIP, section II; TM 11-2557-29, paragraph 721.

8. No! You do not have to receive a clearance to change altitude when cleared to maintain "VFR conditions on top." You may change altitude at your discretion but are required to inform air traffic control of the change. Reference: FLIP, section II.

9. No! The controller is not required to give you an "expect further clearance time" when he clears you short of destination. The controller should issue further clearance at least 5 minutes prior to arrival at the clearance limit; however, if further clearance has not been received within 3 minutes, you should adjust your air speed and prepare to hold at the clearance limit and request further clearance. Reference: FLIP, section II.

10. No! Minimum sector altitudes are not shown on all instrument approach procedures charts. Minimum sector altitudes will not be indicated for back course localized approaches without an NDB (nondirectional radio beacon). Also, the FAA omits minimum sector altitude data from some procedures for charting convenience. Reference: TM 11-2557-26.

11. No! When sector frequencies are shown for approach control (i.e., 90-270—286.5—270-90—284.6), the frequency to use is not determined by direction of flight. The frequencies are designated for aircraft operating in those sections regardless of the direction of flight. Reference: AIM, part 3.

12. No! The size of the VOR (VHF omnidirectional range) compass rose on an enroute chart does not indicate its power output or usable range. The size of the compass rose is determined by space available and many VOR compass roses are made small to prevent chart clutter. Reference: U. S. Government Printing Specifications.

13. No! The test position of the ARN (airborne radio for navigation) 82 does not serve as a VOR receiver accuracy check to meet the requirements of FAR (Federal Aviation Regulation) 91.25. It serves only as a test of the components of that particular set. Reference: FAA ruling.

14. No! "Hold as depicted" is not a correct clearance for holding at a fix where there is a charted pattern. The correct clearance is: "Cleared to Pansey Intersection, hold southeast, expect further clearance 12:45" or "cleared to Cairns outer compass locater, hold

southwest, expect approach clearance 12:45." Reference: TM 11-2557-29, paragraph 900.

15. No! The controller is not in error when he vectors an aircraft below the MEA (minimum enroute altitude). An aircraft may be vectored below the MEA but not below the MOCA (minimum obstruction clearance altitude) if lost communications instructions are given. Reference: TM 11-2557-29, paragraph 791.

16. No! An assigned altitude is not a required part of a holding clearance. It is assumed that you hold at the last assigned altitude unless a specific altitude change is given. Reference: TM 11-2557-29, paragraph 903.

17. No! The examinee does not have to have a current instrument rating for an instrument flight examination to be conducted under actual instrument conditions. An examiner and an examinee meet copilot requirements if the examiner has access to the aircraft controls at all times. Reference: TWX change to AR 95-1.

18. No! The "Blue Table" is not a piece of furniture. It is a table showing units of measurement used by some countries. Reference: FLIP, section II.

19. No! You cannot descend below the circling MDA (minimum descent altitude) for a circling approach in order to remain VFR while circling to the landing runway. The MDA is the lowest legal altitude until the aircraft is in a position for final descent to the landing runway. Reference: AR 95-1.

20. No! The word "holding" is not required as a part of the report when arriving at a holding fix or clearance limit in a nonradar environment. Since in both cases you are required to hold, it is obvious you are doing so. (Correct: Army 12345, Dothan VORTAC (VOR TACAN) 15; 5,000; or Army 12345, Dothan VORTAC 15; 5,000 request further clearance.) Reference: FLIP, section II.

21. No! Regulations do not require you to request altitudes for IFR (instrument flight rules) flight in controlled airspace in accordance with the semicircular altitude rule for direction of flight. You may request any altitude but are required to fly at an altitude assigned by ATC when flying IFR in controlled airspace. FAR 91 requires that you fly at altitudes in accordance with semicircular altitude selection for all IFR flights in noncontrolled airspace. Reference: AIM, part 1; FAR 91.

22. No! The glide slope needle is directional when shooting a back course ILS. Back course glide slopes are now being installed at many locations where operational advantages may be gained. When shooting a back course ILS you still fly away from the localizer needle but toward the glide slope needle. Reference: TM 1-225.

23. No! ATC is not required to inform you that weather conditions at your destination are below minimums on arrival. When weather is below published minimums ATC will give weather to each arriving aircraft and allow the pilot to make the decision on whether or not he can make the approach according to his own governing regulations. Reference: TM 11-2557-29, paragraph 1001.

24. No! An airport does not have to have a control tower operated by the U. S. Government in order to have an airport traffic area. An airport traffic area is an area around an airport with *any operating control tower*. Reference: TM 11-2557-29, Definitions.

25. No! Zero-zero doesn't mean exactly that. The ceiling is reported to the nearest 100 feet and the lowest reportable visibility value is 1/16 statute mile. Therefore, zero-zero will be reported any time the ceiling is 50 feet or less and the visibility is less than 1/16 statute mile. Reference: TM 1-300.

26. No! The controller is not in error if he issues an IFR clearance for an aircraft to operate in a restricted area. It is the responsibility of the controller to obtain clearance from the using agency for the aircraft to operate in a restricted area, or else to route the aircraft so that the restricted area will be avoided. Reference: TM 11-2557-29, paragraph 880.

27. No! You should not transmit V-16 as "victor one-six." You should transmit it as "victor sixteen." Airways numbers should be transmitted as spoken. Reference: TM 11-2557-29, paragraph 170.

28. No! Flight service stations do not have the authority to originate ATC clearances for IFR flight. Flight service stations do not have control authority or responsibility but in many cases will relay ATC clearances for IFR flight which originate from ATC agencies with control function. Reference: FAA manual 7230.1.

29. No! An ATC clearance "cleared as filed" does not include the requested altitude for the flight. In an abbreviated clearance the assigned altitude must be stated even though it is the same as the requested altitude. Reference: TM 11-2557-29, paragraph 951.

30. No! You cannot use prevailing visibility to initiate a

straight-in approach when RVR (runway visual range) is published and reported for the landing runway. RVR is the controlling visibility factor when published and reported for a given runway.

(Example:

Approach Minima

S-ILS-17 496/24 200 (200-½)

Wx—W3X3/4F R17VR15. No, you can't initiate the approach. RVR is inadequate.

Wx—W1X1/16F R17VR25. Yes, you can initiate the approach. RVR is adequate.)

Reference: AR 95-1.

31. No! The airways MEA does not ensure 2,000 feet obstacle clearance over designated mountainous terrain. In the western United States the MEA assures 2,000 feet terrain clearance but only 1,000 feet above the highest man-made obstacle. In the eastern United States mountainous terrain clearance is reduced to 1,500 feet. Reference: FAA Advisory Circular 95-1.

32. No! Approach lights are not a component of the ILS. The components of the ILS are localizer, glide slope, outer marker and middle marker. The approach lights are a visual aid normally associated with the ILS. Reference: TM 11-2557-26, paragraph 910.

33. No! The middle marker is not the missed approach point for ILS. The ILS missed approach point for ILS is a point on the approach course where the height of the glide slope equals the decision height. In some cases it is coincidental that they are collocated. Reference: TM 11-2557-26, paragraph 941.

34. No! You will not be given recommended altitudes during an ASR (airport surveillance radar) approach unless you specifically request them. Recommended altitudes are not essential since the ASR is a nonprecision approach and the pilot may descend to the MDA at his discretion after the final approach has commenced. Reference: TM 11-2557-29, paragraph 1470.

35. No! An ATC IFR clearance does not guarantee separation from all aircraft, only separation from known aircraft. The pilot is warned that if he is in VFR conditions on an IFR flight plan, it is his responsibility to look out for other aircraft. Reference: FLIP, section II.

36. No! ATC does not provide separation for IFR flights in noncontrolled airspace. Noncontrolled airspace is that airspace within which ATC has neither the responsibility nor the authority for exercising control over air traffic. Reference: AIM, part I.

37. No! RVR cannot be used to replace both ceiling and visibility for takeoff minimums. RVR can be used for visibility only. You also must have the ceiling requirement. Reference: AR 95-1.

38. No! You do not have to be on an IFR flight plan to conduct flight in the continental control area. You may fly VFR if VFR weather conditions exist and your flight doesn't penetrate positive control airspace. Reference: FLIP, section II, Pilot Procedures, Enroute.

39. No! You do not have to obtain permission from the using agency to conduct flight in an alert area. An alert area is designated to alert pilots to unusual activity, but you can operate in those areas at your discretion. Reference: FLIP, section IIB, Legend.

40. No! The controller is not required to instruct you when to execute missed approach on a PAR (precision approach radar) approach. He must inform you when you are passing through the published decision height, but your own minimums govern your missed approach. Reference: TM 11-2557-29, paragraph 1500.

41. No! You cannot legally use your required 45 minute fuel reserve to hold at destination waiting for weather to improve. You may elect to hold only if weather is forecast to improve and *all* alternate requirements can be met. Reference: AR 95-1.

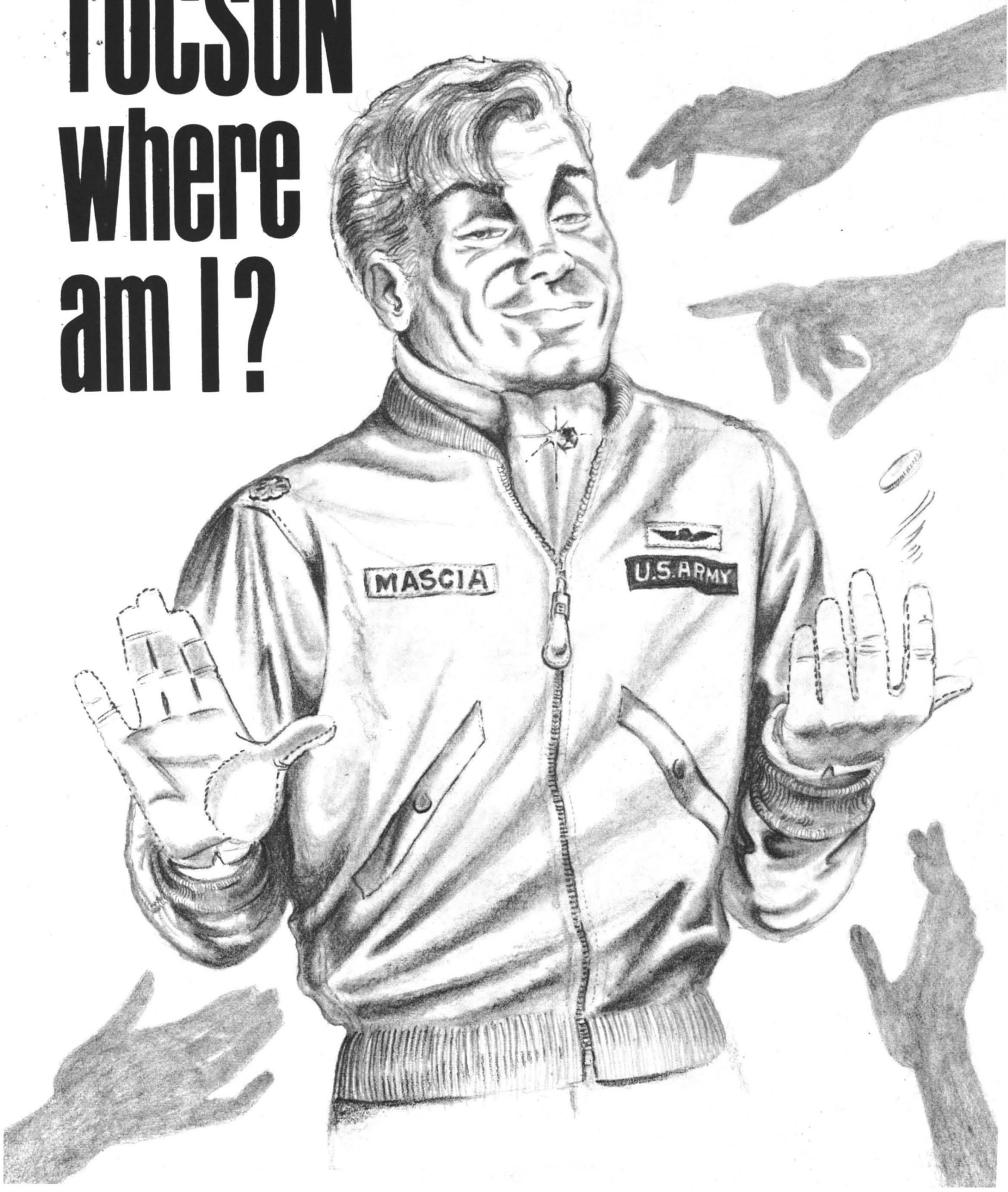
42. No! You cannot legally fly IFR in the 60 day period allowed for renewal of instrument qualification after expiration or invalidation. Aviators who hold *current* instrument ratings may be cleared for flight under instrument flight rules when all IFR requirements can be met. Reference: AR 95-1.

43. No! ATC does not provide IFR separation for aircraft cleared to "maintain VFR conditions on top." When a pilot requests and accepts VFR conditions on top in lieu of a specific altitude he assumes responsibility for his own separation from other aircraft. Reference: FLIP, section II.

44. No! The control tower does not automatically close flight plans for arriving aircraft. It is the pilot's own responsibility to close the flight plan with military base operations or an FAA communications facility. Reference: AR 95-1.

45. No! Your approach minimums are not changed due to approach light or marker beacon outage. Increases in published visibility or minimum descent altitude need not be applied under the conditions of runway approach lighting or marker beacon outage. Reference AR 95-1.

TUCSON where am I?



Every time I flew on a mission, the students waited to see if I would have an empty seat. They longed to fly with me. When I approached them, they clamored for a touch of my hand or for my autograph

Lieutenant Colonel Donald J. Mascia

SOON AFTER graduation day at Ft. Leavenworth, KS, I found myself proceeding out the gate and heading for my new desert home at Ft. Huachuca, AZ. Little did I know that after 1 year of my hermitage at Ft. Huachuca my wife (by legal order) would be spurning me, my three boys ignoring me like I have Montezuma's revenge, my broker not calling or writing anymore and my neighbors keeping me away by continually operating their sprinklers in 360 degrees.

Please allow me to tell you how this all happened. It commenced this way. After I turned in my flight records at Ft. Huachuca's Libby AAF operations, I glanced at the scheduling board to see if I knew any of the local aviation personnel. I almost collapsed when I saw—you remember him—Sparko! Apparently he had shunned fixed wing and now was crewing a UH-1 Huey.

I was mesmerized for a few minutes as my thoughts went back, many years, to my experiences with this "majestic" individual. As you recall, or should recall, I introduced you to Sparko in June 1966 in a U. S. ARMY AVIATION DIGEST article entitled "Would You Believe Four Fingers?" and then again in February 1969 in "A Wink, A Nod, And A Smile." I almost danced with glee as I departed operations—but, I had to keep my composure now that I branch transferred from Infantry to Military Intelligence. I, with haste, located Sparko and we warmly reminisced about the good old days. Again, I could have Sparko as my faithful companion and team member.

About 1 year later the Walter Mitty affair took place. I was to fly Colonel Blunt, plus three, from Libby to Tucson. Takeoff was set for 0730 hours and as usual it was a wait-and-return mission. When I departed Company E's messhall, the students had already assembled around the mess building. Rumors ran rampant every time I flew a mission and the MI students always waited to see if I had any empty seats . . . they longed for the chance to fly with me, The Baron, and Sparko.

I ensured, unobtrusively of course, that the rumors reinforced the fact that our flights were quick, flawless and unparalleled by other military mortals. What a team Sparko and I made—not a word had to be spoken from the ramp to shutdown (*Editor's insert: I see neither had learned their lessons*). As we approached operations another group of men clamored for a touch of the hand or an autograph. I waved, smiled and pushed my way through the throng. (Oh, that was so good for my ego!)

I filed a quick flight plan and glanced out for my normal weather check. No sweat, I thought, I can just pull pitch and be through that low cumulous in no time.

I proceeded to the VIP lounge and greeted my uneasy passengers. I assured them that at no other time would they have such a skillful crew guiding them over Cochise County, Mustang Pass and into the Tucson area.

After a few minutes of small talk (cliches and boasting) we proceeded to the ramp. The Hueys were ubiquitous (*Editor's insert: I think he means all over the place*). However, if you looked far enough you could still see a couple of old fixed wing aircraft on the ramp—as you recall they were involved in my previous (*Editor's insert: And somewhat precarious*) situations.

When we approached the beautiful UH-1H I gave the skid a good kick. "Solid looking ship," I said to my "pale" passengers. (I'm convinced that 06s do not like to view the earth from above.)

"What model is this?" asked Colonel Blunt.

Incredulously, I answered, "This is one of our newest and finest, sir." (Oh, the poor uninitiated!)

"How's the engine?" Colonel Blunt asked.

Sparko winked. I knew that very old signal. "The turbo is fine, sir, and the runup is complete," I said.

I immediately displaced to the other side of the Huey to prevent further questioning and to conduct my preflight. (The tail rotor and the main rotor looked good as I quickly circled the Huey.)

Sparko assisted the passengers into their seats and gave special attention to Colonel Blunt (Sparko does make points for me whenever possible).

I struggled (I'm somewhat corpulent) (*Editor's comment: He's not really "fat," just large for his age*) into my seat and adjusted the pedals and harness.

I glanced at Sparko and he smiled so I was sure all was ready.

I put the starter switch on and shortly thereafter I heard the familiar whop-whop-whop.

I adjusted the engine to 6600

rpm and Sparko's smile was the signal that all was well.

The green light was the tower's signal to me that I was clear. They knew who was at the controls; they loved me because I didn't make unnecessary calls.

Sparko nodded, I pulled pitch and broke left toward Mustang Pass.

When Sparko pulled his visor down I knew we were on course, on altitude and on everything!

What finesse! Any other crew would still be running through the checklist, groping for the inventor switch (*Editor's insert: He probably means "inverter"*), caution lights, etc.

From the movement in the rear I could tell the passengers were straining in their seats attempting to watch the gesticulating "virtuosos" in action. Not a word had been spoken—what a team!

Sparko tuned in Tucson and when I leveled out at 8,000 feet Sparko keyed the mike button—the signal that he had had it! (*Editor's insert: There's one "had" too many in there. Or is there?*) With the skill of a senior Army aviator Sparko adjusted the pitch and rpm and then proceeded on course. I knew I wouldn't have to touch the cyclic or collective again until short final.

