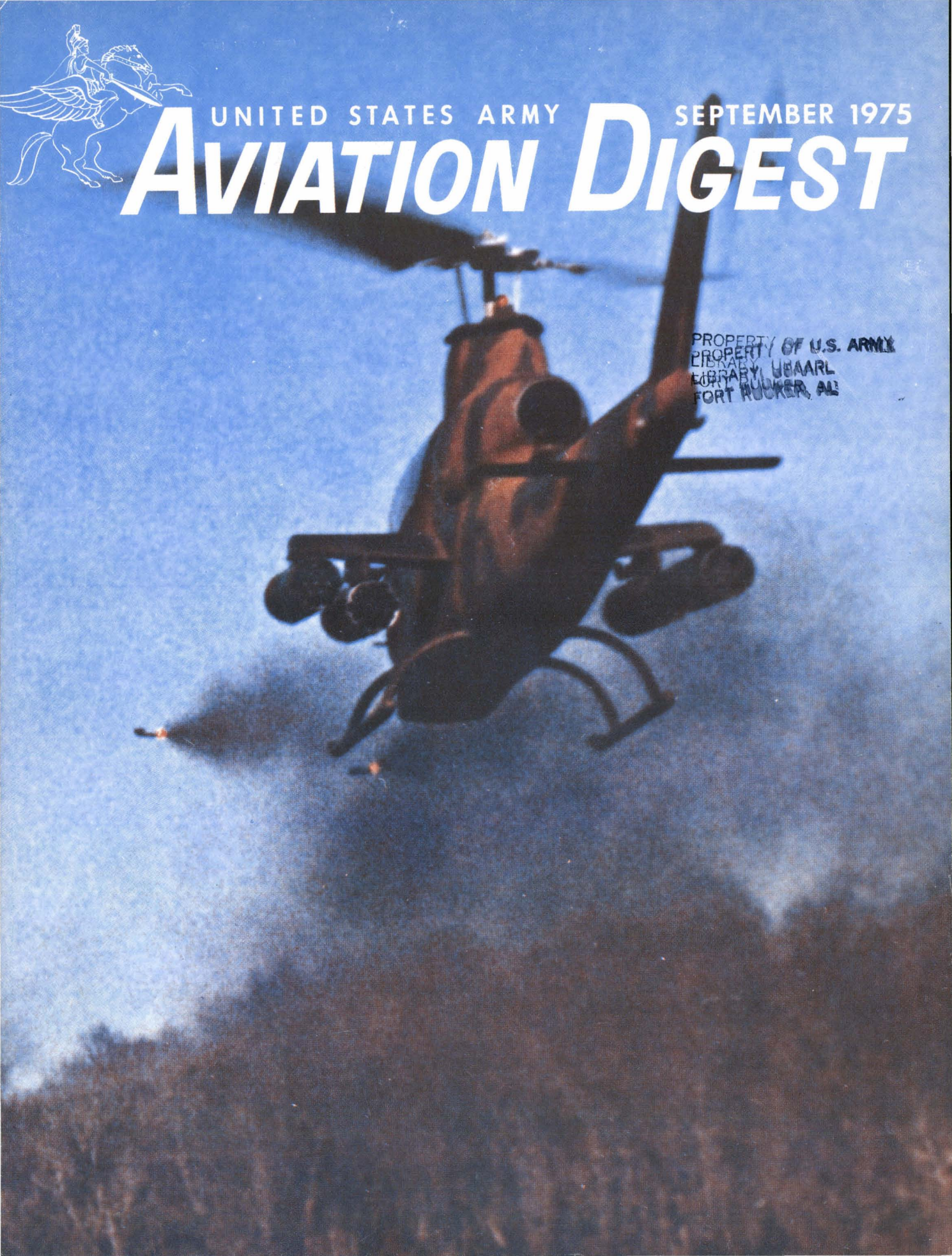
UNITED STATES ARMY

SEPTEMBER 1975

AVIATION DIGEST



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UNITED STATES ARMY AVIATION DIGEST

SEPTEMBER 1975 VOLUME 21 NUMBER 9

VANGUARD OF FREEDOM
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UNITED STATES ARMY

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ABOUT THE COVER

This month the DIGEST accents helicopter armament by featuring articles about smoke, chaff, the MOD-Y test and what bullets would say if they could talk. The DIGEST thanks the 101st Airborne Division (Air Assault) for the cover photograph of a AH-1 firing 2.75 inch rockets.

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

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Articles, photos, and items of interest on Army aviation are invited. Direct communication is authorized to: Editor, U.S. Army Aviation Digest, Fort Rucker, AL 36362.

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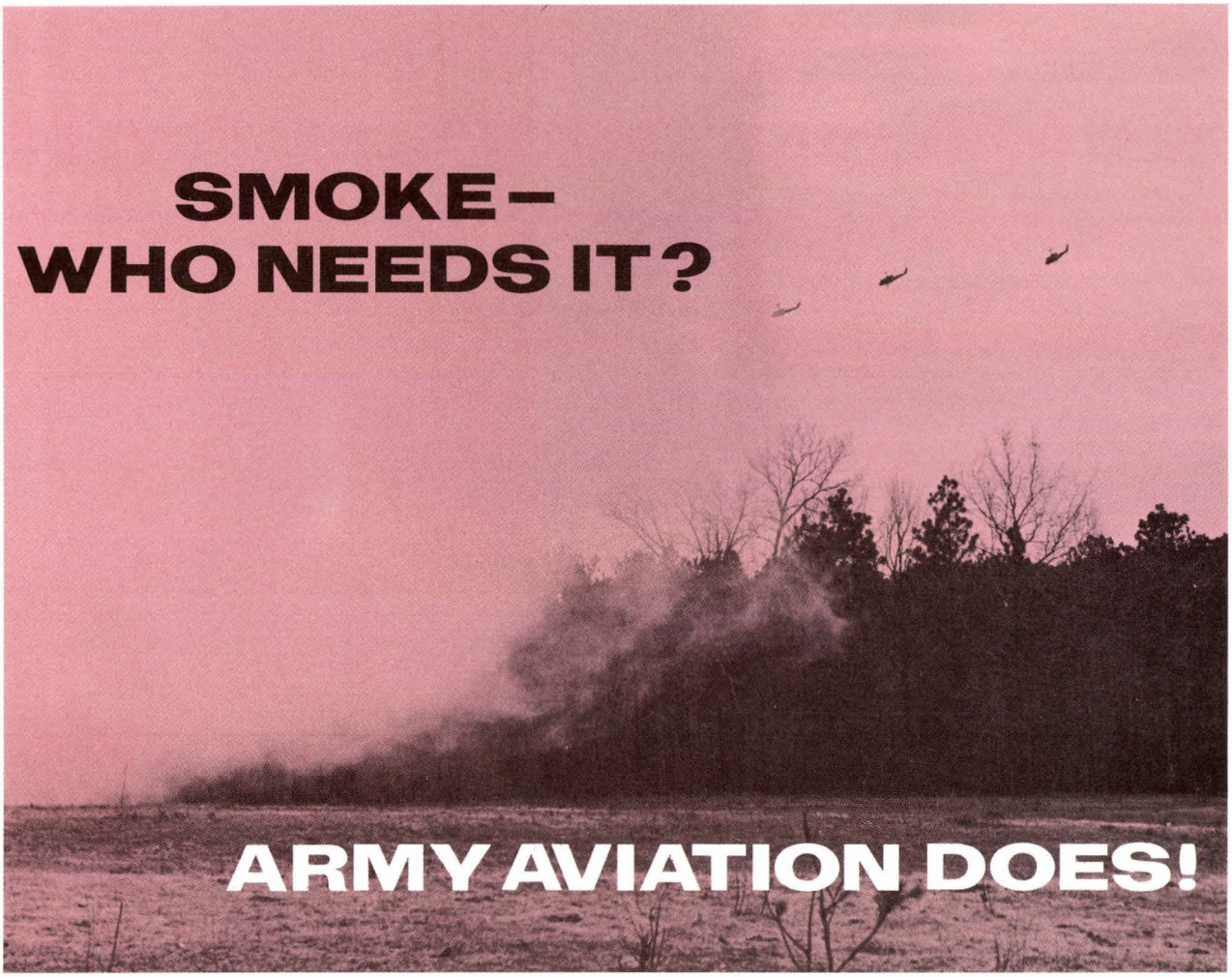

LTC Jesse E. Felter
Director
U.S. Army Transportation Operations
Naha, Okinawa

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CONTEMPORARY doctrine for helicopter employment has established a need for terrain flight to elude the enemy. However, the geographic areas and vegetation on which these low altitude flights can capitalize cannot be chosen as engagement areas. It is therefore necessary that we consider smoke as well as other devices which can be used in open terrain to deny the adversary visual detection and observation of our operations.