One glance at Colonel Blunt indicated that our talent in the cockpit had him mesmerized (*Editor's insert: That's the second time he's used that crazy word which could mean "spellbound" or in this case "scared-to-death"*). Another plus for Army aviation, I thought. I tuned in Tucson and settled back to catch a few winks (Sonny and Cher sounded great—"A cowboy's work is never done . . .").

Suddenly, I was violently awakened when Sparko hit my right shoulder. A new signal?

Sparko broke our "traditional" silence with a shrill voice, "We're IFR!"

"No sweat, Sparko, I have it," I said (poor chap).

After tuning in 321.0, I called Tucson Approach.

"Tucson GCA, this is Army 733, 8,000 over."

"Army 733, Tucson, read you loud and clear."

"Army 733, request GCA, heading 350 degrees, position unknown."

"Roger 733, Tucson GCA, turn left 270 degrees, maintain altitude for radar identification."

"Ah, roger, turning to heading 270 degrees at this time." [I noted my passengers were azure (*Editor's insert: That's blue*) in color. If they only knew who was at the controls; really, I should be flying multihued 707s.]

"Tucson, Huey 733, heading 270 degrees."

"Roger, Huey 733, Tucson, reply mode 3, code 04, over."

Sparko broke in, "Sir, the transponder is inop!" (No sweat, I thought. How long will it take Sparko to realize who is at the controls? It's me, the Olive Baron!)

"Ah, this is 733, the transponder is inoperative."

"733, Tucson, what is your present altitude?"

"This is 733, altitude 8,200." (Much to my surprise I'd gained a few feet!) (*Editor's insert: And lost a few pounds.*)

The air conditioner, TV, oven and bicycle now have checklists

"Roger, 8,200, what is your present heading and approximate position?"

"Present heading 270. Location unknown."

"733, Tucson GCA, can you maintain VFR?"

"733, negative." (Is he questioning my IFR conditions? The fool!)

"733, roger, GCA advises negative radar contact, report over the omni."

"This is 733 . . ."

Sparko broke in again, "Sir the omni is inoperative. I wrote it up yesterday."

"No sweat," I stated in my normal confident voice. "Tucson, I've lost my omni."

"Roger, 733, you are lost at present time. Is this affirmative?"

"733, that's affirm." (At that particular moment I could have cried. If Colonel Blunt could have heard that, I would have.)

"733, roger, what is your present heading? Over."

"This is 733, wait."

What now, I thought. My gyro was revolving wildly. Before I could say anything Sparko broke in again, "Sir, we had a precessing gyro which I wrote up yesterday."

I looked at him incredulously! Is this my crewchief, Sparko? Why didn't he tell me?

"733, this is Tucson, what is your present heading?"

"Tucson, 733, present heading 080." (How did I end up with this heading?) (*Editor's insert: Maybe it's got something to do with "incredulously."*)

"733, thank you, turn right to heading 140 degrees for identification, maintain 8,200. Over."

"This is 733, wait." (My instrument flying isn't as sharp as I thought. Maybe I should have flown it rather than logging it to meet that minimum.)

"Army 733, Tucson GCA, advised we have negative radar contact. What is your present heading?"

"733, my present heading is 210 degrees." (I felt my voice had a higher than normal pitch.)

"Army 733, advised negative radar contact. Request approximate position, please."

"This is 733, I'm in severe turbulence. I'm unable to determine my position." (Again, I noticed my voice was high and strained. It took physical effort to say that short phrase.)

"733, roger, what is your present heading again, please?"

"This is 733, wait." (I was having a rough time; the turbulence and gyro were driving me wild. Additionally, I was suffering from an upset stomach, disorientation and vertigo!)

"Army 733, Tucson GCA, over . . . Army 733, Tucson GCA, over."

I was perspiring excessively and felt nauseated. (*Editor's insert: He's no longer "corpulent."*) Oh, that SOS! I could feel the sweat streams running down my cheeks and arms. The air speed was moving rapidly past 130 knots and I felt as though I couldn't move a muscle in my body. Suddenly, I heard a ripping sound and the empennage fishtailed violently. I looked at Sparko for assistance but he resembled a manikin—pale, lifeless and speechless. I could hear my passengers barfing (*Editor's insert: I give up!*) and screaming and this added to my indigestion. The air speed was moving past 140 knots. I glanced at the vertical speed: pegged! I was sure everyone in the Huey could hear my heart—it was pounding like a triphammer. Instantly, it seemed, there was a blinding light.

We were VFR and closing rapidly on a rock-studded ridge line. Many thoughts raced through my mind in those few seconds. I could see the other aviators throwing rocks at my coffin . . . this was the only UH-1H available for combat readiness flying. My next vision was of the commanding officer of Libby AAF hanging on the curled rotor blade crying like a baby (he loved 100 percent availability.) The other officers, those not throwing rocks, were standing there like a piece of marble looking incredulously at the pile of instant garbage. The crowd, my admirers, stared disbelievingly; it couldn't be the virtuosos!

I yanked the cyclic and pulled the collective. It was too late, the end was near!

Thump, thump, thump! "Sir, sir, wake up, we're on final for 27, you have it."

I couldn't believe it! I looked out suspiciously and a broad smile came upon my face . . . good old Sparko! I thought my days were over. It was good to be at Ft. Huachuca.

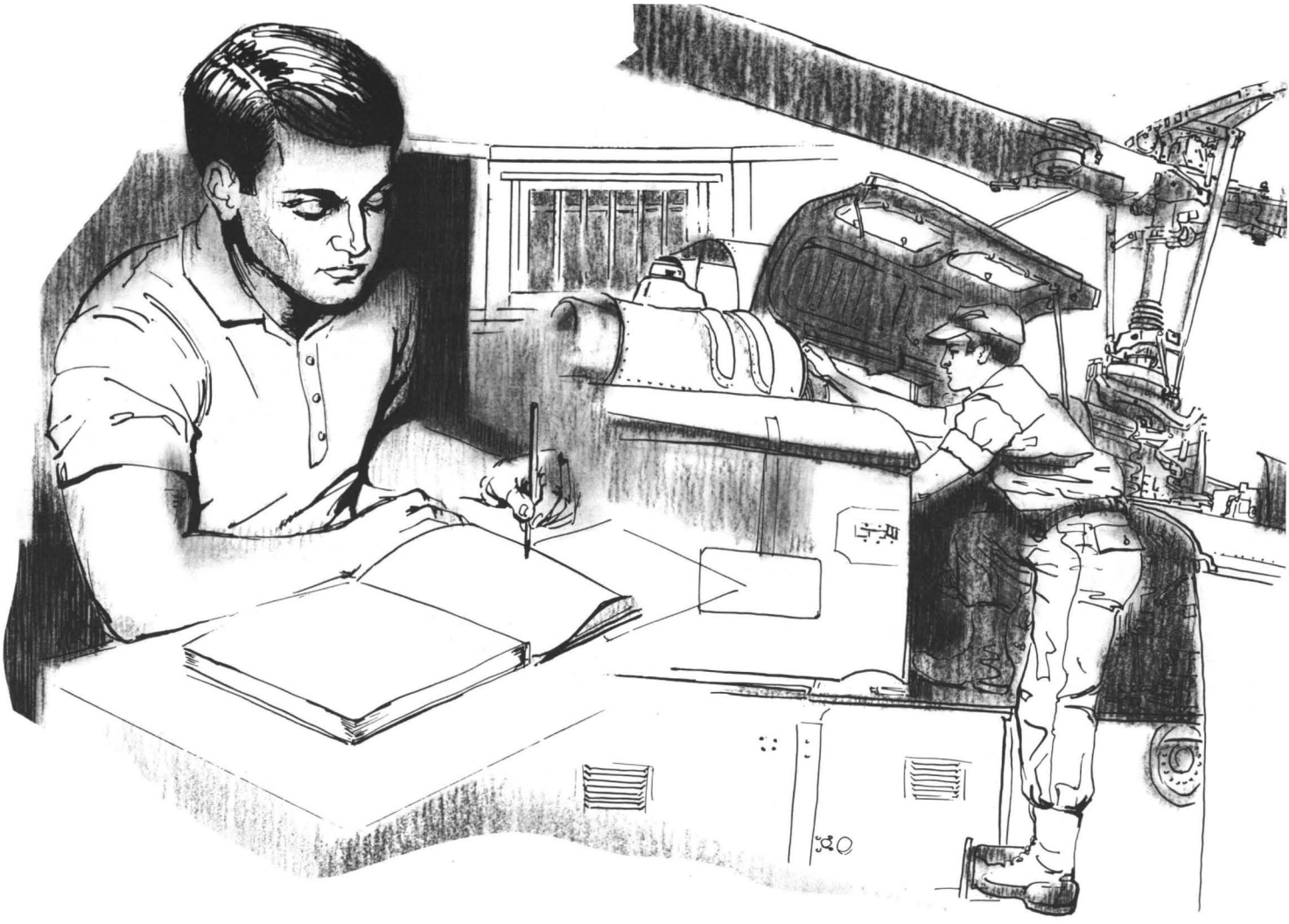
Since that infamous day I have made the metamorphosis from a pseudo "Olive Baron" to a logbook, checklist using aviator. Many say I am "loquacious" in the cockpit, but I can truthfully say that Sparko and I are really a team—after all these years (*Editor's insert: I hope so*).

At home I have acted accordingly. My old 1968 rumbling wreck and new car each has a logbook and I have attached checklists to the oven, bicycle, air conditioner, color TV and sundry other items that require literature. But, *they* don't understand! Still, I continue to rant, rave and holler, "Read the logbook, use your checklists!"

I've warned them all. If they do not use the logbook and checklists, I'll spank them from the beginning of their "exterior" check to the end of their "after operations" check.

So, am I wrong when I holler, scream and yell, "Read your logbooks and use your checklists!"?

(*Editor's insert: Similarities between or among persons and events in this article are coincidental . . . aren't they?*)



An Academic Overview

Most career-minded commanders know the importance of training programs for preparing individual soldiers to successfully pass Army training tests. To keep abreast of our ever-changing aviation technology, the Army Transportation School at Ft. Eustis, VA, will continue to provide the training and training guidance literature necessary for him to qualify as a professional in his chosen aviation military occupational specialty

Lieutenant Colonel Curtis J. Johnson
Chief, Plans, Training & Testing Division
DDLP, Fort Eustis, Virginia

IN TODAY'S ARMY more and more emphasis is being placed on the individual soldier—his welfare, his reaction to social changes, his choice of military occupational specialties (MOSs), and the training he needs to qualify as a professional in his chosen MOS. Service schools are displaying renewed interest and dedication to the development of curriculums and other media for training the whole soldier.

The principal objective of a service school is to increase the Army's professionalism by providing expert training and training guidance to soldiers at all levels of technical development. Let's consider, for example, one facet of this development—training and training guidance in the field of Army aviation maintenance.

As the Continental Army Command's (CONARC) proponent agent for Army aviation maintenance training, the U.S. Army Transportation School (USATSCH) at Ft. Eustis, VA, provides the academic and technical guidance needed to produce optimum professionalism in this field. In keeping with the fast pace of modernization, the Transportation School is striving to provide new and better training techniques for a new breed of soldier to better maintain Army aircraft.

The Army Transportation School is directing, coordinating and supervising the publication of needed transportation training documents and is providing the resident instruction to meet training requirements.

As part of the current training literature program for which it is responsible, USATSCH researches, organizes, prepares, coordinates and forwards for publication 10 technical manuals, four special texts and one training circular, all concerning some facet of Army aircraft maintenance. Specific subjects include powerplant and airframe maintenance, hydraulics, instruments, electricity, propeller and rotor maintenance, problems encountered while maintaining aircraft under extreme environmental conditions, and maintenance procedures, technical inspections, quality control procedures, and maintenance management and production control. Also, currently under development are procedures to use in the recovery and evacuation of Army and selected U. S. Air Force aircraft employing the aerial recovery kit which is being service tested by the U. S. Army Test and Evaluation Command (USATECOM).

Basic and advanced aviation maintenance training guidance publications in the inventory or being produced by the Transportation School include 19 Army subject schedules (two designed for unit training and 17 for teaching individual technical skills), five Army training programs and five Army training tests. Development of each of these documents requires a high degree of technical knowledge combined with a common-sense approach from concept to printed document. Intermediate steps include planning and organization, extensive research, preparation of initial draft, analysis and evaluation by technicians, internal staffing with the academic departments, review by users in the field and final draft based on comments received from field elements. CONARC then reviews these drafts and forwards them to The Adjutant General for publication and Army-wide distribution. Such publications are written for active Army and National Guard and Reserve Components Transportation Corps units and personnel. They reflect the essential training and unit testing required to prepare and evaluate the capability of the individual and his unit to perform prescribed missions.

"Hands-on" training has emerged in recent years as an ideal teaching method. The Transportation School uses 27 programs of instruction in providing subject matter extending from basic subjects taught to enlisted mechanics to complex maintenance test flight procedures taught to experienced Army pilots. Intermediate levels of instruction include training for aircraft enlisted supervisors, technical inspectors and aviation maintenance officers.

The aviation maintenance training workload is made up primarily of enlisted soldiers, with a larger percentage of student input from basic training centers. There are, of course, available courses above the journeyman level; the newest to be implemented during October 1972 is the Noncommissioned Officers Advanced Course. Officers courses include the Aviation Maintenance Officer Course and Aircraft Maintenance Test Pilot Course.

Instruction in the basic aviation maintenance courses is characterized by practical shop training which emphasizes the accomplishment of tasks in keeping with the age-old saying, "Men learn by doing." Demonstrations and laboratory exercises also are used extensively. For students in advanced and special courses a shop laboratory was established to introduce conditions and problems students may encounter after completion of the various courses. The laboratory incorporates current maintenance and management problems from the field to give students the opportunity to solve these problems while in an academic environment. Additional available training facilities include 44 classrooms (about 1,800 square feet each), 99,800 square feet of applied shop space, 214,000 square feet of hangar space and 500,000 square feet of aircraft hardstand.

Higher levels of training for the enlisted soldier include aviation maintenance shop supervision and aviation systems management. In attempting to provide personalized instruction with attention to individual differences and student attitude, USATSCH has introduced a new training method which prescribes a class of from 6 to 12 students. Further student assistance is provided by student counselors who assist in resolving academic and personal problems.

Application for resident courses will vary according to active Army, National Guard and Reserve Components category. Active Army commanders should apply for school quotas through channels to the appropriate Army area commander. National Guard and Re-

serve Components commanders also apply through channels to the Office of the Chief, Army Reserves, Department of the Army; and the Chief, National Guard Bureau, Washington, DC 20310, respectively. In the case of Army Reserve personnel, only active status members are eligible for selection. Further information may be obtained by writing to: Commandant, U. S. Army Transportation School, ATTN: DOI, Ft. Eustis, VA 23604.

Another training medium that helps the individual soldier to keep in step with advancing aviation technology is that part of the Transportation School's correspondence course program which is devoted to aviation maintenance. Individual subcourses are planned, organized, researched and prepared by highly qualified personnel. Analysis and technical evaluation are the final steps before printing and issuing. Correspondence courses are available for MOS advancement for airframe, powertrain, rotor, propeller, and turbine and reciprocating engine repairmen.

Correspondence courses are written for members of all components of the Army, members of other U. S. military services, eligible civilian employes of the Department of Defense, and others specifically authorized by the Commanding General, U. S. Continental Army Command. Because more emphasis is being placed on individual competency, the soldier can join about 6,000 fellow soldiers who are enrolled in MOS-related aircraft maintenance courses. He can earn promotion points by completing correspondence courses at the rate of ½ point for each credit hour up to a maximum of 125 points. Although these courses are MOS-related, they do not qualify the student in an MOS. However, they do teach theory and principles essential to the occupational specialties.

The enlisted evaluation system serves as a measuring stick for evaluating the MOS competence of eligible aviation maintenance enlisted personnel in grades E-3 and higher within the same MOS and skill level. An important facet of the enlisted evaluation system is MOS testing. The Transportation School has proponency for MOS evaluation test items for 22 aviation MOSs. Many enlisted men holding these MOSs do not know where their tests originate and may be surprised to learn that these tests are prepared by highly qualified noncommissioned officers under direction received from CONARC and the U. S. Army Enlisted Evaluation Center (USAEEC), Indianapolis, IN. Perhaps more surprising may be the qualitative management used in producing test items that accurately measure job performance. The item writers, usually in grade E-6 or above, prepare test items under the supervision of test development noncommissioned officers (monitors).

Rather than formulate test items from simple facts, the NCO monitors develop them from actual job situations which will require the examinee to apply his academic knowledge and practical experience to arrive at the best solution. After careful review of all test items by a qualified aviation maintenance technician, an ad hoc "murder board" examines the test items for adherence to current doctrine, correctness of format and technical accuracy. This methodology has continually assured a higher-than-normal acceptance rate of test items submitted to the USAEEC.

Along with the test questions goes a list of references and correspondence courses for inclusion in the examinee's study guide. The results of these tests, administered worldwide to aviation maintenance personnel on a scheduled basis, influence promotion, classification and assignment, further training, proficiency pay awards and reenlistment.

The career-minded enlisted man is very much aware of the many facets of the enlisted evaluation system. He knows he must obtain an MOS test score established by the Department of the Army to be eligible for proficiency pay. He realizes the importance of the enlisted efficiency report (EER) in determining the total evaluation score (the evaluation test constitutes 60 percent; the EER equates to 40 percent). The young career-minded commander knows the importance of a training program with allied Army subject schedules, technical manuals and other publications and training media in preparing individual soldiers to successfully pass an Army training test. The Transportation School will continue to provide the training and training guidance literature that will allow the aviation maintenance field to keep abreast of ever-changing aviation technology.

Technical publications, training guidance literature, MOSs and skill levels for MOS testing, MOS-producing and MOS-related resident courses, and applicable correspondence courses are available upon request to provide the reader a ready reference to Army aviation maintenance training.

A Correspondence Course Catalog which provides all the necessary instructions and application blank for enrolling in the correspondence program was distributed to major active Army and National Guard and Reserve Components units on 1 July 1972. Should your unit not have a current copy (1972-73), one can be obtained by writing to: Commandant, U. S. Army Transportation School, ATTN: ATSTC-NE, Ft. Eustis, VA 23604.

UNIVERSAL:

Aircraft Recovery Kit

Here is a system that may lead to the rapid evacuation of all disabled aircraft, regardless of their condition or location

Robert A. Matthews, DAC
Research Development & Engineering Subsystems Branch, USAAVSCOM

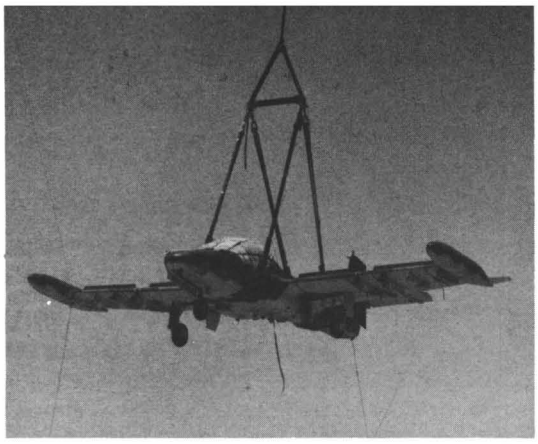
THE INTENSITY of the conflict in the Republic of Vietnam in the mid 1960s generated a host of new support equipment requirements for the rapidly expanding roles and missions of Army aviation. One such item was an aerial recovery kit that would possess the necessary equipment and procedures to evacuate all crashed/disabled Army aircraft in locations inaccessible to surface vehicles. The kit was to be lightweight and easily transportable. It was to be durable and designed in a manner to rapidly rig and evacuate any aircraft. Above all, the kit was to possess the inherent strength and flexibility necessary to recover all aircraft, regardless of condition, again and again.

The U. S. Army Aviation Systems Command (AVSCOM) at St. Louis, MO, was tasked with the overall development and testing of such a system. Sikorsky Aircraft Corporation was awarded a contract for a concept formulation study which would investigate all aspects of the problem and recommend a sound technical approach within the guidelines of current capabilities and within reasonable cost. Inputs from recovery units in Vietnam were obtained in support of this contract effort. The study results are contained in AVSCOM Technical Report 68-2. Subsequently, a competition contract was awarded to the Scientific Division of Dynascience Corporation, Philadelphia, PA, for the design, development and contractor testing of the aerial recovery kit. The kit was to be designed in accordance with the requirement's technical characteristics using the concept formulation study as a guideline.

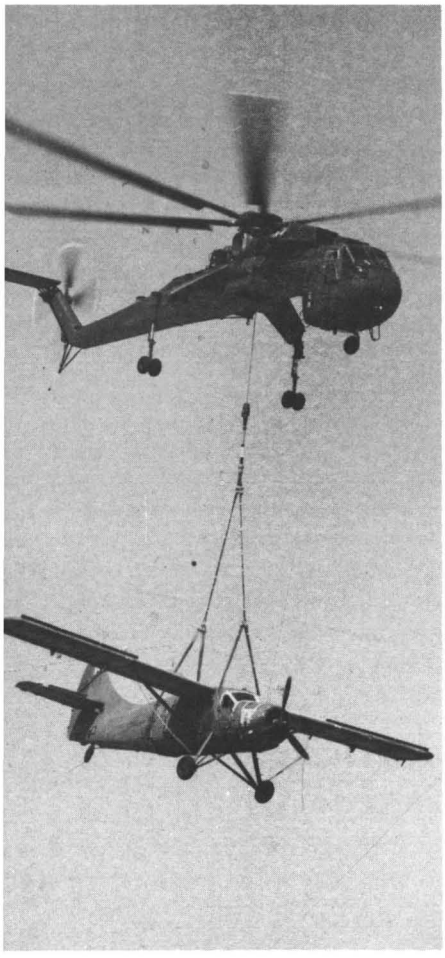
The primary recovery concept selected utilizes bellybands designed to be applicable to all current Army aircraft with inherent spring characteristics to eliminate vertical bounce. An alternate figure eight rotor head procedure is provided for light, single rotor helicopters. Stabilization is by drogue chute. Load spreaders (cushioned aluminum braces) are provided for insertion between the bellybands and fuselage. They distribute the load to adjacent spars to eliminate local and/or progressive skin buckling. Spreader bars are another component which, when used with the bellybands and load spreaders, provide both a functional configuration for the larger aircraft and spread the bellybands to prevent local skin buckling. There are lightweight spoilers for fixed wing aircraft to prevent the recovered aircraft from "flying" in transit. The preceding are key components; included also are the necessary manuals and support components to ensure safe and reliable recovery.

The kit is designed to recover a 24,000-pound load with the bellyband procedure which corresponded to the anticipated CH-47C weight at the time the kit design configuration was "frozen." The rotor head procedure is designed for 20,000 pounds. To ensure reliable safe recovery design load factors for inertia loading, aerodynamic loading, c.g. travel, stitching, ultraviolet deterioration and a 1.5 safety factor are accounted for in the suspension design. The summation of these factors translates into ultimate loads well in excess of 100,000 pounds for a bellyband sling configuration and 80,000 pounds for the rotor head procedure.

Early prototype kits were available for testing by the U. S. Army Test and Evaluation Command (TECOM) at Aberdeen Proving Ground, Aberdeen, MD, in early 1971. An engineering design test on these prototypes was initiated at Yuma Proving Grounds, Yuma, AZ, in January 1971. The results



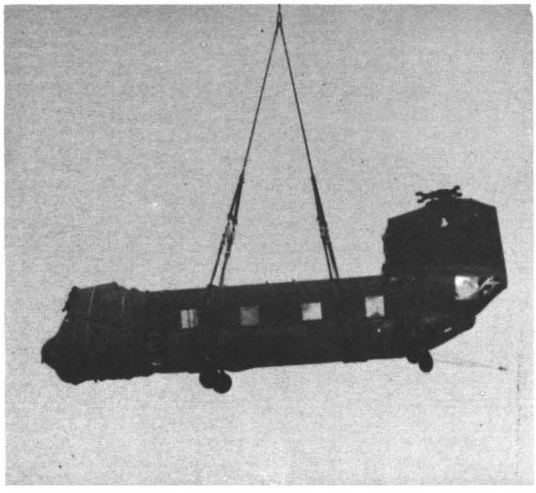
The primary recovery concept selected for evaluation utilizes bellybands as illustrated by the rigged A-37E aircraft (right), the U-1A Otter lifted by the CH-54 (below), the CH-53 lifted by the CH-54 (bottom) and the CH-47 (bottom right)

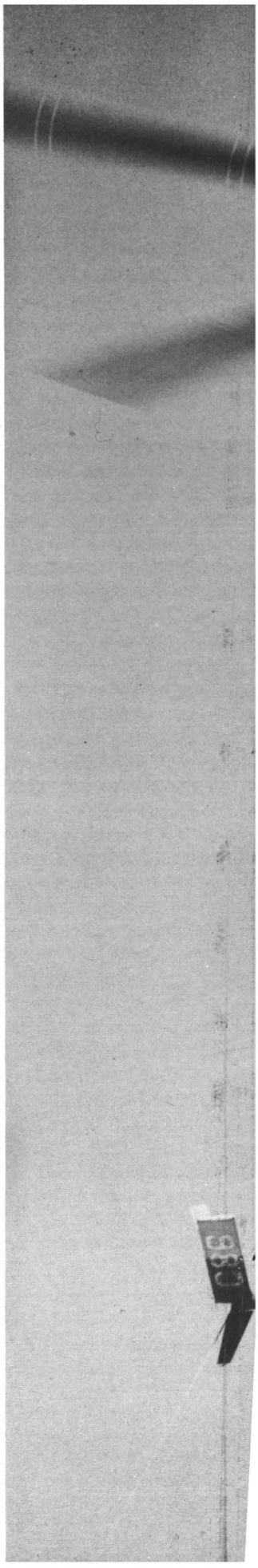


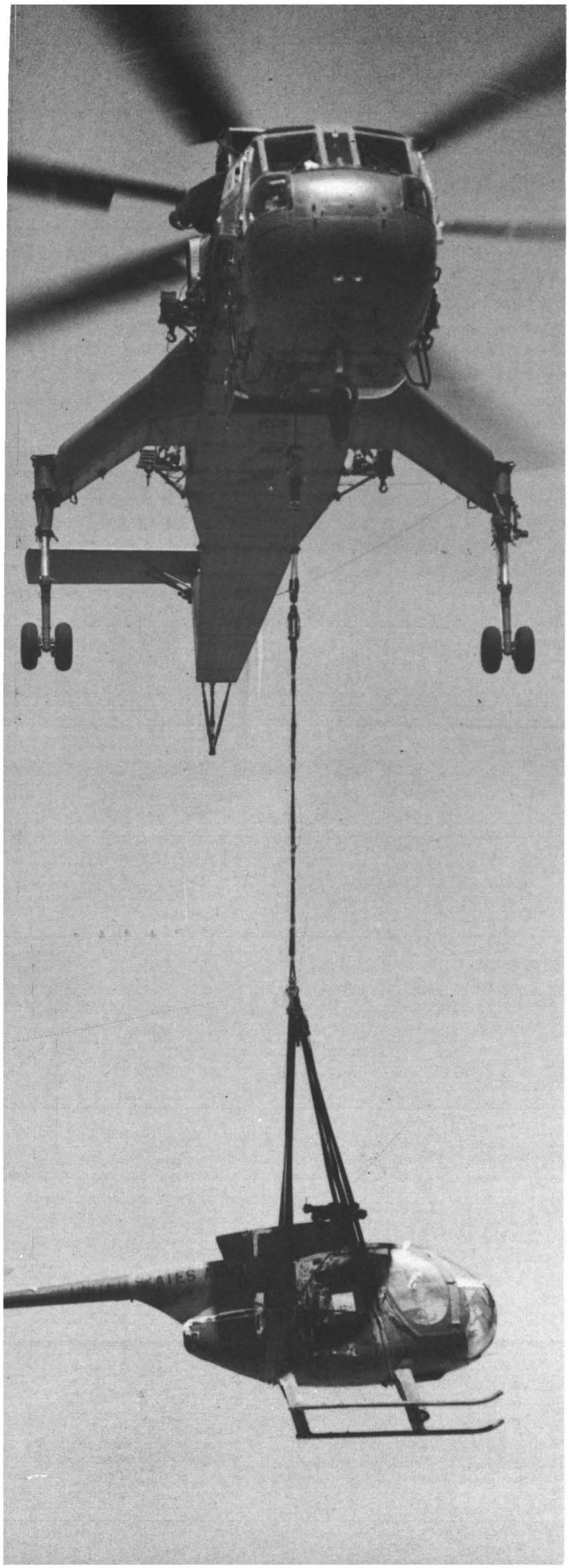
of this test pinpointed some minor design problems which were corrected and incorporated into the kit's final design. In this same time period the U. S. Air Force entered the program as a joint participant. A coordinated engineering and service test of Army and Air Force aircraft was initiated in late 1971 and completed in September 1972. During this testing the following Army aircraft were successfully rigged and airlifted: U-1, U-6, OV-1, O-1, U-10, UH-1, AH-1G, OH-6, OH-58 and CH-47. Also the following Air Force aircraft were successfully lifted: UH-1N, OV-10, O-2, U-3, U-10, HH-43, UH-1, A-37, CH/HH-3 and CH/HH-53.

The cost-effectiveness of the kit has been demonstrated in six successful field recoveries. There have been no failures. Uniquely, these recoveries occurred prior to and during the service test. In early 1971 and 1972, key kit components were used respectively in a jungle recovery of an H-3 in the Philippines and a CH-53 recovery at 7,000 feet in the mountains of Utah. Subsequently, in 1972 the entire kit was used for the recovery of a T-28 which had made a forced landing in a Louisiana rice field and two UH-1s plus one AH-1G in the southwest United States. The total dollar value of the aircraft recovered exceeded 5 million dollars.

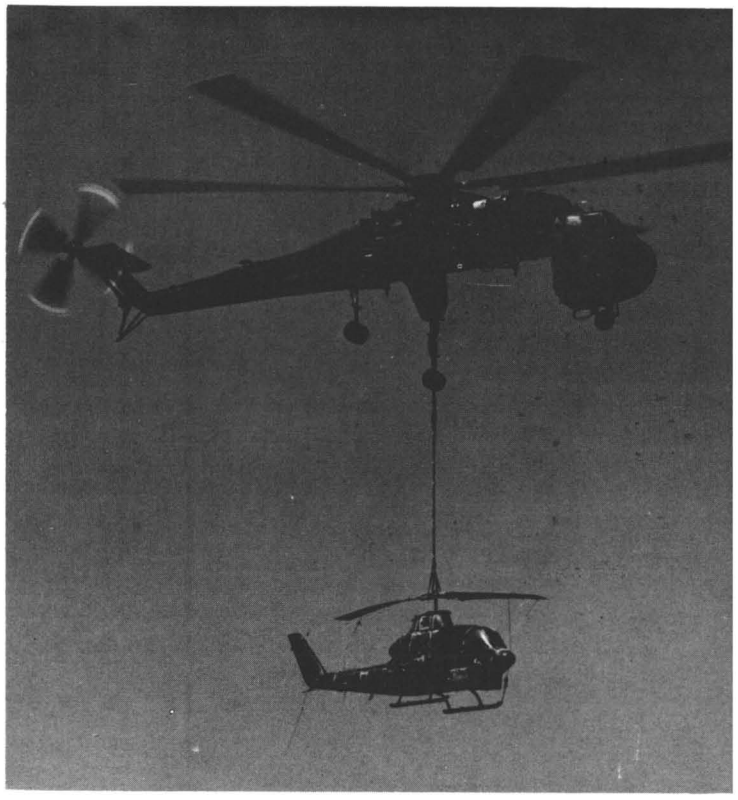
The kit is scheduled for type classification "standard" during the latter part of FY 73. Strong interest has already been expressed by the United Kingdom, Canada and West Germany. It is foreseeable that these nations may consider adopting the kit for their military services, thus making it truly universal.







The AH-1G HueyCobra (above) is being lifted using the bellyband configuration by a CH-47 Chinook, while the HueyCobra (below) utilizes the figure eight rotor head procedure designed for lifting single rotor light helicopters. Notice the absence of spreader bars on the lightweight OH-6 (left)



Ballistic Damage Tolerant Flight Control Systems

Continued from page 5

vulnerability can be reduced at least 75 percent with no increase in system weight; second, the concept of ballistic damage tolerance provides an approach which could be retrofitted into existing aircraft if so desired; and third, the ballistic damage tolerance concept can be integrated into the maintenance system with a minimum of personnel retraining.

Design development of components: The basic design philosophy developed to achieve ballistic damage tolerance is: (1) use redundant load-path designs, (2) use notch insensitive materials, (3) design to limit/localize damage upon impact and (4) use materials that allow penetration by the high-energy projectile with a minimum of energy transfer.

Research programs following this philosophy have substantially reduced vulnerability and virtually eliminated catastrophic failure for several categories of components, to include CH-47 idler arms, bell cranks and connecting links, and UH-1 connecting links and control quadrants. This was accomplished through the development of flight control components made from fiberglass-reinforced composite materials. In these programs several fabrication techniques were explored. This was done to examine a wide variety of ballistic damage tolerance concepts. Figure 6 shows the progressive development of the CH-47 forward bell crank. Representative fabrication techniques are fabric layup, filament winding, molded chopped fiber and Tetra-Core.

Fabric layup: Two components representative of this technique are the UH-1 connecting link and quadrant assembly (figure 7). These components were designed for immediate adaptation to the existing aircraft. Therefore, none of the existing hard points or space requirements for the components could be changed. This limited the size and design of the new components.

For the connecting link the solution was a lightweight double fiberglass tube design that provides dual structural capability (figure 8). Either tube can carry the most critical loads required. After an on-center hit by a tumbled .30 caliber projectile that cuts the central tube, the exterior tube carries the load. After an off-center hit that cuts away one side of each of the tubes, the residual section carries the load.

The link, which had already demonstrated high residual strength, accepted 1,000 cycles at an alternating maximum load after

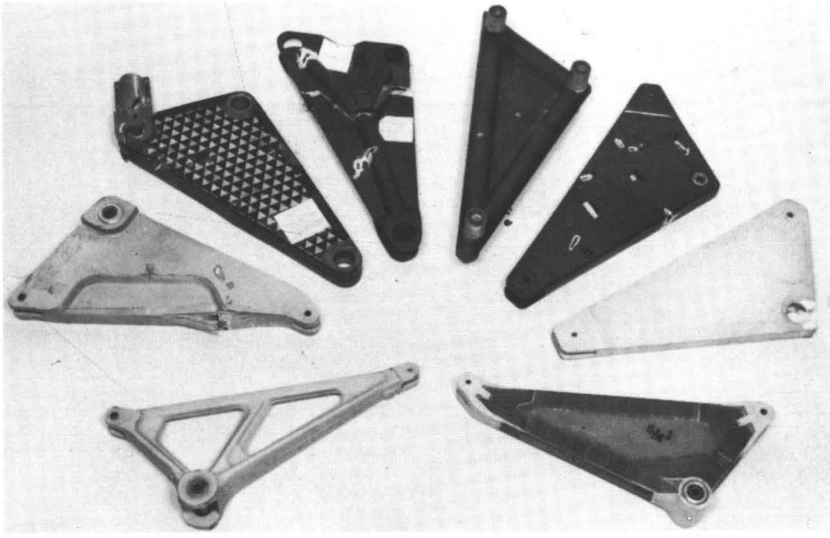
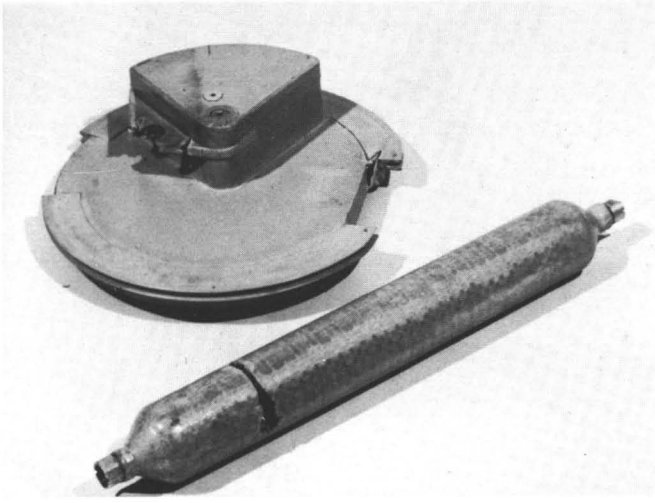
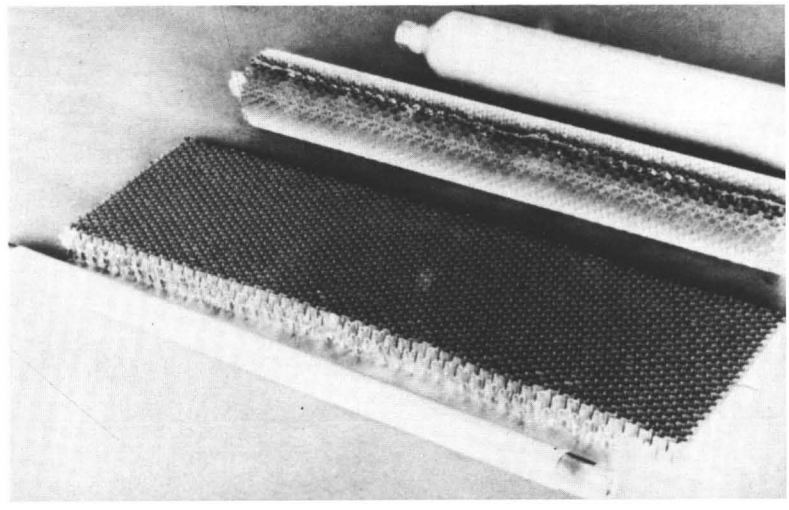


Figure 6 (left): The CH-47 forward bell crank showing progressive stages of development. **Figure 7 (below left):** A UH-1 quadrant assembly and connecting link typical of fabric layup fabrication technique. The components are adaptable to the existing aircraft. **Figure 8 (below):** The UH-1 connecting link solution was a lightweight double fiberglass tube design that provides for either tube to carry the load





impact without failure or visible change. Similarly, a severely damaged quadrant passed 1,000 cycles of fully reversed loading after impact without failure or change.