History reveals many instances where the employment of smoke in tactical operations was successful. One of the first recorded usages was that of Charles XII of Sweden who burned damp straw to produce smoke to screen a river crossing operation. There were many other sporadic attempts to use smoke but results obtained were too uncertain to justify its adoption as an adjunct to tactical operations. Most tacticians were reluctant to investigate smoke usage because of the handicap black powder smoke had placed on the battlefield. The development of methods for smoke generation for battlefield screening essentially was neglected until World War I.

The British were the first to develop a special smoke producing device to be used in land combat. During World War I they introduced a smoke pot containing a mixture of pitch, tallow, black powder and saltpeter. Soon both sides were using many forms of smoke, including white phosphorous, as a screening agent.

Development of smoke generating and delivery technology continued, with World War II and

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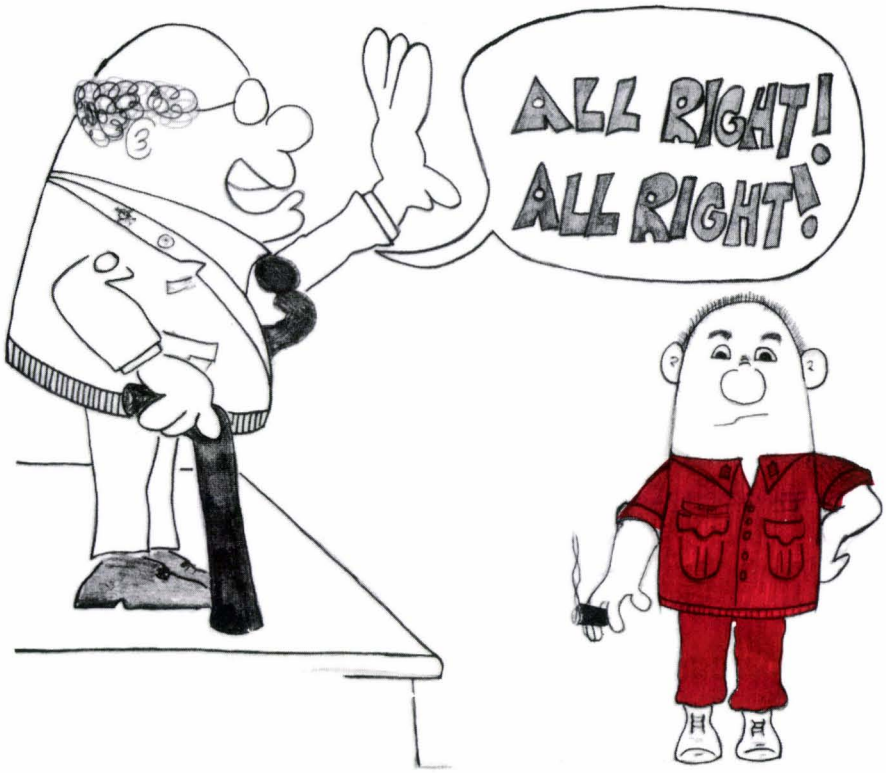
IF BULLETS



IF ONLY INANIMATE objects could talk then perhaps some enlightening things could be said far and beyond what the human designer or user has conceived.

Once, not so long ago in a warehouse probably located within the bowels of Frankford Arsenal, rounds of ammunition got together to have a promotion board. Present were 5.56 mm, 7.62 mm, 40 mm, 50 cal, 20 mm and 30 mm.

The senior bullet present, 50 cal, called the meeting to order. "All right! All right! Let me have your attention please. We are gathered here to decide who should be retired and who should move up to bigger and better things. No controversy has come up yet, mind you, but some decisions have been made and others will be made shortly that could affect us all. Now each of us in this room, to include our distinguished visitor 30 mm, feel we have designated positions, thus fixed uses and should not be tampered with. This may have been true in the past but a new weapons platform that has been developed over the past two decades is here to stay. I refer, of course, to the attack helicopter. Since I am the senior bullet present and each of you individually has mentioned to me that you feel you should have exclusive rights to the attack helicopter . . . "

A gasp from each attendee and a clamor for attention caused 50 cal to use his gavel. Bam! Bam! Bam! "Silence please. We will get nowhere this way. Now you youngsters just sit back a minute and shut up. I have the floor. Perhaps you are surprised the others want in on what you feel should be your exclusive bailiwick. Well, each of you will have the chance to state your case. To keep a semblance of order we will conduct the meeting properly. Size is as good a way as any so 5.56 mm you have the floor but try to keep it brief."

With the slight swagger so often associated with runts, 5.56 mm moved to the podium. "Gentlemen, as you are aware, I am one of the newer calibers to join your illustrious ranks. Once started, there's no stopping me. Why the whole Army now uses M-16 rifles and that's what I'm all about. If I'm good enough for the infantry why I'm good enough for anything. The attack helicopter is absolutely right for me. Since the helicopter is limited to what it can carry I'm the best choice in the room. Why, the helicopter can carry up to 20 of me where it could carry but one of some of you contenders."

Immediately 30 mm and 40 mm jumped up to protest.

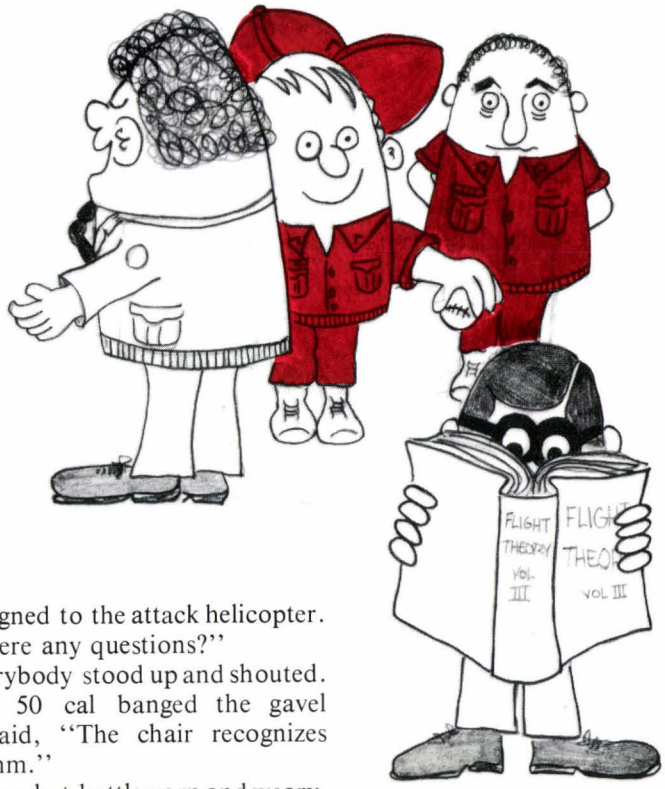
Bam, bam went the gavel as 50 cal said, "Calm down, you will get your chance. Continue 5.56."

"In addition to the advantage of my size and weight, there are other considerations," said 5.56. "When fired, my recoil against the airframe is virtually negligible. I can be fired at a very high rate and I move fast. I mean *fast* so I can get out there and do my thing to the target. That, gentlemen, in a nutshell, is why I should

COULD TALK

LTC George L. O'Grady

Technical Branch
Operations and Plans
HQ MASSTER
Ft. Hood, TX



be assigned to the attack helicopter. Are there any questions?"

Everybody stood up and shouted. Again 50 cal banged the gavel and said, "The chair recognizes 7.62 mm."

Somewhat battleworn and weary, 7.62 mm stood and stated, "5.56, I understand everything you have said. You are in all likelihood an excellent infantry weapon as you have stated. I must admit I've heard some controversy in that area; however, the question today is the attack helicopter. I have heard the attack helicopter wants even a greater range weapon than myself. I will address that later. My question to you, sir, is what is your maximum effective range?"

"Well," said 5.56, "I am not really sure how to answer that. The book says my effective range is 500 meters but I know I can go farther than that."

"Precisely!" shouted 40 mm as he leaped to his feet. "All you little guys without high explosive heads—your range is only effective to the range your tracer burns. I've been reading the book too, 5.56, and let me tell you something. The tracer is the gunner's only fire control. Unless he can see where the tracer goes, why he can't shoot. That's why your effective range is only 500 meters. Now like 50 cal says, let's keep it brief. Based on your tracer alone I think you better be grateful you do have the infantry; take your seat."

"Well said," from 50 cal, "thank you 5.56 mm for your interest. We will not forget you. There may be special times you can be used but for the moment, 7.62 mm, you are already standing, it's your turn."

"Thank you, sir," mumbled 7.62 as he walked rather stiffly to the podium. "Gentlemen, as you know I am a close cousin to dear departed 30 cal—as a matter of fact the only reason I'm here at all is a thing called NATO [North Atlantic Treaty Organization] standardization. Nevertheless, I feel I have already played an important part on all attack helicopters and I feel I should stick around for quite a while yet.

"I apologize for my worn appearance today but basically my appearance is my credential. I venture to say I was fired more in the Republic of Vietnam than any two other calibers here today. I have proved reliable and the weapons that use me either are fully reliable or have identified fixes to make them reliable. I can state *my* advantages are similar to those of 5.56 and then some. I am small, many can be loaded. I am fast and my recoil is negligible. My current maximum effective range is approximately 800 meters but my killing range is closer to 3,000 meters.

Continued on page 20

MOD-Y Test by 101st

CW2 Donald R. McCoy

THE MOD-Y WAS developed as a part of the weapons stores management system for attack helicopters. It gives the pilot a zone select capability for firing the different types of 2.75 inch rockets.

In addition to the zone select capability, a pilot can select single pairs, multiple pairs or quads (firing rockets from all four pods at once). This feature gives the system the potential to carry marking or flare rounds in certain zones along with high explosive (HE), variable time (VT) or delayed penetration (DP) rockets and to fire whichever rockets the mission dictates.

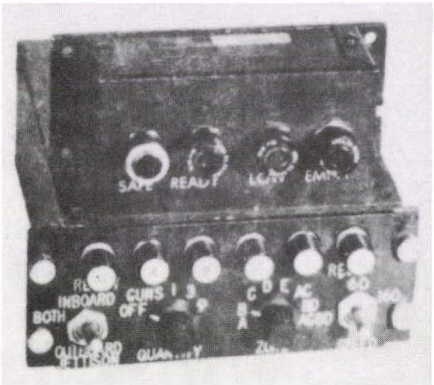
The MOD-Y is a portion of the weapons stores management system which includes the laser rangefinder or a similar range finding system along with a heads-up display to assist in target acquisition and engagement.

The major components of the MOD-Y system include a control head which replaces the pilots' weapons control panels currently used in AH-1 HueyCobra attack helicopters. The two MOD-C intervalometers are replaced by two MOD-Y intervalometers and a wiring harness to adapt the intervalometers to the control head. Installation of the system takes about one-half hour and it can be installed at the organizational level.

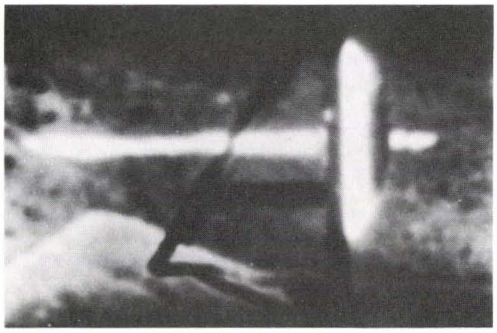
The basic difference between the MOD-Y and MOD-C intervalometers is that the MOD-Y intervalometer can be *repaired* at the organizational level or direct support maintenance level. The inoperative component is replaced at either of the two maintenance levels without removal of the system from the aircraft. There is no weight difference between the MOD-Y and the system now in use; therefore, weight and balance are not affected.

The MOD-Y control head is the same size as the current control head. It consists of two click dials on the left and right center of the panel. The left dial is used for zone select and the right one for pair select. The zone dial can select any of the six zones, quads or all zones can be fired at once.

The pair select dial on the right has a *lamp* position to test the quantity lights, an *off* position and

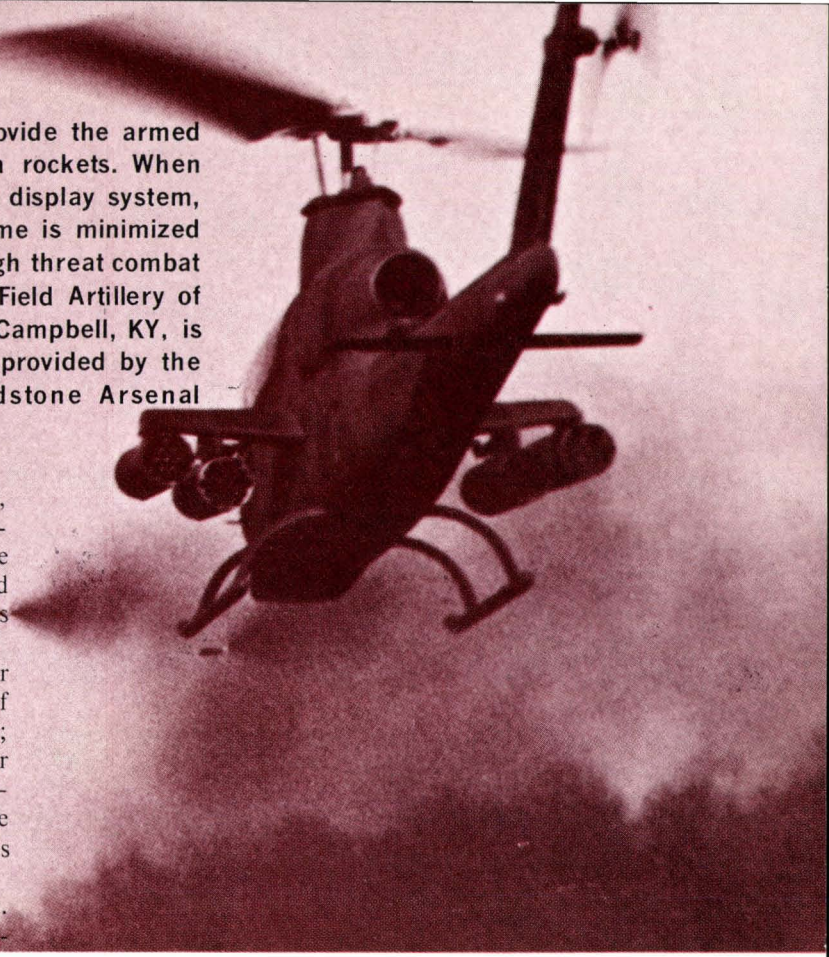


Above, MOD-Y control unit...60 minute retrofit and 6 zone capability. At right and below, 2.75 rocket penetration sequence through 5 inch armor plate. Provides attack helicopter w/anti-tank/antipersonnel capacity in unitary warhead



At right, the hand held AN/GVS-5/XE-2, being studied for possible use airborne as an economical AH-1 Cobra rangefinder system, left, view thru rangefinder

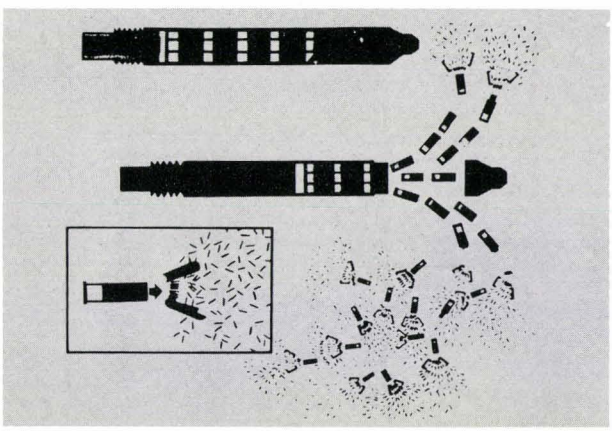
The MOD-Y system has been designed to provide the armed helicopter with a mixed payload of 2.75 inch rockets. When coupled with a rangefinder and the heads-up display system, the MOD-Y equipped helicopter's exposure time is minimized substantially, thus improving survivability in a high threat combat environment. The 4th Battalion, 77th Aerial Field Artillery of the 101st Airborne Division (Air Assault), Fort Campbell, KY, is conducting field tests of two MOD-Y systems provided by the FFAR Tri-Service Rocket Committee of Redstone Arsenal



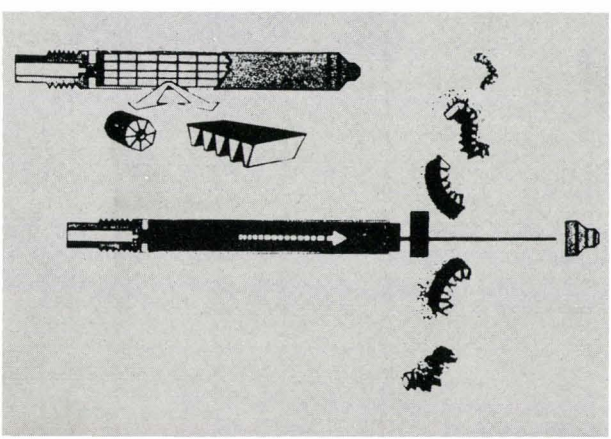
pairs select position. The pairs selectible are 1, 2, 3, 4, 7, 9 or infinity. The infinity selection, in conjunction with full zone select, will allow a pilot to fire 76 rockets in 1.2 seconds. Aviators who have fired the MOD-Y in this manner have coined the words "Quick-Dump" mode for this capability.