Filament winding: This technique was used to fabricate the CH-47 idler and rod end (figure 9) with its innovative ball-and-socket joint. Although this approach has the disadvantage of having non-adjustable rod ends, and does require adoption to existing push pull rods, it does provide an approach for replacement of the vulnerable rod ends and bearings, as a component. Fabrication of the rod end and ball assembly begins with the winding of glass fibers around a precisely shaped dense foam mandrel. The formed ball ends then are contour ground for roundness and sprayed with a tetrafluoroethylene lubricant.

The dual socket is molded from epoxy resin reinforced with chopped fibers. The split halves, with the balls in place, are sealed with bonding adhesive film. The socket unit is then bonded to the idler arm, which is made of glass filament fabric and fiber over a foam core. Two glass fiber layers, one vertical and the other diagonal, are wound around the socket assembly for sealing. This completes the unit.

Several ball-and-socket specimens were tested for load and ballistic damage tolerance. Even after penetration by .50 caliber armor-piercing projectiles, the units showed virtually no frictional resistance when operated at three times the standard flight load for 30 minutes.

Molded chopped fiber: The advantages of molded components from a fabrication/manufacturing standpoint are obvious. An extensive research program was initiated to determine the optimum combination of chopped fibers and resin, both from an ease of fabrication and a ballistics standpoint. Variations of fiber diameter, resin content, fiber finish, random fiber distribution and fiber lengths were investigated.

After several material combinations were subjected to verification testing, it was determined that ½ inch fiber length showed optimum behavior. Cylic fatigue testing of damaged coupon samples showed their ability to maintain high residual strength after severe ballistic damage. The samples in figure 10 were impacted with .50 caliber projectiles.

Under current research programs, actual molded chopped fiber flight control components are being fabricated. Complete ballistic and verification tests of these components will also be conducted. Figure 11 shows the design for a CH-47 molded chopped fiber bell crank. Figure 12 shows the chopped fiber design for a UH-1

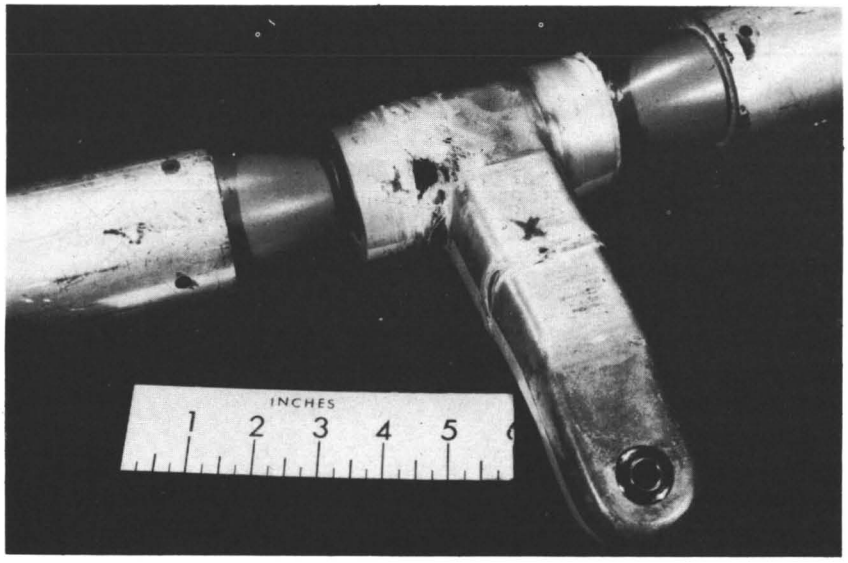
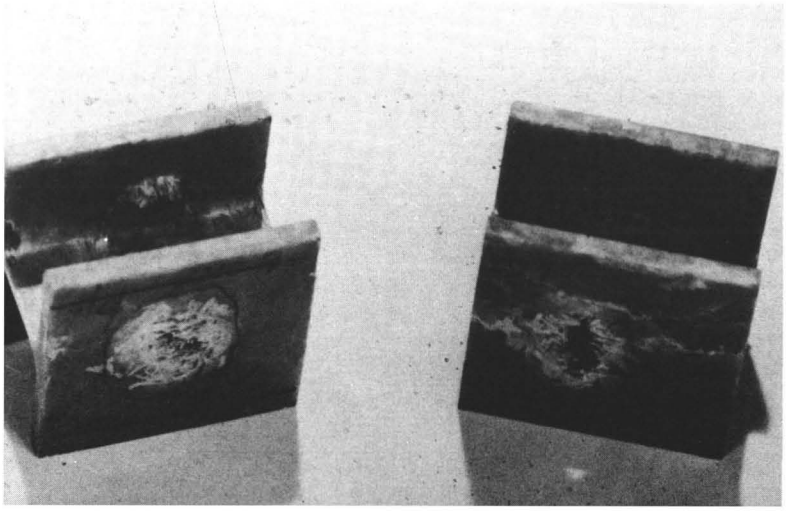
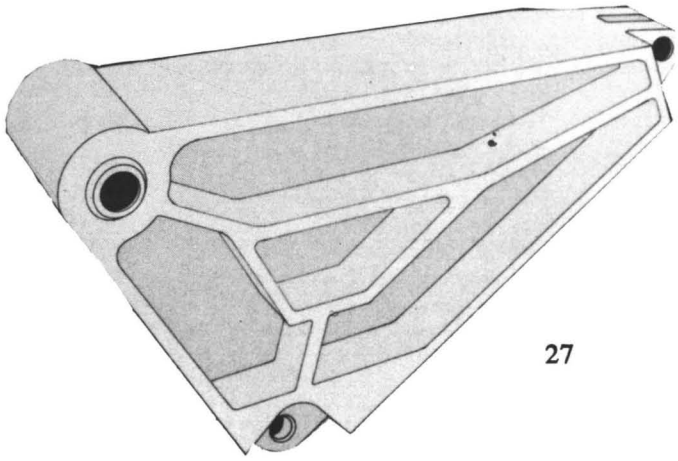


Figure 9 (right): This CH-47 idler and rod end sustained .50 caliber damage. The filament wound ball and socket joint can replace existing rod ends and bearings as a component. **Figure 10 (below):** These molded chopped fiber samples reveal how this fabrication technique withstood .50 caliber impact. **Figure 11 (below right):** Design for CH-47 bell crank to employ the molded chopped fiber fabrication technique





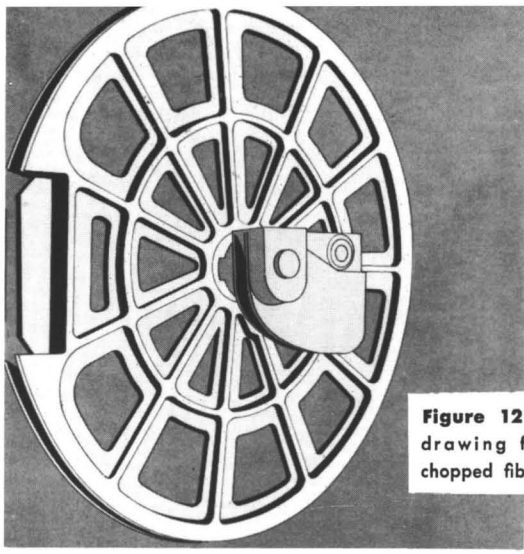


Figure 12 (left): Shows the design drawing for a proposed molded chopped fiber UH-1 quadrant assembly

Figure 13 (right): Newly developed three-dimensional space structure Tetra-Core filament wound samples

quadrant assembly.

Tetra-Core: This is a newly developed three-dimensional space structure that not only has a high strength-to-weight ratio, but also inherently redundant in design. Because of this redundancy, its demonstrated ballistic behavior has been exceptional. Ballistic damage cuts out only a small section of the structure and the surrounding structure simply picks up the load. In ballistic tests damage was confined to the impact area and spall on the exit side was minimal. Figure 13 shows Tetra-Core filament wound samples and figures 3 and 6 a Tetra-Core bell crank. This bell crank was impacted eight times, fatigue cycled 150,000 cycles at three times flight loads and then static tested to 100 times flight loads without failure. Its weight is only two-thirds that of the existing metal component. This design also includes a fiberglass rod end and bearing, which after impact also withstood these same loads without failure.

Manufacturing methods for mass production: The research programs approached the design of components on a nonautomated fabrication and processing basis. The demonstrated success of these components has fostered acceleration of manufacturing methods technology and the development of automated techniques for mass production. Fabrication in mass production from composite materials poses certain problems, however, that require resolution prior to accepting composite components as a bona fide approach. The first of these is the achievement of a high degree of reliability in the predictable structural performance of each component. Implicit in this consideration is the mandatory repeatability in performance from one structure to the next. In other words, before mounting them in an aircraft, we must be able to ensure that each and every component produced can do the job required. The second problem requiring solution is that the costs and weights of mass-produced composite components must be sufficiently low to be competitive with the existing metal ones.

All aeronautical and associated equipment must also pass the accelerated climatic and environmental tests as set forth in MIL-STD-810B. This military specification covers such tests as vibration, fungus, dust and temperature tests. For example, components must withstand adverse temperatures from −65 degrees F. to +160 degrees F. under load without failure. Because of the special nature of composite material, it is also necessary to conduct ballistic tests at adverse temperatures.

Extensive programs are now under way to establish manufacturing methods technology. Quality assurance, to ensure repeatable production of composite components with high reliability, is a prime consideration. These programs include extensive verification testing and environmental tests. In these programs components are being modified for mass productibility, but without sacrificing structural or functional integrity.

CH-47 bell crank: Figure 14 shows the design for the low-cost semiautomated manufacture of a CH-47 forward bell crank. In this design simplicity is the key. End fittings are molded from a chopped fiber bulk molding compound using special tooling. These fittings are then bonded to commercially available tubing and flat sheet with a quick-setting epoxy adhesive. Bearing alignment during bonding and curing is provided by a special jig. Projected cost and weight in mass production of this bell crank are competitive with those of the existing metal one.

UH-1 quadrant: Figure 15 shows the design for a long-fiber UH-1 quadrant assembly. As for the bell crank, the original design has been modified for ease and cost of manufacture. The two halves will be formed from inexpensive fabric using matched molds developed as special tooling. Inserts molded from bulk molding compound will provide the geometry and strength required for

end fittings and attachments. The halves will be bonded at the seams and to the molded foam core. The metal bearing will then be bonded in place, thus completing the unit. Projected material cost for this component excluding the bearing is just over $8.00.

CH-47 idler and rod end: To reduce manufacturing costs this component (figure 16) was significantly modified for mass production. Chopped fiber bulk molding compound, which is commercially available at low cost, was substituted for the filament winding process previously discussed. The ball and rod end, as well as the two halves of the idler arm and socket assembly, are formed from this compound using high-compression matched metal molds. Overwrapping is also simplified by using unidirectional tape. A significant simplification was the introduction of the retainer ring. The retainer, which is bonded in place as the last step in the process, allows for preliminary assembly before the ball is inserted. It also allows for final friction adjustment of the ball and socket while the retainer is being bonded in place.

The result of these research and manufacturing programs has been the development of a whole new family of ballistic damage tolerant flight control components made from fiberglass-reinforced composite material. These components are capable of one-to-one replacement of existing metal components. Simplification in design for manufacture will result in low-cost, low-weight components comparable on both counts to the existing metal ones. Through extensive environmental and verification testing, both before and after ballistic impact, the feasibility and reliability of these new components are being proven. In addition programs are now underway to reduce the vulnerability of rod ends and rotating joints.

Perhaps of greater significance is the development and acceptance of the concept itself. Ballistic damage tolerance is equally applicable to all aircraft structures, such as drive shafts, rotor blades and even the entire fuselage. The concept is, in fact, a prime consideration in all new composite structural designs.

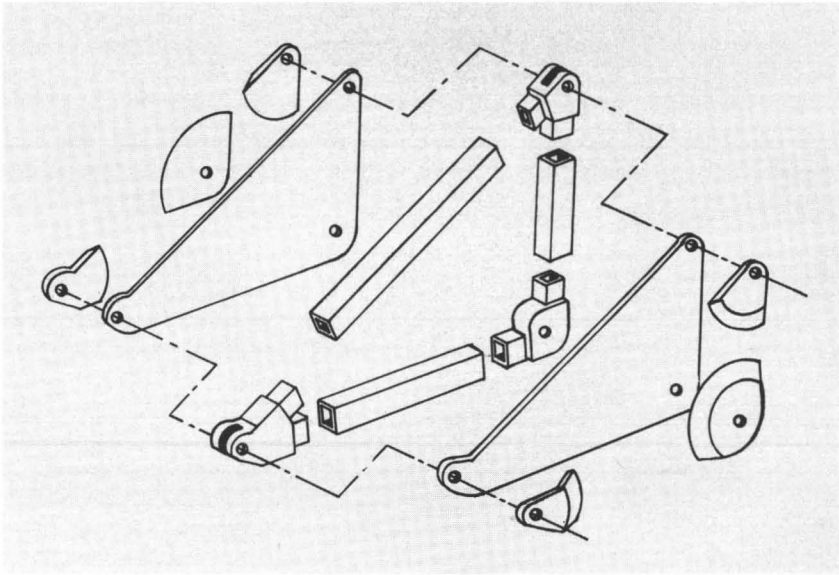
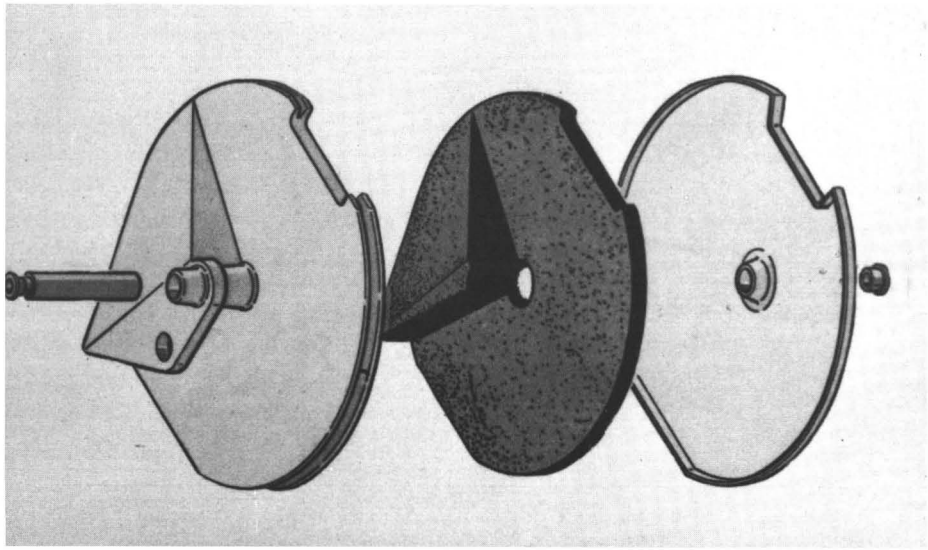
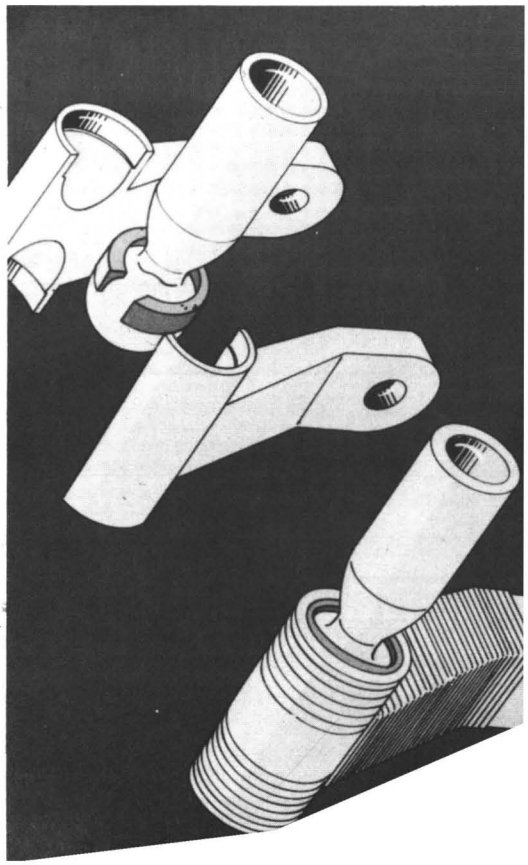
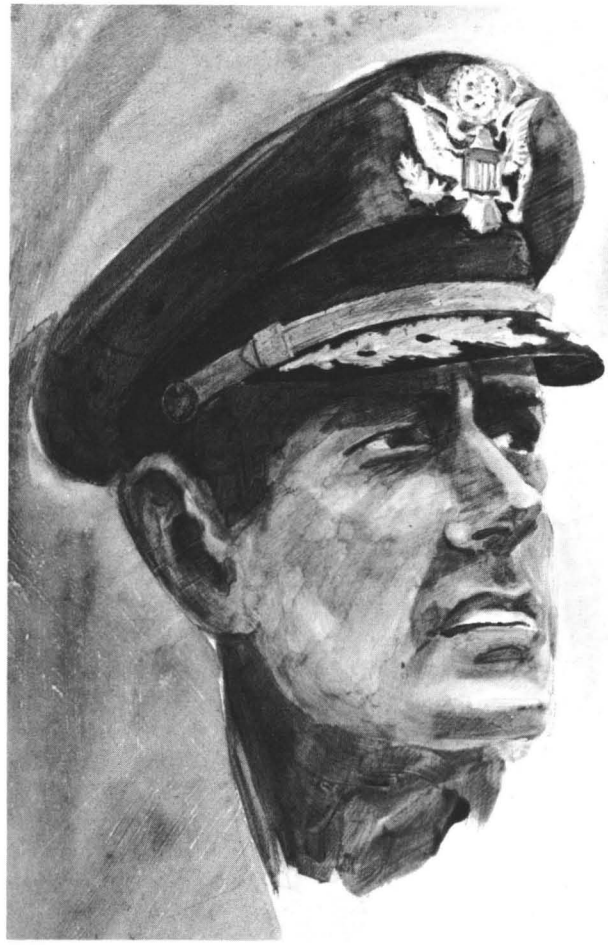


Figure 14 (above): Design drawing for low cost semiautomated manufacture of the forward bell crank for CH-47. **Figure 15 (below):** UH-1 quadrant design for mass production uses long fiber material. Projected material cost excluding metal bearing is just over $8.00. **Figure 16 (right):** CH-47 idler and rod end design for mass production, using chopped fiber bulk molding to reduce manufacturing costs (compare with figure 9)







Ted Kontos
Directorate for Education and Prevention
USAAAVS

IMPORTANT BYPRODUCT FOR THE COMMANDER

ARE SOME PILOTS more prone to crew error accidents than others? This question has been debated for years, and will probably continue to be debated for some time to come. Despite a recent study completed by USAAAVS (U. S. Army Agency for Aviation Safety) in an attempt to find the answer, no positive conclusion has yet been reached. But while researchers have been unable to resolve this issue, their efforts have produced a significant byproduct—the revelation that approximately 20 percent of all crew error accidents involving "repeaters" (aviators who have had one or more accidents) could be prevented by proper supervision, including positive command action.