There are two toggle switches in the upper center of the control head. The left switch is for rate of fire either 60, 110 or 160 millisecond firing cycles; the right switch is used for wing store jettison either inboard, outboard or both. There are four lights—three green and one red—at the bottom left of the control panel that indicate how many pairs of rockets remain in each zone.

The red light illuminates when each zone is empty. The large white light located in the upper right corner of the panel is used in conjunction with the reset toggle switch in the lower right hand corner. Acquisition to all switches is easy, they are illuminated at night and are readily visible.



Chaff concept is to disperse chaff with the 2.75 rocket to enhance the attack helicopter's survivability against radar directed antiaircraft weapons. Shotgun shell and modular wheel concepts shown



The MOD-Y intervalometers divide the M200E1 pods into three zones inboard and three zones outboard. "A" Zone is the middle nine tubes outboard; "B" zone is the bottom seven and "C" zone the top three tubes; "D", "E" and "F" zones are inboard, with "D" being the middle nine, "E" the bottom seven and "F" the top three.

Battery A, 4th Battalion, 77th Aerial Field Artillery, 101st Airborne Division (Air Assault) at Fort Campbell, KY is conducting field tests using two MOD-Y systems provided by the 2.75 inch FFAR Tri-Service Rocket Committee, Redstone Arsenal, Huntsville, AL. Thus far, 3,254 rockets have been fired through the two MOD-Y systems by the 4/77th using running fire and hover fire techniques. Areas being tested are pilots' adaptability to the system, zone selection, hover fire adaptability, "Quick-Dump" mode, and organizational and direct support maintenance.

In the area of pilot adaptability, no problems have been encountered once the aviator has familiarized himself with the various switches and their functions.

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AIR ASSAULT UPDATE

...a unit commander's view

Major John R. Mills

S-3, 101st Aviation Group
101st Airborne Division (Air Assault)
Fort Campbell, KY

IN JUNE 1974, the *U.S. ARMY AVIATION DIGEST* published an article entitled "The 11th Air Assault and the Future" by LTG G. P. Seneff Jr. The tactics described in the following article might be considered as part of the future tactics which have developed from the well-laid foundation pioneered by the 11th Air Assault Division (T) in the early 1960s.

During the period 24 May 1974 through 8 June 1974, Company D, 158th Aviation Battalion, 101st Airborne Division (Air Assault) participated in exercise Solid Shield IV, east of Ft. Bragg, NC. This exercise consisted of Army, Air Force, Navy and Marine forces in a Joint Training Exercise (JTX). Company D (Ghostriders) was tasked to support the 101st Division's Third Brigade, commanded by Colonel W. F. Honeycutt (now Brigadier General) as part of Joint Opposition Forces (JOF) against the "friendly" 82nd Airborne Division. This exercise was the Ghostriders' test much as Air Assault II was the test for the 11th Air Assault Division.

Prior to this, in August 1973, Company D, 158th Aviation Battalion began an intensive training program. The company had just received its last aircraft which brought the total to 20 UH-1H Huey helicopters. Being the last assault helicopter company to be reformed in the 101st Airborne Division since its return from the Republic of Vietnam, as well as having 68 percent of its pilots fresh out of flight school, an extensive training program was needed and quickly developed. After many hours of classroom discussion, Company D, 158th Aviation Battalion began its air work with basic formation flying in groups of four to five aircraft. Due to the diverse requirements of the infantry, formations of every description were tried and tested. In addition to extensive formation flying, the standard altitude was gradually lowered until all flights were flown at or below treetop level.

As proficiency in terrain flying increased, we continued to vary the formations to fit the tactical

situation. The idea stressed most was that mid-intensity warfare presented a high threat environment to any aircraft which was not flown as close to the ground as possible. The techniques of flying in an assault helicopter company have to vary as dictated by the enemy threat. We decided early in our training program that the best way to handle light enemy opposition in offensive operations was to conduct all assaults at or below treetop level. Continuing in this phase, if a raid behind enemy lines was to be conducted, techniques which we called combat assault by infiltration (CABI) were used (this will be discussed later). If small insertions of squad-size infantry troops were to be employed, nap-of-the-earth (NOE) techniques were used.

Moving to the delay or defensive operations, we experimented with NOE techniques. At times, we went in downwind with single aircraft until the formation had fully arrived in the infantry PZ (pickup zone). Then we turned around and the last aircraft in became the leader back out. This technique was used particularly to extract friendly troops from behind enemy lines without causing excessive exposure of aircraft to enemy fire. As with both offensive and defensive operations, the entire crew of each aircraft had to be aware of the total available intelligence of enemy positions, weapons, dispositions, etc.

Along with the tactics phase, an intensive navigation program was initiated. Recalling past training with the 11th Air Assault Division, I could remember the long flights from South Carolina into North Carolina in which a deviation of 5 seconds from specified LZ (landing zone) time was not acceptable. With this in mind, the Ghostriders undertook the same professional approach to navigation and ETAs (estimated times of arrival). Utilizing the basic concepts of time, distance and heading, the only addition was terrain appreciation. Thus, if a valley was nearby, aircraft would use it by flying on tops of trees, on the sides of the valley and by following the contour of the valley in lieu of using a heading to guide on. All pilots went through the naviation training. It was felt that all had to develop the ability of being a flight lead since in the mid-intensity environment, the day of mass 60-aircraft formations would be few. More emphasis needed to be placed on single or two-or-three-aircraft groupings.

A deviation of 5 seconds from specified LZ time was not acceptable

Along with navigation and backward sequence planning to arrive on time, the Ghostriders' approach to communications was the negative use of radios. All briefings were conducted on the ground in as much detail as possible, so that all required changes would be accomplished automatically at a specified time or by the use of hand signals. Thus, flights entailing strict radio discipline became the norm. Internal calls were kept at a minimum and all calls to the infantry were very explicit in nature. For example, the aircraft lead made a call to the infantry one minute prior to pickup. Once on the ground, as the aircraft became loaded, the pilots indicated this to the next aircraft by hand signals in the day and flashlights going to steady at night. The Grimes light for 5 seconds indicated takeoff, or at RP (release point), indicated landing and any prearranged formation change. The infantry battalion commander was not called by the flight lead if ETA was accurate, but only if he was going to be late. This approach made aviators strive for exact LZ times.

All briefings were conducted on the ground in as much detail as possible

All calls to the infantry were very explicit

As was the case with the 11th Air Assault Division, Company D learned to handle the weather, i.e., landing to wait it out, and the flight lead out ahead as a weather scout made it possible to fly in

Continued on page 28

New Horizons

CPT Clifford Thomas
Project Officer, D-3
Deputy for Developments
Fort Rucker

If we don't use the right techniques and tactics, don't have the hardware, and don't have properly trained people, we can expect to be destroyed in the first battle of the next war

FOR THE PAST few years, new developments or changes in the fields of hardware, tactics and doctrine have been "hot and heavy." During this time our mission (what we do) has remained essentially unchanged while our doctrine (how we do it) and our hardware (what we will use to do it with) have evolved by leaps and bounds. Because of this rapid evolution, a significant problem has raised its ugly head—tactical training is not keeping pace. Why?

Under normal circumstances, "there will always be that 10 percent that won't get the word." But where aviation units are concerned, the problem of getting the word out to the units is even more complex because doctrinal changes in this field have been much broader and even more rapid than for any other member of the combined arms team. The writers of our training literature have been hard pressed to keep pace with the new developments and get new literature in the hands of the user as fast as the changes occur. Sometimes, new equipment will reach the field units while new doctrine or training literature is "enroute." The Army-Wide Training Literature Program (ATLP) is our vehicle. Like the old Model-T, "she don't go very fast, but she'll get you from here to there."

The U.S. Army Aviation Center's literature program is enroute. There are a number of new or revised publications coming down the pike that will help fill the present void and provide the foundation upon which field units can build meaningful and realistic training programs.

FM 1-1, Terrain Flying: As the replacement for the original nap-of-the-earth training manual, TC 1-15, FM 1-1 incorporates the latest doctrine and flight techniques that will be required of our aviators to operate on future battlefields. It provides the super-structure for individual qualification and unit training programs.

FM 1-5, Instrument Flying and Navigation for Army Aviatiors: This publication replaces two older manuals, TM 1-215, "Attitude Instrument Flying," and TM 1-225, "Navigation for Army Aviation." This new publication is our basic instrument and navigation textbook. Chapter 22 is of particular interest to field units. It introduces a new concept for aviation unit operations—tactical instrument flight and navigation. Aviation units must be able to operate intermittently into and out of frontline instrument conditions in an electronic warfare environment. This chapter presents some basic methods and techniques that will serve as a point of departure and will allow field units to take the first step in this direction.

TC 1-28, Rotary Wing Night Flight: This publication will provide aviation units with a comprehensive reference for night operations and unit training. Aviation units must be organized and trained to operate around-the-clock—not be transient daytime visitors to the battlefield. This means that we must fly at night on a regular, sustained basis either with or *without* night vision aids. Obviously, we must gain confidence in operating without night vision aids before we take on sophisticated equipment which may be available to only a limited number of aircraft.

ST 1-28, Night Vision Goggles for Army Aviators (AN/PVS-5): This publication is a spin-off from TC 1-28, and will be published at the Aviation Center to provide instructional information pertaining to the operation of this night vision device pending formal publication and distribution of TC 1-28 and/or other literature. It will be available upon request by writing to: Commander
U.S. Army Aviation Center
ATTN: ATZQ-D-TL
Fort Rucker, AL 36362

FM 90-1, Employment of Army Aviation Units in a High Threat Environment: This is the cornerstone manual of the Aviation Center's literature program. In addition to describing how aviation units contribute to the Army's land combat capabilities, it is designed to provide a broad doctrinal foundation for future publications.

FM 1-105, Aviator's Handbook: Unlike the manuals discussed previously, this one is not new. It has been in the field for about a year. However, a recent survey of Army aviators revealed that a surprising percentage of those questioned had never heard of this book. This publication provides the Army aviator with a pocket guide of useful information covering a wide range of topics. It is designed so that the aviator may have at his disposal, both in flight and during preflight planning, a handy summary of procedures and checklists which will facilitate his mission under any environment.

Tactics Sampler: The "Sampler" is now available. It is a series of articles written by senior commanders, school commandants and cockpit aviators for the ***DIGEST*** in 1974 and 1975. They offer views on tactics, training and hardware needed to win the first battle of the next war.

The books discussed here are the latest additions to our "Model-T." As we said before, "she don't go very fast, but she'll get you there." However, there are times when the old girl can use an assist. The writers of these publications are vitally interested in improving their product. But they do need your help. If you have a training problem, would like to see something added or a modification made to an existing publication or need a new publication, put your idea or problem on a piece of paper and send it to:
Commander
U.S. Army Aviation Center
ATTN: ATZQ-D-TL
Fort Rucker, AL 36362
or call: AUTOVON 558-2482/3801

Either way it won't cost you: It's official business, so use an official envelope or the AUTOVON line. You'll be more satisfied knowing you've been heard and we at the Aviation Center will be doing a more comprehensive job furthering developments in Army aviation. It takes all of us together . . . we're on the same team and . . . we want to be winners!

A discussion of the development of a device to adapt the ground Interference Generator so that it could be used in helicopters to simulate jamming during aviator tactical training. The author also clarifies EW terms. The companion story on page 12, "How's Your EW Training," relates experience of student aviators contending with jamming

Aerial Radio JAMMING

Captain Luther O. Waller
Chief, Training Branch
Department of Resident Training Management
U.S. Army Aviation Center, Fort Rucker

MOST OF TODAY's Army aviators never have been subjected to a serious electronic warfare (EW) threat, but they have been jammed or "blocked out" during what seemed like the most critical portion of a radio transmission by "friendly" radios. As aviators, we know how disruptive to the mission this interference can be, and it is this confusion that the enemy will be attempting to achieve by employing electronic countermeasures during future battles.

EW and the multitude of acronyms that are associated with it has created a mystique in the minds of many Army personnel. It is for this reason that the following clarification of the three broad divisions of EW are needed for any discussion on the subject.

Electronic Warfare Support Measures (ESM) is that division of EW involving actions taken to search for, intercept, locate and identify immediately radiated electromagnetic energy for the purpose of immediate threat recognition. Thus, ESM provides a source of EW information required to conduct electronic countermeasures (ECM), electronic counter-countermeasures (ECCM), threat detection, warning, avoidance, target acquisition and homing.

Electronic Countermeasures is that major subdivision of EW involving actions taken to prevent or reduce the effectiveness of enemy equipment and tactics employing or affected by electromagnetic radiations and to exploit the enemy's use of such radiations.

Electronic Counter - Countermeasures is that major subdivision of EW involving actions taken to ensure our own effective use of electromagnetic radiations despite the enemy's use of countermeasures.

The high level of ECM employed during the 1973 Mideast War prompted the U.S. Army Aviation Center at Ft. Rucker to recognize a deficiency in EW training being provided to its students, especially in the area of radio jamming.

The Aviation Center lacked local units with a jamming capability and had a recurring training cycle with the initial entry rotary wing course. Inquiries revealed that the Interference Generator SG-886T/UR could provide effective training, but was compatible only with the tactical ground series of radios in the inventory.

The problem was presented to U.S. Army Electronics Command representatives at Ft. Rucker, and Mr. Don C. Maier began the search for a way to adapt the device to Army aircraft. The engineering considerations of such an adaption presented several technical problems because of the voltage and impedance characteristics of the dissimilar pieces of equipment.

A relatively inexpensive cable was fabricated and within a week an initial test was flown within the tactics training area at Ft. Rucker. A simplified schematic of the interconnecting cable has been provided as well as the schematic of an additional cable that was fabricated for a portable tape cassette player using prerecorded jamming signals.

The end product is a jamming package that is compatible with most Army aircraft and a relatively simple airborne jamming platform that can be adapted to a multitude of training situations in support of air or ground operations.

Installation of the package in Army aircraft does not require any modification, thus facilitating transfer from one aircraft to the other (see "How's Your EW Training," page 12 this issue). With the electrical power being supplied from the aircraft, an effective signal can be transmitted by the pilot monitoring the training aircraft's assigned frequencies.

In this regard, some might consider this "cheating," but for the sake of training time and lack-

ing the ability to easily sweep the frequency spectrum, this dictates knowing the jammed aircraft's assigned frequencies. Additionally, the technical reader has perhaps also realized that the capability exists to jam on all of the aircraft transmitters. The jamming operator must judiciously use this multiband capability for obvious inflight safety and emergency situations.

The successful initial testing of the device prompted its immediate implementation into the tactics phase of the initial entry rotary wing program (IERW). Development of jammer employment techniques strictly has been trial and error. The jammer aircraft flies to the tactical area separately and with a degree of deception from the unknowing students who are flying scenarios dictated by assorted operations orders. Once in position, the jamming aircraft will begin his transmissions, forcing the students to apply antijamming measures.

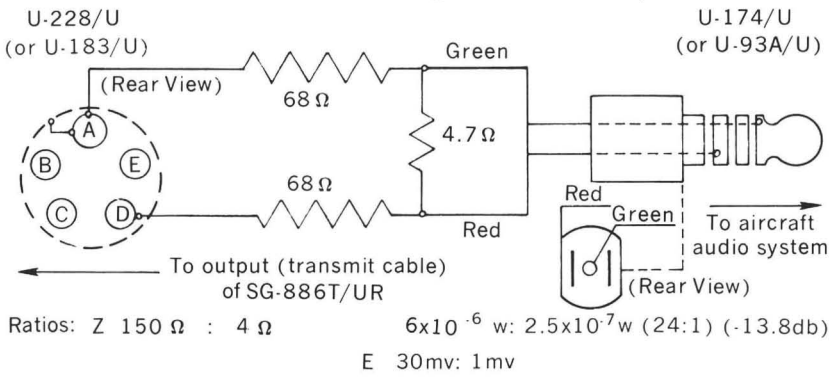
It must be recognized that the jammer aircraft is transmitting with the same power output as the other jammed aircraft and total obliteration is obtained only under the most ideal conditions. Further refinements of these techniques are continuing but training personnel favor this simple system over more complex devices.