This means that of the 249 crew error accidents researched during this study, 50 could have been prevented by more stringent supervision. In terms of losses, these 50 accidents represent 47 fatalities, 46 injuries, 20 destroyed aircraft and a cost of $9 million—an exorbitant price for complacency.

What type of positive command action was taken in the 249 crew error accidents studied? IP or AC orders were revoked in two instances after first accidents, in six instances after second accidents and in one instance after a third accident. There were four flight evaluation board actions and in only two instances were pilots required to undergo additional training, and this was only after they had been involved in second accidents. Let's look at some of these accident briefs.

One pilot took off from a pinnacle with his helicopter loaded with troops. Rpm decreased and the aircraft crashed into trees. The pilot had not bothered to count the troops or determine gross weight, and attempted the takeoff with the aircraft grossly overloaded. On a subsequent flight, his aircraft stalled and spun into trees. The pilot had been overeager to accomplish a mission which involved "personal goals." Serving as maintenance officer, he had performed his own maintenance, disregarding safety procedures, policies, regulations and SOPs.

After completing a flight, another pilot was ordered to get airborne as soon as possible. He and a second pilot selected helicopters parked in adjacent revetments, and meshed rotor blades when starting the engines. The revetments were too close to permit two helicopters to be started at the same time. Some time later, one of the pilots involved in this accident rolled

his helicopter during an unsuccessful autorotation after his engine failed. *He was performing an unauthorized low level flight at the time.*

An IP failed to take corrective action in time to prevent a transitioning pilot from making a hard landing and severing the tail boom during a practice touchdown autorotation. The IP had not attended ground school for this type aircraft. This IP later made a nose-high autorotation landing, allowing the tail of his helicopter to hit the ground.

An AC, complacent and overconfident about his pilot's ability, allowed the pilot to land hard during a combat assault. This AC later allowed another pilot to make an approach into an area unsuitable for landing. Rpm was lost and the helicopter landed left-side-low, causing the main rotor blades to strike the ground. Still later, when this same AC allowed his pilot to hover the aircraft from a revetment, the tail skid struck the ground. There was confusion in the cockpit as to who had control, and during this confusion, the helicopter pitched up and the tail rotor struck the ground.

Another pilot who had been flying approximately 7 hours during a single day was involved in an accident. He was given a postaccident check ride and told to take the rest of the day off. Approximately 5 hours later, he was requested to fly a Cobra as part of a Cobra fire team demonstration. He accepted the mission, and shortly afterwards, crashed. The pilot was killed and the aircraft was destroyed.

Granted, it is sometimes difficult to accurately analyze accidents which involve human error, particularly when the only information available is that contained in the accident reports. Often, all the circumstances surrounding an accident are not known. But a careful analysis of the facts presented in the 249 accident reports studied has resulted in the formulation of 10 basic rules which, if used as a guide, will go a long way toward preventing crew error type accidents. Because they are simple, their value can be easily underestimated. Nevertheless, their application can prove invaluable to the Army aviation safety program. They are:

1. Be constantly on the alert for changes in behavior of aviators in your unit. These changes generally result from different types of stress, and aviators under stress are more likely to commit errors which cause accidents.

2. Be firm with aviators involved in accidents which were caused by pure carelessness, inattention or willful misbehavior. Experience has shown that only positive corrective steps will prevent a repetition of the actions which caused these accidents.

3. Closely supervise aviators who have recently been involved in accidents. Approximately 20 percent of these aviators are generally involved in a second accident within 60 days of their first one.

4. Be extremely selective when appointing aviators as instructor pilots, especially those with less than 150 to 200 hours pilot time since graduation from flight school. Exercise extreme care in reinstating IP orders once they have been revoked.

5. Provide careful guidance for those pilots who are *overly* eager to excel, succeed and accomplish missions. Although these can be desirable qualities, they can adversely affect an aviator's judgment.

6. Supervise aviators who have had one or more incidents involving pilot error factors as closely as you would if these mishaps had been accidents. The difference between an incident and an accident is often measured in inches or seconds and the mistakes leading to both types of mishaps are usually identical.

7. Carefully evaluate and supervise those aviators who have been involved in accidents caused by personal error but who staunchly refuse to admit any such personal error. Since they do not blame themselves, they fail to benefit from their experience, and therefore, are apt to commit the same error at some future time.

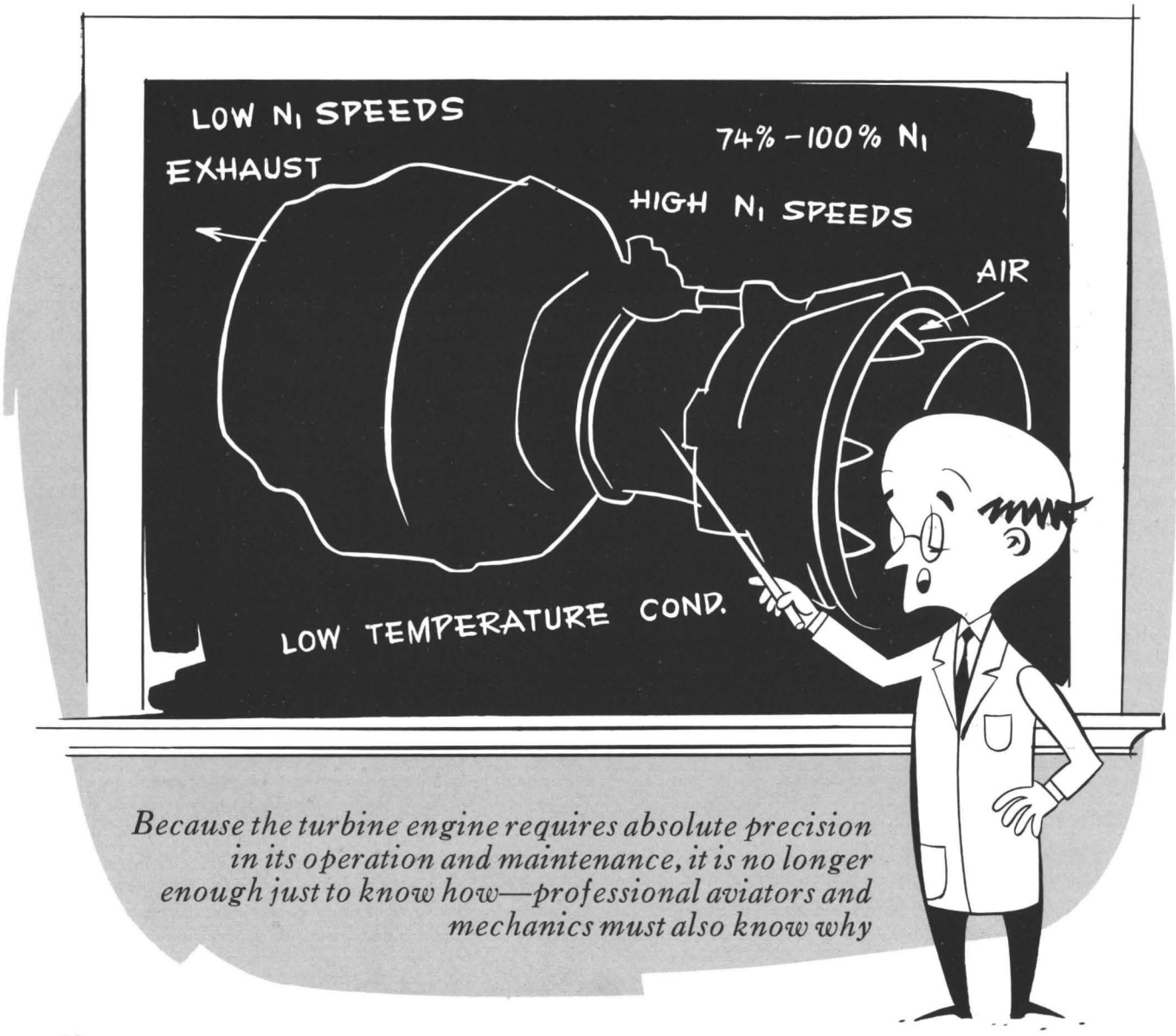
8. Provide ample training, guidance and opportunities to develop proficiency for those aviators involved in accidents in which a lack of experience, proficiency or currency in type aircraft was a responsible or contributing cause factor. Without additional training, these pilots may very well repeat their mistakes if confronted with a similar situation.

9. Stay alert for opinions of each pilot's ability as expressed by fellow aviators. When one pilot says of another, "He's an accident waiting to happen," he is usually right.

10. Examine your own aviation accident prevention program. Remember one out of five of the crew error accidents studied involved some form of supervisory error as a contributing cause factor.

No, we still don't know whether some pilots are more prone to pilot error accidents than others, but two things we do know: A breakdown in command attention and supervision can cause needless losses of lives, aircraft and dollars, and adversely affect the Army's mission capability; and YOU are the only one who can provide the cure. Think about that!

Turbine Engine Know-Why



Because the turbine engine requires absolute precision in its operation and maintenance, it is no longer enough just to know how—professional aviators and mechanics must also know why

Gene Berta
Directorate for Education and Prevention

Clarence J. Carter
Directorate for Aircraft Accident Analysis and Investigation
USAAAVS

THE PRESENT-DAY gas turbine engine has proved to be a dependable and easily maintained aircraft powerplant. The gas turbine is the only powerplant adaptable to both airplanes and helicopters without major modification, and builders of both fixed and rotary wing aircraft are demanding smaller, more powerful engines. To meet this demand, the gas turbine manufacturer is attempting to increase the power and efficiency of his engine without increasing its size and weight. A continuous modification program that is taxing the state of the art to the utmost is underway to obtain faster speeds of the rotating components, higher operating temperatures in all areas and improved efficiency from the fuel and lubrication systems.

In the effort to produce a more powerful and efficient engine at no cost in engine size and weight, the manufacturer has introduced modifications to the turbo prop engine that have created an aircraft powerplant considerably different from the pure jet engine. Today, almost all of the small turbine engines have reverse-flow combustion chambers, variable stator vanes and a combination of axial and centrifugal stages in the compressor whereas the pure jet engines have all-axial compressors and straight-through combustion chambers. These changes are based on a set of thermodynamic and aerodynamic principles that, in turn, require rigorously precise operation and maintenance. Because the small turbine engine is a precision machine composed of many expensive parts, absolute adherence to the prescribed operation and maintenance procedures is a must.

PRECISE OPERATION AND MAINTENANCE

Professional operators and mechanics not only know how, they also know "why!" To understand better why maintenance and operational practices are so critical with the gas turbine engine, let us discuss the thermodynamic and aerodynamic functions and associated subsystems within the engine and how they are affected when these practices are not "by the book."

Any disturbance of these functions may cause a loss of engine efficiency. Therefore, both meticulous maintenance and early detection of efficiency loss through such means as the turbine engine analysis check (TEAC) and the daily engine reading (DER) program must become a vital part of a mechanic's performance. Further, since gas turbines also lose efficiency as a result of improper operation, it behooves the operator not only to *know* correct operational procedures but also to reinforce his knowledge with the understanding of why incorrect procedures will adversely affect the internal workings of the engine.

COMPRESSOR STALL

One of the major sources of efficiency loss when the turbine is not operated and maintained properly is the compressor—in particular, compressor stall. It should be noted here that engineers of the turbine engine industry refer to compressor stall as "surge." So for the sake of uniformity, we will use the term "surge" when talking about the complete engine in stall. The boundary where engine surge can occur has been precisely located and is known as the engine surge line. For the most efficient use of the gas turbine, the engine should be operated as close to the surge line as possible, but so as to avoid the danger of engine surge under any specified operational or environmental condition. To provide for this type of operation, gas turbine engines are shipped from the plant with a minimum surge margin—differences between the normal engine operating line during "jam" or maximum acceleration and the surge line. Let's look at the compressor and see what causes stall and surge.

The compressor of the small turbine engine used in Army airplanes and helicopters is really two compressor designs—the axial and the centrifugal—combined into one. The principles of construction and operation are considerably different. In order to have a thorough understanding of both types, it is best to discuss them separately.

The axial compressor consists of a disk into which are set blades or small airfoils. Each disk with its blades is one stage of compression. The blades of each successive disk from front to rear are shorter than the preceding ones and are set at a different angle so as to increase both the velocity and pressure of the incoming air at the same time. The disks, or stages, are separated by spacers to permit mounting

stators or stationary vanes into the compressor housings between the stages to direct and smooth out the airflow. In addition, the stators reduce air velocity while further increasing pressure. The air is squeezed into an ever-decreasing space, thus increasing air pressure up to nine or more atmospheres and raising air temperatures as high as 600 degrees F. The successive increases and decreases in air velocity throughout the stages of compressor blades and stators practically cancel each other. Thus, the velocity of the air leaving the axial compressors is only slightly greater than that of the air entering the compressor.

The blades of the axial compressors are small airfoils shaped in a cross-section similar to that of an airplane wing and, as such, are subject to aerodynamic stall. The blades stall when the smooth flow of air over the airfoil surface breaks away as the result of an excessive angle of attack. (The angle of attack is the angle formed by the direction of the airflow in relation to the chord line of the airfoil. The chord line is the center line of the airfoil from front to rear.) When the angle of attack becomes too great, the air separates from the surface and the airfoil loses a substantial amount of its lift. The transverse velocity of the blades resulting from rotation substantially affects the angles of attack, even though they are mounted at a fixed angle in the compressor disk.

Studies show that the stalled condition of the blade is a transient phenomenon rather than a static condition. All blades do not stall at the same time, but the phenomenon moves from blade to blade opposite the direction of rotation. If the condition that caused the stall is not relieved, stall begins to affect other areas. Several stall conditions can exist within different rows or stages of the compressor without a complete loss of airflow. The blades within a row are not shaped exactly alike because of manufacturing tolerances and mounting differences. The blade with the greatest angle of attack will stall first. The stall causes the smooth airflow to be interrupted on the surface opposite the direction of rotation. This turbulence restricts the flow of air in the passage on the lifting (low pressure) side of the blade, causing a larger than normal amount of air to strike the next blade in the direction opposite rotation at an increased angle of attack, making it stall also. The originally stalled blade moves into smooth air and out of the stalled condition. The stall phenomenon continues until airflow is completely disrupted or back pressure is reduced.

A partial stall condition in the axial compressor often causes surging. A stall of any degree reduces airflow. The fuel control senses the reduction in airflow and reduces the fuel flow, which, in turn, decreases the back pressure on the compressor and relieves the stall. The airflow is no longer interrupted, and the fuel control restores the fuel flow. If the back pressure increases to the point of stall again, the cycle is repeated until the power requirement is reduced. The sound of axial compressor stall may vary from a rumble, as with a partial stall, to a violent explosive "bang" resulting from a complete stall.

Designed for operation at high speeds, with a high airflow and a high pressure increase from the first to the last stages of compression, axial-flow compressors are especially vulnerable to stall conditions during starting and low-speed operations. The forward compressor blades may not be able to compress incoming air enough to force it through the rear stages of the compressor. The absence of increased pressure in the last stages leads to a higher than normal airflow and "choking." This condition is generally relieved by the release of air to the atmosphere at the rear, or last stages, of the axial compressor. A bleed band or valves release a predetermined amount of air until a selected compressor speed is reached, at which point they close automatically. Many of the advanced state-of-the-art engines contain variable inlet guide vanes (VIGVs) and/or variable stators. These devices are very effective in preventing choking and compressor stall by directing and metering the airflow in the forward stages of the compressor, but their opening and closing must be carefully scheduled to preclude surge. If they open too soon, the front stages of the compressor are subjected to an excessive angle of attack. If the VIGVs open too late, the engine is slow to accelerate simply because the airflow coming into the engine is restricted.