Initial reaction to the jamming was that it was a novelty but this attitude changed with the introduction of *threat* awareness instruction and actual EW demonstrations. Student critiques have strongly favored more jamming training, and it is being incorporated into solo missions.

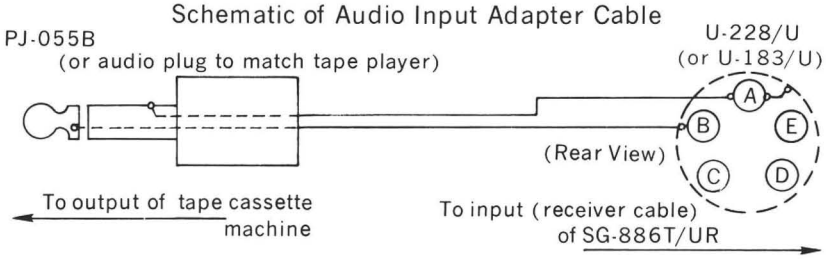
The efforts outlined and the initial actions taken might at first seem meager when compared to the equipment hardware and doctrine of our sister services. When the mission and operational environment of Army aviators are put into context with everyone's responsibility for ECCM, the electronic warfare awareness instruction provided at Ft. Rucker makes a significant contribution.

All materiels necessary for the radio jammer are readily available through normal channels and with a little ingenuity, another degree of realism can be added to produce effective EW training in preparation for future conflicts.

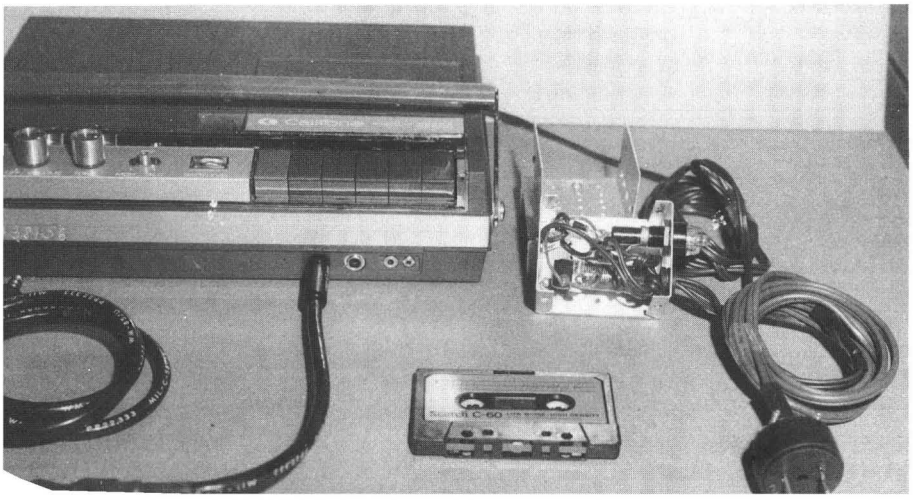
Schematic of Interconnecting Cable with Adapter Pad



Schematic of Audio Input Adapter Cable



Above figure shows interconnect cable for Signal Generator and a cable for adapting a tape player using prerecorded jamming signals. Below, complete jamming unit—cover removed from power supply. Right, tape player jamming unit in UH-1 ready for use



How's Your EW TRAINING?

Major Walter L. Bragg

Advanced Division
Department of Undergraduate Flight Training
U. S. Army Aviation Center

MOST ARMY AVIATION units train extensively to counter the enemy air defense threat, but how many units train to counter the electronic warfare (EW) threat? A frequently expressed excuse for not training is that there is no jamming equipment available. The Advanced Division of the Department of Undergraduate Flight Training at the U.S. Army Aviation Center, Ft. Rucker (the unit responsible for presenting UH-1H Huey transition and tactical training to initial entry rotary wing students) was faced with this problem: How to integrate EW training into tactical flight training (see "Aerial Radio Jamming," page 10 this issue).

The following equipment and procedures were developed and may be a possible solution to the EW training program.

The equipment that is used in the Advanced Division consists of off-the-shelf commercial equipment that is cheaper and more reliable than the SG-886T/UR. A portable cassette tape recorder (the Califone AV-80A model which costs $54.90) was obtained through the audio-visual section of the Training Services Office. Several cassette tapes were recorded with static, tone, bagpipes, unintelligible conversation, music and other types of noises. An RCA pin plug was obtained to fit the external speaker outlet on the tape recorder while a visit to the flight helmet repair shop produced several male plugs to fit the mike cords on the aircraft. A cord was fabricated to connect the RCA plug and the helmet plugs so that the tape recorder could be hooked up to the mike cords in the aircraft (see photos).

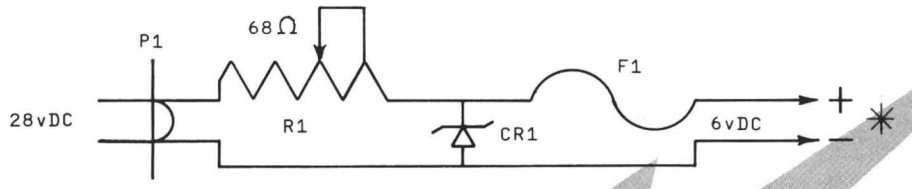
To operate the jammer, a tape is inserted in the cassette recorder and the recorder is plugged into the rear mike cord on the UH-1H. The aircraft radio is tuned to the frequency to be jammed and the transmitter selector switch for the rear mike cord is turned to the appropriate transmit position. The tape recorder is turned on to the play position and when the transmit switch on the mike cord is depressed the frequency selected on the radio is being jammed.

This system worked fine except that after 1 to 2 hours operation the 4 D-cell batteries used in the tape recorder were dead proving to be an expensive proposition due to the quantities of batteries used. To solve this problem, a power supply for the recorder was needed. The heated blanket outlet in the UH-1H provides 28 volts d.c., but the tape recorder needs 6 volts d.c. The obvious solution was a step-down transformer which was fabricated locally. The male plug is plugged into the heated blanket receptacle on the UH-1H and the positive and negative wires of the power supply are attached to the appropriate terminals in the battery compartment of the tape recorder. This eliminates the requirements for batteries. The wiring diagram for the power supply and materiels list appear in figure 1.

As can be seen, the total cost is well below that of the SG-886T/UR ($231.00) and the added advantages are no batteries to contend with and an unlimited availability of various jamming noises. With another fabricated adapter cord, the unit can be hooked up to ground type tactical radios.

The effectiveness of the jamming unit depends a great deal upon the method in which it is employed. It is impossible to drown out everyone on a frequency due to the limited transmitter power of the aircraft radio. Figures 2 and 3 give a brief example of possible employment methods.

Figure 1



P1 Hubbell #7547
R1 75 25 watt (Newark 13F560)
CR1 In 5341 Zener Diode
F1 1/2 Amp
Voltage reducer (28vDC to 6vDC) 500 mill amp
Designed to permit operation of 6vDC tape recorder from heated blanket receptacle in the UH-1H

*NOTE: Initially a volt ohm meter must be used to assure proper voltage adjustment from R1 prior to connecting tape recorder

QUANTITY	ITEM	COST
1	Califone Model AV-80A Cassette Tape Recorder	$54.90
1 or more	Pre-recorded cassette tapes	.70
2	Plugs to fit aircraft mike cords, plugs from salvage flying helmets may be used	1.00
1	Hook-up cord, 5 ft @ $ .11 ft	.55
	POWER SUPPLY	
1	Male plug to fit 28 volts DC heated blanket outlet in UH-1H	1.82
1	Electric cord, 5 ft @ $ .11 ft	.55
1	Tapped resistor, Ormite Dividohm, 210-15K-4, No. 0367, Ohms 75, Y-45, 25 watts (Other similar models may be used)	1.40
1	Fuse Holder w/fuse	2.00
1	Zenier Diode 5341B, 1R, 1N	2.20
1	Assorted screws, scrap sheet metal and circuit board	1.50
	Total Cost Excluding Labor	$66.62*

*NOTE: Initial cost; cost for multiple units would lower as quantity increases. Also, the tape recorder was locally available but further savings would result from using a tape player instead of tape recorder.

Figure 2

If the jamming aircraft positions itself between two stations, then communications between these two stations will be blocked.

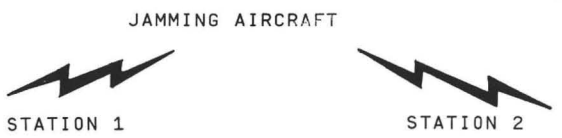


Figure 3

If, however, the jamming aircraft is in a position other than indicated above, the communications will be interfered with, but may not be blocked.

The closer the stations are located to each other, the less effective will be the jamming. For example: In order to block communications between aircraft flying in formation, the jamming aircraft must be part of the formation. Even though communications are not blocked, the operators will gain the experience of working through jamming.

If a unit never has been exposed to jamming before, they are missing a valuable training experience. Try employing this type of training on your next field exercise; you will marvel at the results.

AT YOUR SERVICE

Mr. Edward A. Ewell, DAC
Training Specialist
Field Support
Army-Wide Training Support
U.S. Army Aviation Center

MANY ARTICLES have been written about the Department of Army-Wide Training Support (DAWTS) at the U.S. Army Aviation Center, Fort Rucker. But there are those who still are unaware of the many services DAWTS provides and how easy it is for you to take advantage of them.

To begin to grasp the concept and scope of DAWTS it may be better to first take a close look at the mission outlined in the accompanying box. The mission indeed covers a broad spectrum of responsibilities. To accomplish its tasks DAWTS has been apportioned into the following five divisions:

- Administration and Processing
- Course Development
- Field Support
- Non-resident Instructional Materials Supply
- Training Extension Courses

DAWTS is most widely known for its work and support in the area of correspondence courses. It offers four professional development courses (Warant Officer Senior Course; Aviation Warrant Officer Advanced Course; Air Traffic Control NCO Advanced Course; and Air Traffic Control NCO Basic Course) and seven skill progression courses (Flight Training Preparatory Course; Flight Operations Coordinator Course; Army Aviation Command and Staff Officer Course; Aircraft Maintenance Entry Course; OH-58 Helicopter Repairman; UH-1 Helicopter Repairman; and Aviation Accident Prevention Management Course). This provides about 220 subcourses that may be obtained through DAWTS. Few, however, think about the work and coordination it takes to make all of this possible.

In addition to making subcourses available, the Administration and Processing Division also is responsible for counseling services to students who request it. Administration and Processing Division personnel work with each student as if this person were the only one enrolled. They provide the experienced guidance so necessary for successful progression at all subcourse levels. Each student receives individ-

ualized personal attention and the individual's progression rate in each course is proportionate to the amount of time and effort he or she applies. This division also is responsible for scoring lessons and examinations, computing grades, posting records and advising students of their grades.

The Administration and Processing Division has grown since July 1974. Correspondence courses have gained significantly in popularity in a relatively short period of time. For example, in July 1974 the active student enrollment in the correspondence course program was 5,617. By March 1975 it had jumped to 8,716. The additional 3,099 students represent a phenomenal 55.17 percent increase in student enrollment in just nine months. This is the largest single growth rate since DAWTS began maintenance and administration of subcourses in 1966.

DAWTS' Course Development Division is the backbone of the correspondence course program. Its personnel are the unsung heroes that provide the consistently high quality course training materials. This division is staffed with education specialists who write and rewrite course materials that provide each student with personalized self-teaching instruction. These specialists ensure that course materials are revised periodically to include the latest information and techniques. In the past two years, the total hourly credit value for subcourses has increased from 200 credit hours to more than 2,000. The Course Development Division also has a staff of editors who assist the professional educators with proper verbiage and methods of expression—thus ensuring the best possible presentation.

Students should understand that correspondence courses parallel courses taught in resident training programs, and that entry into a correspondence course program will not have an adverse effect should a student desire to enter a resident program later. There are some courses not taught in resident training. By regulation, equal credit is given whether an individual completes resident training or a correspondence course.

The Field Support Division receives queries, requests and requisitions pertaining to aviation orientated instructional materials from service schools, U.S. Army Reserve (USAR) schools, Reserve component units, Reserve Officers' Training Corps (ROTC) units, Army National Guard (ARNG) units, active Army units and individuals. The division has available all lesson plans, programs of instruction (POIs) and programed texts used in the Aviation Center's resident training courses. These training materials are valuable refresher instruments used in maintaining operational readiness, combat effectiveness and personal professional parity.

The Field Support Division also is responsible for staff visits to USAR schools and ROTC and ARNG units to provide assistance in the evaluation of training materials. It is responsible for the worldwide distribution of the Army Aviation Annual Written Examination to Army aviators.

More than 22,000 examinations were issued last year and more than 25,000 study guides furnished to all units with aviation assets and to all rated aviators. This alone is a big undertaking as it requires massive coordination efforts.

DAWTS does not have technical manuals (TMs), field manuals (FMs) or training circulars (TCs) available for routine issue. If these type publications are required, you should order them through your appropriate Adjutant General (AG) channels.

The purpose and intent of the correspondence course program is for the personal and professional development of the individual and to enhance his military career through comprehensive education. This approach to personal education helps to develop the "total" Soldier and his achievements are appropriately recognized with the awarding of a certificate upon successful completion of the course. Correspondence courses or any of a large variety of subcourses may be obtained by following proper enrollment procedures as prescribed in AR 351-20. Group enrollment is encouraged if two or more individuals are taking the same course and would care to study together.

Emphasis now is being placed on group study because it has opened a world of possibilities in progressive education of particular interest to the reserve components. This provides unit commanders with an additional educational tool. Procedures have been developed in which correspondence course material is implemented in the support of training.

Responsibility for the administration of the course material rests with the instructor within the unit. The Ohio State National Guard is conducting the Aviation Warrant Officer Career Course using Aviation Center correspondence course material. These classes are being conducted in a classroom environment using Guard instructors as a part of normal scheduled drills.

This innovative approach of using group study as a part of drills is being closely evaluated; initial reactions by the enrolled students appear favorable. Colonel Jo S. Drechsler, Commandant, Headquarters 5041st USAR School, in a letter dated 2 March 1975 to the Aviation Center and DAWTS said about the evaluation study program, "Those of us in this school associated with this course believe that through close liaison with your office we can continue in the development of courses that will provide high quality instruction to the students and enable students to advance in their military career and ben-

DAWTS' MISSION

- Prepares and revises, in coordination with resident departments, correspondence courses and materials pertaining to Army aviation
- Administers correspondence courses
- Serves as program coordinator for all Reserve component training support activities of the Aviation Center
- Procures, stores and issues instructional material for non-resident students and resident material for qualified activities of Reserve and active Army
- Distributes the Army Aviation Annual Written Examination and other special projects when directed
- Develops and/or coordinates the development of instructional materials designed in support of Training Extension Courses (TEC)

efit the service in general throughout the country. We stand ready to cooperate with you to continue this course and hope that it will continue and serve as a model for other schools to follow."

Group study is encouraged and DAWTS pledges full cooperation in providing the course materials required for these programs. DAWTS now has 1,412 students enrolled in similar group study courses.

The Non-resident Instructional Materials Supply Division carries the biggest operational burden of all. Every training document or course is handled and maintained by the supply division. They order, ship and stock a tremendous volume of such materials daily. They are responsible for the assembly of all course documents and supplies into the individual packets students receive.

DAWTS supply division has an over-the-counter feature on issuance of correspondence course materials for resident people at Fort Rucker. Everything produced for resident training; a subcourse requirement; or that which is acquisitioned through inter-school subcourse programs is physically handled by this division. The 25,000 sets of study materials for the Annual Written Examination must be stocked and assembled to include a map, study guide, reference data book and exam materials before being packed and mailed. In short, the Non-resident Instructional Materials Supply Division carries the burden of getting it together and shipping it out.

The Training Extension Course Division prepares aviation-related lessons for civilian contractor development. They are used by active Army and Reserve component forces. These courses differ from correspondence courses in that they utilize a multimedia approach to education. They can be audiovisual, audio only, programed text or a combination of the three.

The courses are systems engineered and directed to the following MOSs: 71P, 67N, 67V and 93H. Aviation-related lessons scheduled for fiscal year 1976 development are the DD 175 Flight Plan; Aeronautical Charts and Symbols; UH-1 Preventive Maintenance Inspections; and OH-58 Preventive Maintenance Daily Inspections. They are scheduled for delivery to the field next summer. The lessons will be used for MOS refresher training, on-the-job training programs, and may be used to supplement or replace nstitutional instruction.