As previously stated, most of the gas turbine engines that power Army aircraft contain both axial and centrifugal stages in the compressor. The centrifugal impeller does not depend on airfoil-shaped blades and stators to increase the pressure and velocity of the air flowing through it as does the axial compressor but, instead, increases the air velocity (as its name implies) by centrifugal force, the difference in surface speed and the depth of the vanes from the inside to the outside diameter. The centrifugal compressor requires an air diffuser to convert the high velocity of air leaving the centrifugal compressor to high pressure while reducing the air velocity. Therefore, it has different performance and stall characteristics, but the airflow characteristics are the same.

This phenomenon can be demonstrated if you place your hand over the outlet of a vacuum cleaner while it is running. As the opening is closed off, you will notice that the airflow will decrease, but the pressure will remain the same until the entire opening is blocked. At this time, you will notice a complete and sudden loss of air pressure and an increase in motor speed. The impeller is completely stalled. If any air at all is allowed to escape, the air pressure will resume and the motor will slow down while the impeller resumes its load. This entire sequence happens with the centrifugal compressor in the engine within a fraction of a second and with varying results. If a stall occurs at low engine speed, you may hear a low rumble, but if at high speed, the effect is an explosive bang. Continued operation is likely to lead to physical damage from impact loads and high-frequency vibration. Remember, the vacuum cleaner motor is turning about 4000 rpm, whereas the centrifugal compressor of a large aircraft gas turbine normally turns over more than 15,000 rpm and a small, as much as 50,000 rpm. Therefore, the unloading and loading of the impeller in the gas turbine at high speed has all the characteristics of an explosion.

As previously stated, the engine is operating as close as possible to the surge line so anything that happens to the engine that will affect the airflow at high power settings can cause surge. Let us say, for example, that a rivet head or small nut about the size of a pencil eraser is sucked into the front of the compressor and dents the leading edge of a compressor blade. The shape of that airfoil has been changed and if its new shape causes it to have a greater angle of attack than the other blades in that row, it will be the first to stall. Anything that affects the clean,

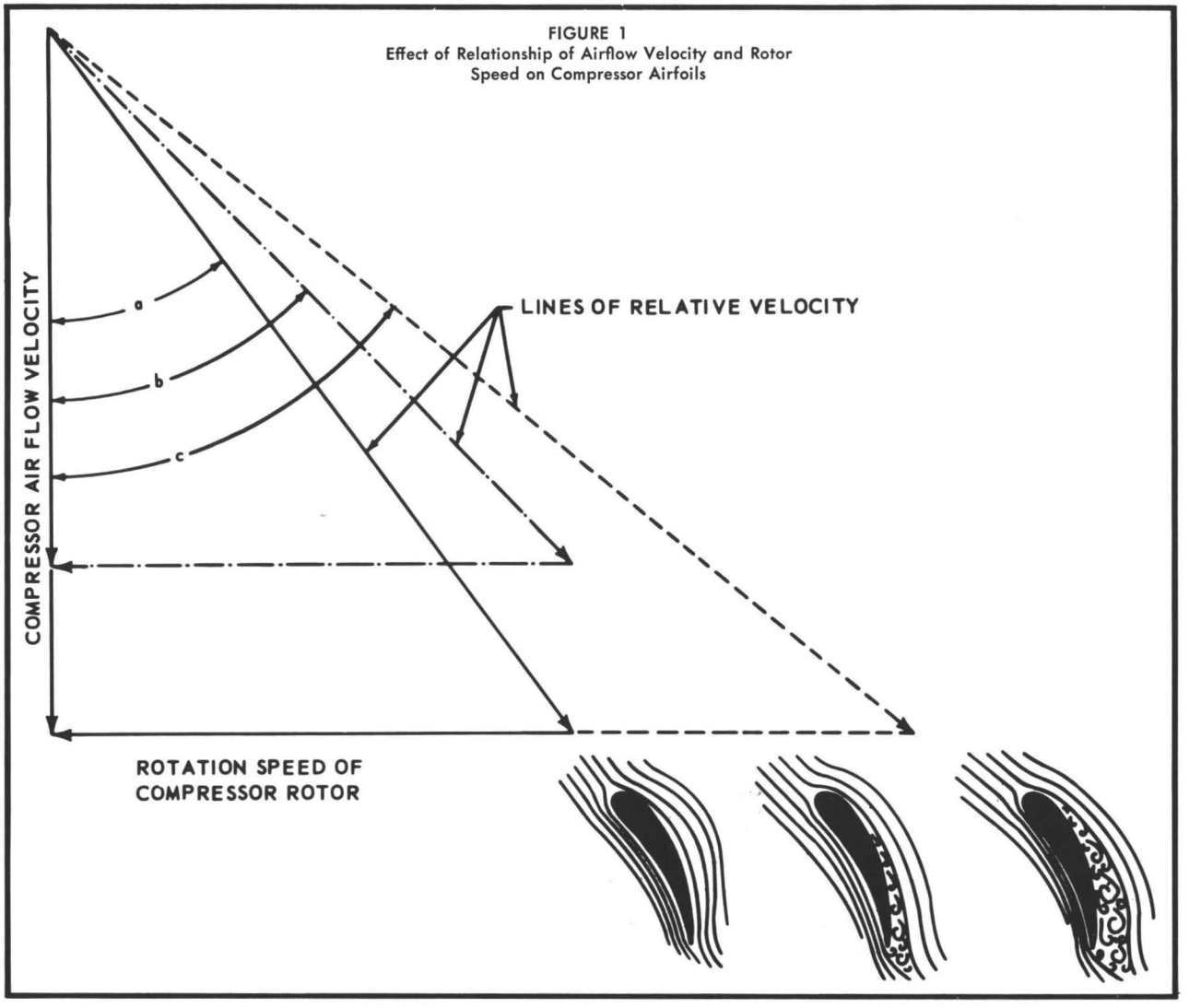


FIGURE 1
Effect of Relationship of Airflow Velocity and Rotor Speed on Compressor Airfoils

smooth airflow through the compressor causes it to move closer to the surge line. Examples are dirt, dust and oil that stick to the blades and stators, grass and leaves that block areas of the inlet screens, and sand that erodes the metal of the blades and changes their shape.

ANTI-ICING SYSTEM

For many of the same reasons, the anti-icing system should be operated and maintained with care. Although gas turbine engines are not plagued by the icing problems inherent in the carburetor used on piston engines, they are not immune to the effects of freezing water. Some of the present-day engine compressors turn up to 50,000 rpm, and a little ice will do a lot of damage. Whenever moisture such as fog, drizzle, clouds, rain, etc., is visible in the air and the temperature at the engine inlet approaches freezing, ice is very likely to form on the inlet cowling, nose cone, inlet guide vanes and first-stage compressor blades. If the anti-icing subsystem is not turned on in time, or if it is not working properly, ice that collects on the air inlet areas of the engine will break away in chunks, causing compressor stalls and impact damage and possible engine failure. For this reason, the inlet housing struts and inlet guide vanes on most engines are hollow to provide passage for hot, high-pressure bleed air taken from the aft end of the compressor. The cockpit control switch actuates the anti-icing air by sensing the temperature at the engine diffuser case. As bleeding air from the compressor for any reason always results in a loss of power and an increase in specific fuel consumption and exhaust gas temperature, the anti-icing system should be used only when required. *But it should be turned on as soon as icing conditions are encountered.*

Presence of moisture and super-saturated air creates the most critical condition as far as engine icing is concerned. The greatest temperature drop through the inlet housing occurs at high rpm during aircraft ground operation and takeoff. During these phases of operation, visible moisture, which will pass through barrier filters and particle separators, can produce icing at the inlet housing even though the outside (ambient) air temperature is well above freezing, and external ice has not commenced to form on other parts of the aircraft.

THOROUGH INSPECTIONS

Because so many different factors can change the aerodynamic function of the compressor, the TEAC and the DER program mentioned earlier are most important to safe and efficient turbine engine performance. When these checks are accomplished properly, they indicate, by changes in power required to achieve a certain flight condition, when something is happening within the engine that is causing a loss of efficiency. The technical manual states the loss of power permitted before engine cleaning is required. If engine cleaning does not restore engine performance to within acceptable limits of the first readings taken when the engine was installed, then some other system or component is causing the problem. The real advantage these checks afford you as a maintenance man is that you will know when you have cured the problem because you have the base line power readings to compare with. Trial-and-error troubleshooting methods without any idea of what the engine power reading should be is a very costly and deadly process.

Malfunction of the compressor bleed-air system (the VIGVs and/or variable stators) can also cause erratic engine operation. Air leaks caused by fittings, valves that do not close completely or leaking bleed bands will usually be indicated by higher than normal temperatures. If the leak is severe enough to affect the gross output of the compressor, low power and slow acceleration will accompany the high temperatures. If the bleed air system is not scheduled to open and close properly, still other symptoms are evident. If it is closing before the desired rpm is reached, choking and surge result. If the system is closing after the proper rpm is reached, high temperatures and low power result. Any time erratic engine operation is encountered, the bleed-air and anti-ice systems should be given a thorough inspection and operational check.

ENGINE TEMPERATURE

A second major source of engine efficiency and power loss is excessive internal temperatures. If an engine is to develop power required for today's aircraft, high internal temperatures cannot be avoided. The problem lies in keeping these temperatures within tolerable limits to preclude damage to the combustion section with the inevitable reduction of both power and efficiency. To understand the importance of right operational and maintenance practices in this area, let us look at the internal function of the combustion section.

The forward part of the combustion section attaches to the diffuser, which is between the compressor and the combustion housing and directs the air from the centrifugal compressor into the combustor housing. The air delivered by the compressor

The anti-icing system should be operated with care and used only when required . . . but it should be turned on as soon as icing conditions are encountered

is required for the combustion of fuel and internal cooling. Cooling consumes the major portion of the inducted air while the remaining air is required to burn the fuel in the combustion process. The burner section is designed to burn the fuel air mixture and deliver the gases to the turbine at a temperature which will not exceed the allowable limit at the turbine inlet. The burner must add sufficient energy to the gases passing through the engines to accelerate their mass enough to provide the desired power for the turbine. In addition, the pressure loss in the burner must be minimized while efficiency is maintained at a high level. Temperature distribution must be uniform and no burning should occur beyond the burner outlet. This critical task is accomplished by the combustor liner. The combustor liner is usually a metal shape (known as the "can, can annular or annular" type) that roughly follows the inside shape of the combustor housing. Suspended in the center of the combustion area, the linear accommodates fuel nozzles at one end and outlet ducts at the other, the liner surface being specifically designed to match compressor output and fuel combustion to achieve maximum power.

In the typical liners discussed, the air is admitted progressively through simple holes or slots, with a small gap being left between the liner and the housing to provide a film of cooling air for the final contraction of the liner before the gas producer turbine nozzle entry.

It is also common practice to introduce "secondary" air. In the combustion process, this air promotes mixing and ensures adequate oxygen for the fuel down-stream from the nominal reaction zone. An excellent method of keeping the liner walls sufficiently cool is "film cooling," a process in which the liner is made in overlapping sections so that each side has a

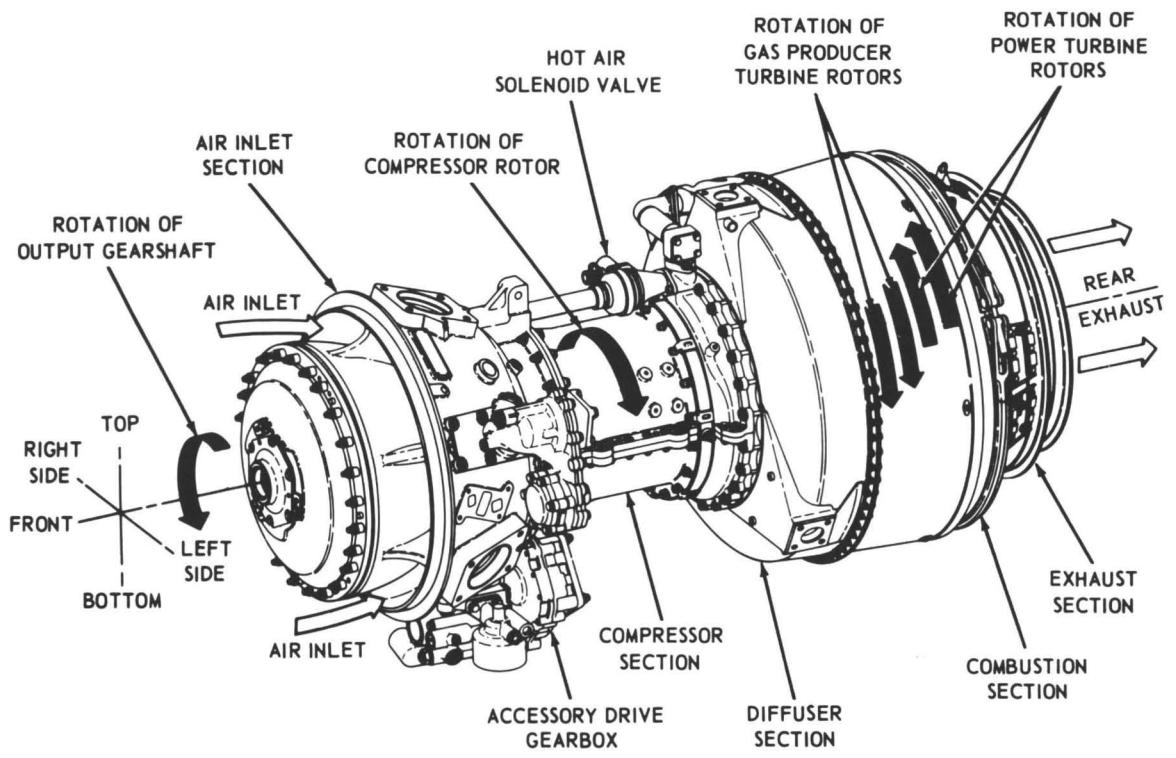


FIGURE 2
Directional References, T53-L-13 Engine

layer of cooling air flowing over it. The mixing air must reach well toward the axis of the combusion, or a core of high temperature gas will persist downstream of the combusion area.

The temperature at the flame center is about 3000 degrees F., or about 1000 degrees F. hotter than the melting point of the alloys used in the combustion housing and liners. The actual operating temperature of the metals in the combustion housing ranges from 1200 degrees to 1800 degrees F. Design innovations ensure the centering of the combustion flame within the liner and provide a blanket of cooling air around each component. This delicate condition must be maintained at all times to ensure long life and efficient operation of the engine. When the combustion liner is subjected to drastic temperature changes, it may distort and, in extreme cases, crack from distortion. Once a crack starts, it can propagate rapidly due to inherent and high-frequency vibrations. Cracks alter cooling airflow and can encourage "hot spots," resulting in heat damage to the liner or turbine components. The operator can be most helpful in preventing damage to the combustor components by allowing the engine to warm up slowly and by always allowing ample cooling time when shutting down.

It may seem strange that metallurgists have difficulty in finding suitable high temperature materials when tungsten melts at 6200 degrees F., molybdenum at 4800 degrees F. and columbium at 4400 degrees F. The problem arises from the fact that the melting point is not the most important consideration in determining whether a metal can withstand the rigors of the jet engine environment. The three most important characteristics that metallurgists seek in metals for high temperature applications are resistance to oxidation, strength at high temperatures and corrosion resistance.

Probably the most vital of these three characteristics is the capacity to resist oxidation, because structural strength is useless if a metal rapidly burns away. At jet-engine operating temperatures, ordinary steel burns like paper; and tungsten, molybdenum and columbium oxidize quickly as do most high-melting-point metals. The ability of a metal to resist oxidation at elevated temperatures is largely determined by the type of oxide scale it forms. Laboratory investigations show that many metals form a tough, impervious scale that retards progressive oxidation. Others form a porous type of scale which continues to build up and flake away, eating into the metal. Over prolonged periods of exposure, however, almost any type of oxide film tends to break down because the repetitive heating and cooling cycles experienced in jet engine operation cause compressive stresses in the oxide film as the underlying metal tends to contract faster than the oxide scale allowing it to break away.

The second most vital quality that a metal must possess is strength at high temperature. The deleterious effect of heat on metal strength is demonstrated by structural carbon steel, which has a tensile strength of 140,000 pounds per square inch at room temperature. After exposure to 1400 degrees F. for 1,000 hours, a temperature within the normal ranges for combustion chambers, the tensile strength is reduced to only 1,000 pounds per square inch. It is obvious that the metals selected for jet engine construction must withstand many torturous stresses, and the selection process of necessity involves evaluation of all kinds of strengths exhibited by alloys such as ultimate tensile strength, yield strength, creep strength and stress rupture strength. This is why those who have a first-hand knowledge of the internal functions of the jet engine will always express intense concern for temperature ranges and stabilization for all phases of engine operation. Maintaining the proper temperature range for all operations and limiting the transient thermal effect during transitions from start to full power and from full power to stop actually determine the useful life of the engine.

Having discussed the characteristics of the high temperature section of the engine, let us look now at a practice that has caused "hot-end" component failure.

MARKING "HOT-END" COMPONENTS

When the hot end of the engine is disassembled for inspection, it is common practice to mark the different sections and components so they may be reassembled in the same position. On occasion, marking materials have been used that damaged the marked item. It is very important that only approved marking materials be used because the material with which these parts are marked can ultimately cause their failure. Each manufacturer specifies materials to be used to mark the components of his engine. Before a marker is approved, it has been analyzed for content, lead, iron, copper, etc., to determine its exact makeup, and it has been used on various components of the hot end and evaluated after a test run of the engine. Marking materials containing a high percentage of lead are those most undesirable as materials for marking high temperature components. Lead, for example, breaks down at high temperature and mixes with the chromium, steel, iron, etc., of the engine components and weakens them to the point that they can readily crack, break or crumble.

GAS PRODUCER NOZZLE

The first major engine component the reactant gases reach after leaving the combustion liner is the gas producer nozzle, which accelerates and directs the hot gases onto the blades of the turbine wheel. The nozzle consists of hollow blades welded between two concentric rings. The exit area between the partitions, or vanes, of the nozzle is much smaller than the inlet area so that the velocity of the air increases through the nozzle while the pressure decreases in order to exit at the same rate of flow at which it enters. The nozzles (most engines contain more than one) are the primary source of the restriction that permits the high pressure in the combustion area. This back pressure is very important because it keeps the combustor components in a stable temperature environment that is as free of turbulent airflow as possible. As energy is extracted from the hot gases by the turbine, a drop in temperature occurs; thus the gases become cooler as they flow through the turbine section.

The design and condition of both the gas producer and power turbine nozzles are most critical in the free turbine engine. The gas producer nozzle and gas producer turbines must derive enough energy from the gas stream to operate the compressor at maximum efficiency and still allow enough energy to pass on to the power turbine nozzles and turbines to drive the power shaft and produce rated engine power. At this point, it should be realized why the established maximum gas temperatures of the engine should never be exceeded. If the size, shape or gas flow pattern of any nozzle or turbine is changed in any way such as by burning of the vanes due to excessive temperatures or warping resulting from improper cooling during shutdown, the engine will never again produce peak power without extensive and costly repair.

TURBINE WHEELS

Because of the high general level of temperatures encountered in normal operation of the state-of-the-art engines, the strength of the turbine blade material may be critical to within small limits. Turbine wheels are among the most seriously stressed components of the entire engine. The blades of the turbine are subjected to high centrifugal stresses and to streams of hot gases at fluctuating temperatures and may, at the same time, be subject to vibratory stresses. The disk of the wheel is heated by conduction from the blades and may in some cases be directly heated by the combustion gases. Temperatures of over 1500 degrees F. are not uncommon near the rim of the first turbine wheel. When the gas turbine engine was in its infancy, the turbine wheels and blades were the parts that failed most often. Present-day turbine wheels and blades now operate for hundreds, even thousands, of hours of operation.

The rotating parts of a turbine are subjected to stretching loads imposed by the centrifugal force which results from rotating speed and bending loads imposed by the gas flow. During high power demands, the turbine wheel and blades experience both high loads and high temperatures at the same time. Because the strength of the turbine blades less[redacted]erating temperature increases, the blad[redacted] to the highest stress when they are weakest. At this time, they may undergo a distortion and lengthening known as "creep." This condition is cumulative and permanent. Although creep is normally so small that it is measured in millionths of an inch, the rate of creep increases greatly as the engine operating limits of gas temperature and speed are approached.

PROFESSIONAL CARE

Almost all maintenance on the gas turbine engine requires special tools. The mechanic must know what they are as well as when, where and how to use them. The gas turbine cannot and will not tolerate sloppy and careless maintenance. In addition, the good mechanic must be ground-safety conscious. Accidents occur because someone pays too little attention to a long line of sound advice and the published safety regulations. Good housekeeping practices must become a fixed habit, for this is a vital part of both gas turbine engine maintenance and the prevention of accidents. Clean engines inside and out, clean hangar floors and aircraft parking ramps, the prompt disposal of rags, waste and scraps, quickly mopped-up drips and spills and tools that are always in good condition become more necessary than ever before when working with the modern-day gas turbine engine. It has been proved that if the engine is kept clean internally, is operated in accordance with the operator's manual and is not exposed to extreme temperatures and fluctuations, the engine subsystems will take care of themselves.

Through competitive buying, extensive testing, research and improvement to existing equipment, the U. S. government has provided Army aviation with the most modern equipment available. The only way to employ this equipment to its best advantage is to ensure that it is operated and maintained by competent and conscientious people. Achieving this goal requires the complete teamwork and the professionalism of all personnel in Army aviation.

Arnold R. Lambert
Directorate for Education and Prevention
USAAAVS

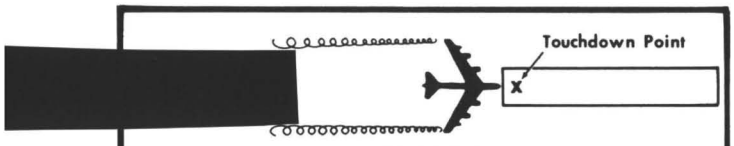


FIGURE 1
Landing behind a heavy jet—same runway: Stay at or above the heavy jet's final approach flight path—note his touchdown point—land beyond it.

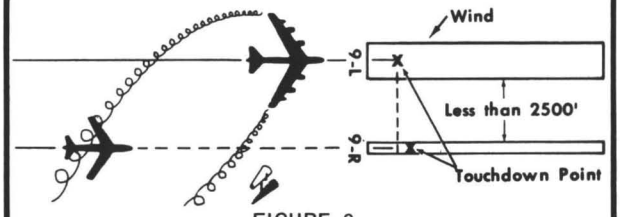


FIGURE 2
Landing behind a heavy jet—when parallel runway is closer than 2,500 feet: Note wind for possible vortex drift to your runway—request upwind runway if practical. Stay at or above the heavy jet's final approach flight path—note his touchdown point—land beyond a point abeam his touchdown point.

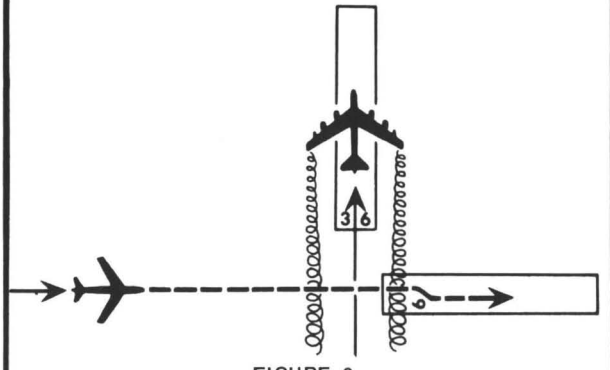


FIGURE 3
Landing behind a heavy jet—crossing runway: Cross above the heavy jet's flight path.

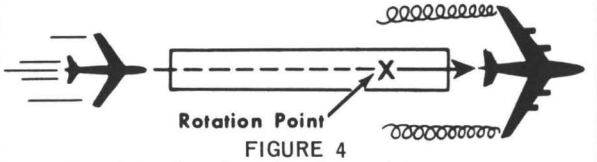


FIGURE 4
Landing behind a departing heavy jet—same runway: Note heavy jet's rotation point—land well prior to rotation point.

VISUALIZE THE INVISIBLE

EARLY MAN took to the caves lickety-split to avoid the mammoth beasts that threatened his life. This method of avoidance was effective, but hunger forced him from the caves and into combat with his enemies. Man soon learned that a club in his hand tended to equalize things somewhat. He later learned that his spear was nearly as sharp as his enemies' teeth and claws. He learned about their vulnerability and was thus able to survive.

Centuries later, our reactions are still the same as our predecessors' when our safety is threatened. We instinctively avoid a hazard until we can develop a means to eliminate it. But how can we deal with a hazard that we cannot readily detect with our natural senses?

Our first objective in dealing with this type of a hazard is to develop a method of detection. Once detected, steps can be taken toward avoidance or possible elimination of the hazard.

Thanks to the ingenuity and perseverance of our research scientists and engineers, many detection devices have been developed for our protection. The microscope enables us to detect our microscopic enemies. The x-ray helps detect internal body abnormalities. Radar aids us in navigation as well as

detecting severe weather and enemy aircraft. Sonar, mine detectors, infrared searchlights and the image intensifying night sight are just a few more of the detection systems now in operation. We are even capable of detecting lies with a machine.

Wake turbulence (WT) is one of aviation's invisible hazards that has become a major problem. Every aircraft, while in flight, generates a pair of counterrotating vortices trailing from the wing tips. With a helicopter as the generating aircraft (GA),

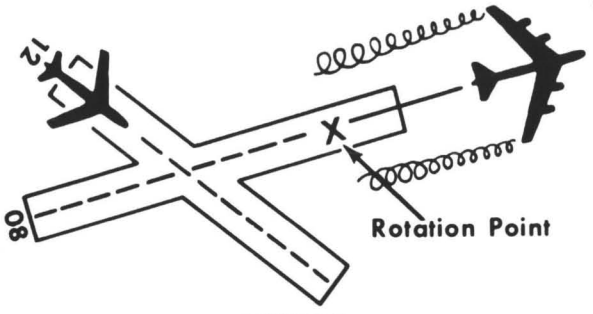


FIGURE 5

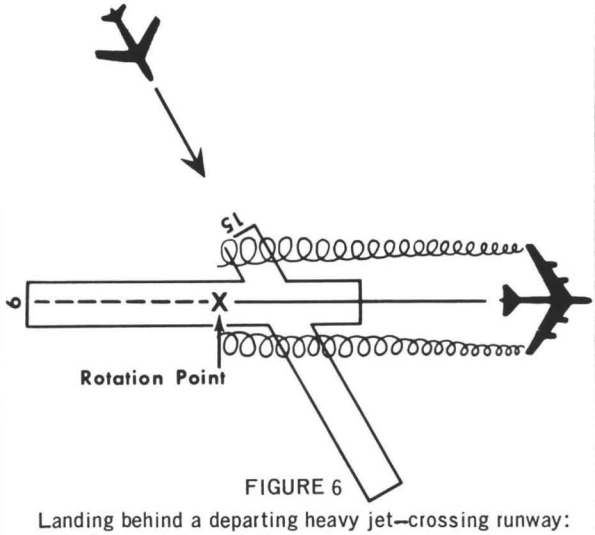


FIGURE 6

Landing behind a departing heavy jet—crossing runway: Note heavy jet's rotation point—if past the intersection—continue the approach—land prior to the intersection (figure 5). If heavy jet rotates prior to the intersection, avoid flight below the heavy jet's flight path. Abandon the approach unless a landing is assured well before reaching the intersection (figure 6).

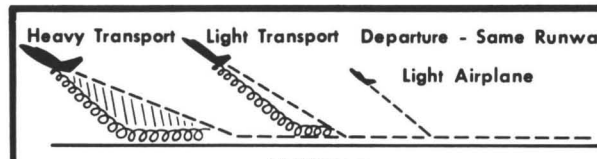


FIGURE 7

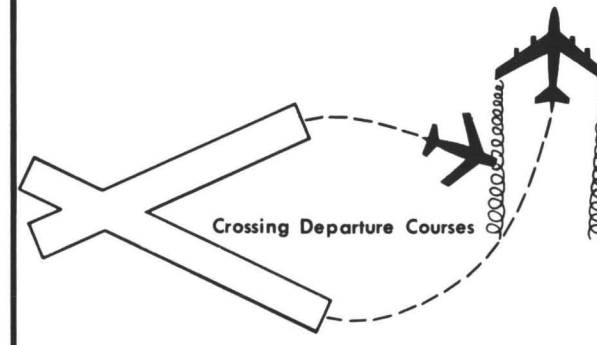


FIGURE 8

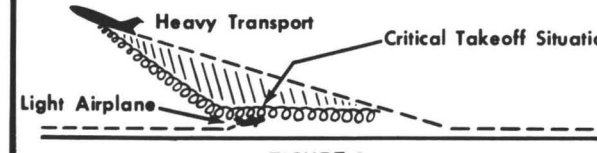


FIGURE 9

Departing behind a heavy jet: Note heavy jet's rotation point—rotate prior to heavy jet's rotation point—continue climb above heavy jet's climb path until turning clear of his wake (figure 7). Avoid subsequent headings which will cross below and behind a heavy jet (figure 8). Be alert for any takeoff situation which could lead to a vortex encounter (figure 9).

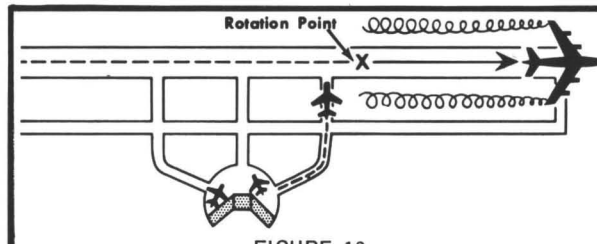


FIGURE 10

Intersection takeoffs—same runway: Be alert to adjacent heavy jet operations particularly upwind of your runway. If intersection takeoff clearance is received, avoid subsequent heading which will cross below a heavy jet's path.

VISUALIZE THE INVISIBLE

the vortices trail from the rotor tips. The generation of vortices begins when an aircraft attains lift and ends when the aircraft touches down. (*Generation ends with touchdown, but vortices or WT already created can still be in the area.*)

WT intensity depends on the weight and speed of the GA with weight being the basic contributing factor. The greatest strength of vortices is generated on takeoff and landing when the GA is heavy and slow and a high angle of attack exists. Therefore, WT hazards are greatest at airfields with heavy jet traffic. Low altitude encounters with vortices, which usually happen at or near airfields, are more hazardous than high altitude encounters in that there is less time to regain control of the aircraft.

This information and much more was obtained from tests conducted by FAA and other organizations, including some aircraft companies. The tests involved the use of generated smoke that was drawn into the wing-tip vortices trailing behind various heavy jets. The smoke made the vortices visible so they could be filmed. Study of the test results and films concluded that vortices have definite behavior patterns and their presence and location can be predicted to some degree.

With the knowledge already gained concerning the characteristics and behavior of WT, FAA has launched an R&D program that could go on for 5 years and cost as much as $10 million. The primary objectives of the program are to learn more about vortices and to develop an operational avoidance system. Four sensor systems, employing either acoustic radar or laser radar, are already planned for testing during the program. AVIATION WEEK & SPACE TECHNOLOGY, August 14 and November 13, 1972, contain some of the details of the program objectives.

Figures 1 through 11 show recommended vortices avoidance procedures for several situations. These procedures are included in FAA Advisory Circular No. 90-23C, dated 16 May 1972.

Elimination of WT hazards around airfields may be accomplished soon and some day WT itself may be eliminated through aircraft design. But until then, avoidance is your only choice.

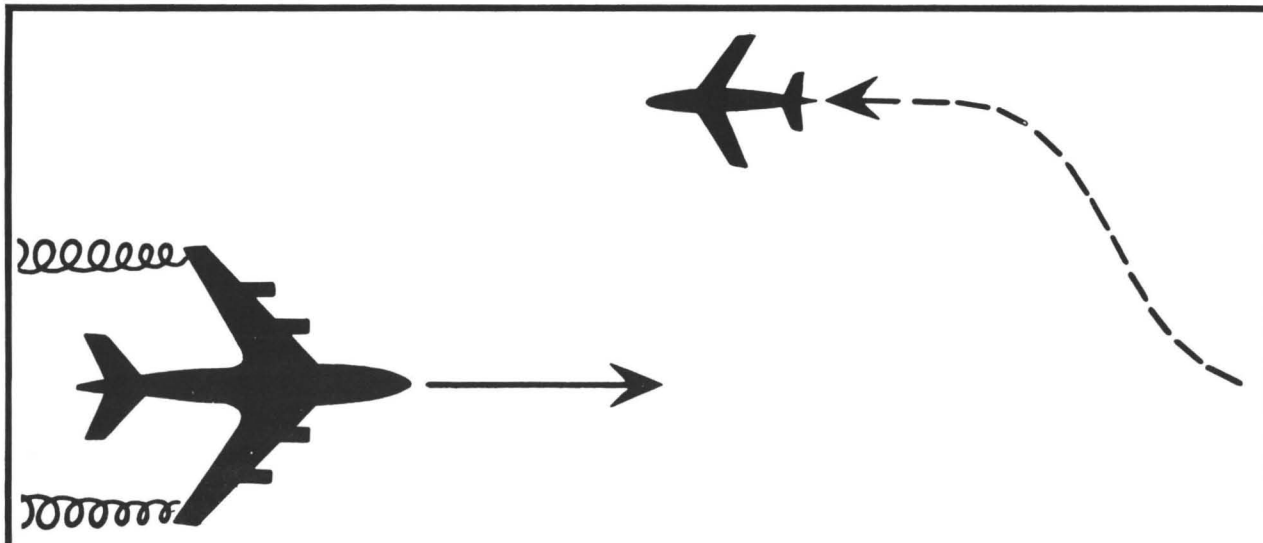


FIGURE 11
Enroute VFR—(thousand-foot altitudes plus 500 feet): Avoid flight below and behind a heavy jet's path. If a heavy jet is observed above you on same track (same or opposite direction) adjust your position laterally, preferably upwind.

Icing Conditions

What is meant by light and moderate icing conditions?—Aviator

According to Message, R182155Z Dec 72, from Department of Army, the National Coordinating Committee for Aviation has defined various icing conditions as follows:

Trace—Accumulation of one-half inch of ice on a small probe per 80 miles. The presence of ice on the airframe is perceptible but the rate of accretion is nearly balanced by the rate of sublimation.

Light icing—Accumulation of one-half inch of ice on a small probe per 40 miles. The rate of accretion is sufficient to create a hazard if flight is prolonged in these conditions but is insufficient to make diversionary action necessary.

Moderate icing—Accumulation of one-half inch of ice on a small probe per 20 miles. On the airframe, the rate of accretion is excessive, making even short encounters under these conditions hazardous.

Heavy (severe) icing—Accumulation of one-half inch of ice on a small probe per 10 miles or less. Under these conditions, deicing equipment fails to reduce or control the hazard.

Ice Buildup

Two Bell 205s (civilian models of the UH-1H) recently were damaged during mishaps caused by ice buildup at the base of the cyclic servo. Condensation collected and froze on the outside of the servo, making the cyclic controls immovable. What does the Army do to prevent this problem?—Civilian helicopter pilot

The preflight checklist for operation of Army counterparts in cold climates requires that the boot covering the control mechanism at the base of the servo be inspected before each flight. A new boot has been proposed that if adopted will protect the servo from moisture accumulations, thus preventing the freezing problem.

Nomex

Information is needed as to where or how our unit can obtain white Nomex for our medical corpsmen as we become more available to the civilian communities in project MAST. It is felt that a white Nomex fireproof will be more appropriate for identification by the local law enforcement agencies and rescue teams within our area of operations.—Commander

There is no white Nomex suit in the current Army inventory, and a suit of this type is therefore not available through normal supply channels. Since your problem is one of identification and not of adequate fire protection, we suggest you consider some method of identification other than white flight suits, such as a distinctive armband or brassard. If you feel that white Nomex is the only solution, you should submit a suggestion to the Surgeon General that this type of suit be adopted. Approval of this suggestion, however, appears unlikely at this point in time as cost estimates available to USAAAVS indicate that the small quantity of white Nomex flight suits needed to support MAST units could cost as much as $800 per copy.

Emergency Escape Systems

I am interested in helicopter emergency escape

If you have a question concerning aviation accident prevention, write to
CO, USAAAVS
ATTN: Orval Right
Fort Rucker, AL 36360

Write to Right

systems. Do you have any unclassified facts or statistics on UH-1, AH-1, or CH-47 helicopter catastrophic accidents that could have been survived if the crew could have been ejected from the helicopter, or the cabin parachuted to earth after severance of the rotor systems and the tail boom?—Aviator

You will be interested to know that both the armed services and industry are working on this problem. The Naval Weapons Laboratory has proved the feasibility of a zero-altitude and zero-airspeed emergency extraction capability for the AH-1 and has requested a joint Army/Navy development program. DA has established with the U.S. Navy a coordinated joint research and development program for attack helicopters. In addition, Sikorsky Helicopter Company, along with Teledyne McCormick-Selph, has demonstrated a helicopter sequential blade-shedding system that will permit upward extraction of individual crewmen or a modular concept. You will find some statistics in the following references:

Isadore Senderoff, "Helicopter Escape and Personnel Survival Accident Data Study," D210-10267-1, April 1971; W. H. Baker, "The Helicopter—Hazardous at Any Height?", ARMY AVIATION DIGEST, September 1971; Paul H. Johnson, "Emergency Escape Systems for Helicopters," ARMY AVIATION DIGEST, August 1971; John Ennis, "Helicopters: Unsafe at Any Height," POPULAR MECHANICS, September 1971; J. H. Arnold, Jr., and F. B. Pollard, "Emergency Helicopter Crew, Passenger, and Vehicle Survival and Recovery Techniques," and Gordon A. Valentine, "An Escape System for Helicopters," *SAFE Engineering Journal,* 7252 Remmet Avenue, Suite 207, Canoga Park, CA 91303. In addition, both Teledyne McCormick-Selph, P.O. Box 6, Hollister Airport, Hollister, CA 95023, and Stanley Aviation Corporation, P.O. Box 20308, Denver, CO 80220, have published literature concerning helicopter escape and recovery systems and associated problems.

AH-1G Jettison Cartridges

The policy of my unit is to move our AH-1G helicopters into the hangar each night to protect them from weather, especially high winds. Should pylon stores jettison cartridges be removed from the helicopters each time they are moved into the hangar?—ASO

USAAAVS takes the position that jettison cartridges do not have to be removed before the AH-1G is placed inside the hangar for reasons other than maintenance *provided that:*

- Qualified personnel ensure that the battery is disconnected.
- Ground safety pins are installed in each pylon-stores rack.
- A placard is placed on the helicopter stating jettison cartridges are installed.
- After the aircraft is removed from the hangar, jettison switches are in the OFF position before the battery is connected.
- Explicit instructions on these four items are published in the unit SOP and personnel are thoroughly familiar with them.

System Safety

I've been hearing a lot lately about system safety. Could you give me titles of publications to which I could refer for details as to how it affects Army aviation?—Army aviator

The first publication that comes to mind is USAAAVS's "System Safety Newsletter," published quarterly. I looked at a recent issue and found additional references which should prove of interest to you:

- DOD Directive 5000.1 ("Packard procurement policy")
- DOD Directive 1000.3 (safety policy)
- Williams-Steiger Occupational Safety and Health Act (OSHA)
- DOD Mil Std 882, "System Safety Program for Systems and Associated Subsystems and Equipment"
- AR 385-16, "Safety for Systems, Associated Subsystems and Equipment"
- Army Materiel Command Pamphlet (AMCP) 385-23, "System Safety Management" (the Army's system safety "cookbook")
- USAAAVS Technical Report 72-8, "Preparation of a System Safety Program Plan," revised. The revised edition contains an annex entitled, "The System Safety Process," and copies of the report should be requested from USAAAVS on organizational letterhead stationery.

You may also be interested in three articles appearing in the AVIATION DIGEST: "The System Safety Process," May 1970, and "Eliminating Safety Hazards in Future Army Aircraft," November 1971, both by LTC James T. Darrah, Jr.; "System Safety in Army Aviation: A Coming of Age" by MAJ William F. Gabella, March 1973.

Editor's Note

AR 746-1, 10 April 1972, with change 1, 17 November 1972—not AR 746-5 as stated in last month's column—spells out how to paint and mark equipment used in aircraft maintenance shops and on the airfield. Paint numbers given as 24260 and 11106 should be 24272 and 11105 (or 11136) respectively.

PEARL'S

Personal Equipment & Rescue/Survival Lowdown

Water Survival Equipment

In accordance with paragraph 4-13, AR 95-1, aircraft on extended or sustained overwater flights will be equipped with appropriate emergency survival equipment. My questions are:

What is an extended or sustained overwater flight in a multi-engine aircraft?

What has been the failure rate of both engines simultaneously due to malfunctions other than fuel exhaustion?

Is there a life raft available other than the one normally contained in the individual overwater survival kit that can be carried in the Army standard multi-engine aircraft, i.e., U-8, U-21?

The intent of paragraph 3-35a, AR 95-1, dated 1 January 1973, is not to distinguish between single- and multi-engine aircraft, but to establish basic criteria for equipping Army aircraft with survival equipment. Whenever an Army aircraft is to conduct a flight over a body of water such that a forced landing terminating on land cannot be negotiated, that aircraft must be equipped with sufficient life vests, life rafts and appropriate survival equipment for each person aboard. The pilot will ensure that all passengers and crew are familiar with the location and general use of all life support equipment and methods of egress from the aircraft after water contact.

In order to address your second question, a thorough examination of the accident reports submitted during the period 1 January 1967 to 20 December 1972 was made. This study revealed that, for the period, there were no cases when both engines of multi-engine fixed wing aircraft failed simultaneously for reasons other than fuel starvation.

In reply to the third question, yes, there is a one-man and a seven-man life raft available for use in the U-8 and U-21 aircraft. These rafts and their components are listed below. The number of life rafts authorized for these and other types of aircraft can be found in table 1-3, chapter 1, section VI, TM 55-1500-204-25/1, General Aircraft Maintenance Manual.

As the aviation safety officer for an Infantry division, I feel a sense of responsibility to see that the aviators assigned are provided the best available survival equipment. Due to the location of our division our aviators are required to perform regular flights of single-engine aircraft over extended portions of the open sea. As an added thrill, mother nature has added numerous sharks.

To date, the only life support equipment that we seem to be able to get is the LPU-10 water wings. Do you feel this type of protection is the best that can be made available for an Army aviator? If not, what do you recommend?

No, I do not feel that the life preserver, underarm, LPU-10, if this is the only item of water survival equipment you have, is the best equipment that can be made available. Listed below are many additional items of equipment which you should have and be using to augment the preserver and enhance an in-

PEARL'S personal equipment & rescue survival
dividual's chances of survival in the water.

Recommend you query your units to ensure that the needed items are on request. Ensure that, in those cases where the equipment authorization is other than Common Table of Allowance 50-901/2, appropriate changes to TOE/TDA with justification are made. Verify the status of all requisitions for this equipment with your G-4 supply, making sure requests are valid. If the proper procedures are followed, you should have no trouble obtaining your water survival equipment through the Army supply system.

1. Survival kits:

a. FSN 8465-973-1863—Survival kit, individual: w/legend "survival kit overwater"; furnished w/case; MIL-S-43301 (GL).

b. FSN 8465-965-4702—Survival kit, individual: w/legend "survival kit, OV-1 aircraft, overwater"; furnished w/case; MIL-S-43423.

c. Vest, survival, SRU-21/P and components by FSN are:

NOUN	FSN
Vest assy, complete	8465-177-4819
Vest, SRU-21/P	8415-177-4818
*LPU/2/P life preservers (complete assembly)	4220-630-8714
Left-hand packet	4220-645-6995
Right-hand packet	4220-645-6989
Lighter marker distress SDU-5E	6230-938-1778
a. Flash guard AGR-FG1B	6230-917-6692
b. Battery (light, marker, distress)	6135-269-5843
Signal kit, foliage penetrating Model MBA-201G	1370-490-7362
Flares, signal kit	1370-490-7363
Survival kit, ind., tropical	6545-782-6412
Tourniquet	6515-383-0565
Compass lensatic	6605-846-7618
Net, gill, fishing	4240-300-2138
Knife, pocket	5110-162-2205
Bag, water, size B	8465-634-4499
Mirror, mark 3, type I	6350-105-1252
Fire starter (butane lighter)	9920-999-6753
Assembly instruction sheet	Dwg # X11-1-1783

The following components are not issued with the vest, but are issued at the mission site at the discretion of the local commander:

Receiver-transmitter, radio, AN/URC-68	5820-832-9158
Battery, dry, BA 1112/U (replacement)	6135-935-5241
Receiver-transmitter, radio, ARC-RT-10	5821-912-4480
Battery, dry (replacement)	6135-930-0810
Receiver-transmitter, radio, AN/PRC-90	5820-782-5308
Battery, dry (replacement)	6134-838-0706
Revolver, .38-caliber, special	1005-937-5839
Ammunition, bal, .38 caliber, 17 ea	1305-028-6625
Ammunition, tracer, .38 caliber, 6 ea	1305-301-1692

*Not issued with the vest but used in conjunction with it.

2. Life preservers:

a. LPU-10, FSN 4220-850-8655LS

b. Parachutist, type B-7, FSN 4220-657-2197.

See CTA 50-901 for basis of issue.

3. Life rafts:

a. One-man, MB4, FSN 4220-541-9872.

Accessories, one-man life raft

Bag, storage, drinking water	1
Bailer, boat	1
Box, match	1
Case, individual survival kit	1
Case, individual survival kit	1
Compass, magnetic, unmounted	1
Desalter kit, sea water	3
First aid kit, aviator	1
Fishing tackle kit	1
Food packet, survival	3
Fuel, compressed, trioxane	3
Hat, reversible, sun	1
Insect net, head	1
Knife, pocket	1
Life raft, inflatable	1
Match, nonsafety	3 boxes
Mirror, emergency, signalling, MK3	1
Paddle assembly, life raft	2
Pan, frying	1
Repair kit, life raft	1
Sea marker, fluorescein	2
Signal, smoke and illuminating, Marine	2
Sponge, cellulose	1
Spoon, picnic	1
Sunburn preventive preparation	1
FM 21-76 Survival Manual	1
NLABS 11-1-172 packing list	1

b. Seven-man, MRK7, FSN 4220-245-7751.

Accessories, seven-man life raft

Accessories container, P/N 59J3779	1

Pump, hand, MIL-P-8258 Type III	1
Adapter, pump, P/N MS21962 (ASG)	1
Kit, repair, MIL-S-6330	1
Kit, first aid	3
Beacon, personnel locator, AN/URT-21	1
Mirror, signalling, search and rescue, Mark III	1
Signal-distress, AN Mark 13, MOD O	4
Light, marker distress, type SDU-5/E	1
Kit, desalter, type MK-2, MIL-D-5531	2
Distillation kits, sea water, solar MIL-D-5850, Class B	2
Adapter distillation bag, MS23004 (ASG)	1
Food packet, survival, general purpose	3
Rations, survival, type ST	3
Bag, water, plastic, size A, MIL-B-8571	3
Manual, survival, AFM 64-5	1
Sponge, size 8, type II, L-S-626	1
Bucket, bailing, 44D9376	1
Kit, fishing, MIL-F-6218	1
Paulin, lightweight, size 77	1
Sunburn preventive	4
Cord, 30 ft length, MIL-C-5040, type I	2
Compass, magnetic, unmounted, pocket survival, MIL-C-6235	1
Oars, metal, sectional MS26529-2	2

c. Twenty-man, FSN 4220-563-3560, for CH-34, CH-37 and CH-47 aircraft. This life raft is not an Army-stocked item but is available through U. S. Air Force supply.

USAASO Sez

The U. S. Army Aeronautical Services Office discusses

Special Use Airspace: Public Law 85-726 enacted in August 1958 charges the administrator of the Federal Aviation Administration (FAA) with giving full consideration to the requirements of national defense in matters pertaining to airspace utilization. However, the same paragraph also charges him with the requirement to give full consideration to the public right of freedom of transit through the navigable airspace.

Special use airspace is a constant irritant to the FAA, the civilian air carriers, the private pilot, the local politician and the environmentalist. Modern weapons and training requirements make the use of restricted airspace one of the most critical items of interest to commanders at all levels. Regular and reserve units must train with the weapons to be proficient. New weapons systems must be tested and for some more airspace is required. On the other hand, the FAA is pressured by the civilian community to eliminate, or at least drastically reduce, the military use of restricted airspace. The individual opportunist looking only at his personal advantages uses every issue he can find to agitate and influence the FAA in its determination on restricted airspace, hoping to reduce these activities so he can proceed with *his* plans for expansion. In other cases dedicated Americans lobby for the reduction or elimination of special use airspace for worthwhile programs but counter to military programs. All commanders must become familiar with the requirements for use of restricted airspace, what is required by the FAA in joint use restricted airspace and what is expected of the FAA.

All users of restricted airspace must ensure that they are cognizant of other users' requirements and establish procedures that will ensure that the airspace is properly managed to provide the most acceptable use or they will soon find that the FAA has no option except to conduct airspace reviews that may result in restricting, or in some cases eliminating, these areas for use by the military. These pressures mentioned above are not what might happen—they are happening today, right now. So the time is now to review our use of these areas and ensure that we have eliminated (as far as missions will allow) all issues and/or procedures that could be used to indicate that we are not managing our airspace in the best interest of all. Also, remember that not too many months remain until the next annual restricted area utilization reports are due. Those reports provide FAA with information which either supports continuation of designation of the restricted areas or invites attempts to discontinue or limit the current designation. Well-kept records of all activities occurring in restricted areas (including activities by sharing agencies) make possible the preparation of convincing utilization reports.

USAASO Sez—"A stitch in time. . . ."

☆ U.S. Government Printing Office 1973—746-161/5

HOW TO GET THE DIGEST

THE U. S. ARMY AVIATION DIGEST is an official Department of the Army monthly publication for those having an interest in Army aviation. Official distribution of the magazine is handled by The Adjutant General.

Active Army requests for both initial issue and revisions to an account are submitted on DA Form 12-4, "Requirements for Department of the Army Administrative Publications Other Than Regulations and Circulars." The completed 12-4 is submitted to the: Commanding Officer; USA AG Publications Center; 2800 Eastern Boulevard; Baltimore, Maryland 21220.

Detailed instructions for preparing the form and other pertinent information is provided on the back of the DA Form 12-4.

National Guard and Army Reserve units under pinpoint distribution also should submit DA Form 12-4. Other National Guard units should submit requests through their state adjutants general.

Distribution criteria to be used for the AVIATION DIGEST is as follows:

One (1) copy per two (2) Military and Civilian on flying status.
One (1) copy per four (4) Military and Civilian in nonflying status, but directly associated with Army aviation, i.e., maintenance, air traffic control, air staff section, etc.
One (1) copy per twenty (20) Personnel assigned to airmobile combat units.

Air Force and Air Force auxiliary elements should use local funds and submit their requests for paid subscriptions as outlined in the last paragraph.

Navy and Marine Corps activities to include reserve units submit their requests to: Director, Navy Publications and Printing Service; Building 157-3; Washington Navy Yard; Washington, D.C. 20390.

Coast Guard units submit requests to: U.S. Coast Guard (OSR-2/73); 400 Seventh Street, S.W.; Washington, D.C. 20590.

Official distribution is not made to civilian organizations. The editorial office of the AVIATION DIGEST does maintain a limited number of exchange subscriptions for other technical publications and house organs. Request for an exchange should be made by letter, inclosing a copy of the publication proposed to be exchanged to the: Editor; U.S. ARMY AVIATION DIGEST; Fort Rucker, Alabama 36360.

Paid subscriptions for the AVIATION DIGEST are available from the Government Printing Office at $8.00 a year for mailing to a domestic or APO address and $10.00 to a foreign address. Individual copies are 75¢ each. Make your check payable to the Superintendent of Documents and address your request to the: Superintendent of Documents; Government Printing Office; Washington, D.C. 20402.

A "New" Warning System?

Maintenance personnel and aviators need an alarm system which would warn them of imminent engine failure. What can be done though? Have you any ideas?

CW2 Peter J. Smith

HOW about a warning system that would ring a loud bell revealing an impending engine failure. Sounds great, doesn't it? Just think, there would be time for maintenance to correct the problem.

What would you say if I told you that such a system exists right now with many of our aircraft, but that there are many pilots who are not doing their parts to make it work effectively?

The warning system is called the daily engine recordings (DER) check. It is a warning system based on the assumption that to attain a predetermined power setting, any irregularity in the air inlet compressor, diffuser, hotend or rotating portion of the engine will require more fuel and a corresponding higher exhaust gas temperature (EGT) to obtain the setting. Thus maintenance can get an indication of the health of the engine by comparing the EGT with a predetermined baseline EGT established when the engine was installed.

The DER check is performed at a certain altitude and power setting in order to set up a "standard" condition. If the EGT is 20 degrees higher than the baseline, the warning bell comes on when maintenance makes the comparison. Or at least it should.

If the EGT is 20 degrees or more above the baseline, then an entry should be made on DA Form 2408-13 and maintenance notified. If the EGT is 30 degrees or more above the baseline, common sense says that the aircraft should be grounded.

EGT is not the only key parameter in the DER program. N_1 speed also should be observed and recorded. N_1 trends along with EGT trends can assist the maintenance officer in monitoring engine condition and determining engine fitness.

A recent accident investigation disclosed that an OH-6A aircraft incurred major damage and the pilot received minor injuries when the aircraft was autorotated to the side of a mountain following an engine failure. The aircraft rolled over due to the severity of the slope and came to rest against a tree.

Who's at fault here? Let's look at this accident a little closer. The aircraft had been flown on three separate flights that week, *but no one had bothered to perform the DER check.*

The final results of the engine teardown analysis have not been received, but it is a definite possibility that DER checks might have shown some indication of the impending engine failure.

Let's draw a parallel to failure to perform DER checks. It is like someone handing you a loaded gun to face a charging tiger. You remove the ammunition, then point the gun at the tiger and pull the trigger. The Army has handed the aviator a loaded gun in the form of a DER check. It's up to him to use it to serve the purpose for which the DER was designed.

The warning system is there to use, but it is not fully automatic—it requires a little input on the part of every aviator to make it work. This input is minimal compared with the results that can be obtained.

The DER check is designed to protect *you*. Take advantage of it every time you fly.