DAWTS has experienced rapid growth during the past few years due to the new interest shown by individual troops in furthering their job related skills. Just as a person's body requires physical exercise to stay in shape, the mind also must be developed and exercised. There is no better way to exercise the mind than with strong educational development.

The Army's greatest asset is the mind of the individual and particularly the mind that has been exercised with productive education sources and materials. DAWTS has taken an affirmative stand in seeing that the individual who wishes to participate in the correspondence course program gets an opportunity to do so. If you have not signed up for a correspondence course, take this important step in the development of your career—today! DAWTS' catalogs of all available instructional materials and correspondence courses may be obtained by writing to: U.S. Army Aviation Center, Department of Army-Wide Training Support, Fort Rucker, AL 36362. Your sincere comments and constructive criticism now or in the future will be appreciated.

Five New World Helicopter Records

Major General Manuchehr Khosrowdad, commanding general of Iranian Army Aviation, has claimed five world helicopter records with the Bell 214A helicopter at Ahwaz, Iran on April 29th. The record performances in light helicopter class E-1.e are as follows:

Time to climb to 3,000 meters—1 minute, 58 seconds;
Time to climb to 6,000 meters—5 minutes, 13.2 seconds;
Time to climb to 9,000 meters—15 minutes, 5 seconds;
Altitude—29,760 feet; and altitude in horizontal flight—29,560 feet.

The record flights were conducted under the auspices of the Imperial Aero Club of Iran, the Iranian representative of the FAI; however, the National Aeronautic Association provided technical assistance both here in the United States and on location in Iran. Randy Randleman, secretary of NAA's Contest and Record Board, monitored the calibration of the photo panel recording instruments in Fort Worth, TX, prior to the record flights and then accompanied the Bell Helicopter team to Iran to assist the Imperial Aero Club of Iran in monitoring the actual record attempt flights.

MOD-Y Test by 101st

Continued from page 5

Thus far, this has been accomplished by a five-minute session at the aircraft while looking at the control head and a familiarization flight with a gunnery instructor pilot.

The zone select capability of the system is perhaps one of the most important factors associated with the MOD-Y. The payloads used by the unit have been mixed—VT, HE and flechette rockets—with outstanding results. More recently during the unit's operational readiness training test, the MOD-Ys were loaded with 2.75 flare rockets and HE rockets. This combination allowed the pilot to illuminate and engage his target on the same firing pass. Another use of this capability can be for lighting friendly or enemy positions and still have different types of rockets available for firing as necessary. This system precludes the pilot from having to shoot needed flares or marking rockets to get to HE, VT or other rockets required at the moment.

The rate of fire select capability gives the pilot the ability to fire at 60, 110 or 160 millisecond intervals so target acquisition and engagement can be achieved with minimum exposure time. This is paramount for survival in a high threat combat environment.

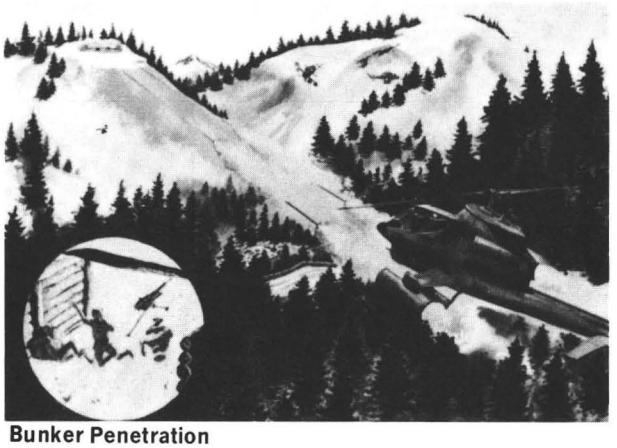
Maintenance of the system is enhanced by four stepper switches inside the MOD-Y intervalometer. These switches can be replaced easily at organizational level without removal from the aircraft.

The MOD-Y system, as part of the weapons stores management system, is needed as evidenced by the difficulty in using low level contour or hover fire techniques. The problems using these firing techniques are target acquisition and range estimation, both of which increase exposure time. The MOD-Y, coupled with a range-finder system and heads-up display, greatly reduces this exposure time and enhances the attack helicopter's survivability.

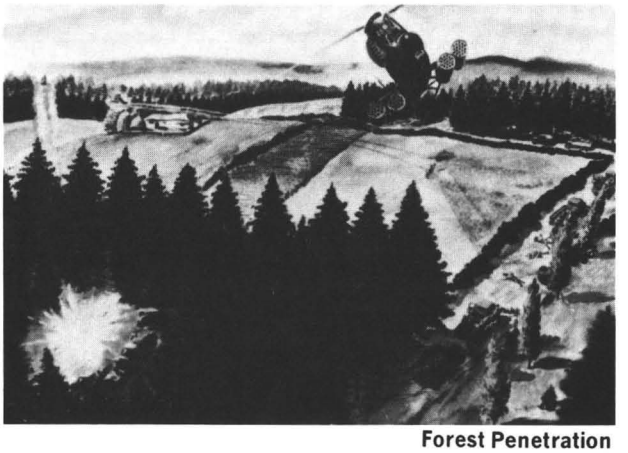
The MOD-Y is of tremendous value to all 2.75 inch armed helicopters including an air cavalry helicopter in a reconnaissance role; an attack helicopter in either a ground troop support or helicopter escort role; or as a battery of aerial field artillery.

The author has worked on the MOD-Y program at Redstone Arsenal. CW2 McCoy completed the Armament Maintenance Supervisor Course and was recently honored by the Army Aviation Association of America as Aviator of the Year 1975. He is currently attending Embry-Riddle Aeronautical University in the Bootstrap program

Typical uses of 2.75 rocket with remote set fuzing



Bunker Penetration



Forest Penetration

Building Penetration

Open Area Assault

Transmission SEIZURE

. . . Main rotor separation at 1,500 feet . . . 1430 hours . . . 1,500 feet AGL . . . ten UH-1H Huey helicopters, staggered trail . . .

"Centurion Lead, this is Four. I have a 'transmission pressure low light' burning and my pressure gauge is approaching zero."

"Roger, Four. Do you want to drop out? You can proceed to the emergency strip."

"Negative, Lead. My transmission temperature is holding within limits. I'll monitor it and keep you informed. I'll continue the mission."

"Roger, Four. Keep me advised and if necessary, I'll break out trail to escort you to the nearest safe area."

"Roger, Lead."

Within the next few minutes, it was all over! The shattered remains of the aircraft, crew and passengers were scattered throughout 400 meters of swamp. The lower transmission had seized and welded itself together due to heat buildup following the loss of lubrication.

Stupidity? Insanity? Neither!

MAJ Jan R. Moore
Chief, Operations Division
Department of Academic Training
USAAVNC, Fort Rucker

FAILURE TO UNDERSTAND how the sensing device of the transmission temperature gauge functions could lead to transmission seizure. The U.S. Army Aviation Center at Fort Rucker teaches principles of systems operations to minimize incidents such as those discussed in the introduction above. Enough background is taught to ensure a safe preflight and a valid instrument interpretation. The highly motivated pilot mentioned in the introduction was relying on the transmission temperature gauge to warn him of a dangerously hot transmission. When the transmission oil is gone, as in a massive leak due to rupture or battle damage, the oil temperature transmitter will not give an accurate reading. Designed to operate on the "wet bulb" principle, it *will not* reflect the dangerous temperature level of the transmission if there is no oil to conduct it to the transmitter. According to the UH-1 Huey dash 10, a total rapid loss of transmission pressure dictates a "power on" landing as soon as possible.

A rare event—transmission pressure loss? Maybe. From 1968 to 1971 there were four fatal UH-1 accidents charged to seizure of the lower main transmission following the loss of lubrication. Considering the number of hours flown during that period, four accidents may not seem significant. However, any accident is significant if you are involved in it!

In the 2 years ending 30 April 1974 there were 1,302 UH-1 systems failures, 141 of them were transmission systems failures. During the same period there were 194 AH-1G HueyCobra systems failures, 31 of

them were transmission systems failures. The failures lead to mishaps* and are reported as they occur. Certainly all failures don't lead to accidents, but they sure give one an excellent chance to happen! During the 2-year period ending 30 April 1974 there also were 7 AH-1G accidents and 21 UH-1 accidents attributed to systems failures and/or malfunctions.

The purpose here is not to spread horror stories about the UH-1 transmission which, incidentally, is a very reliable component. The objective is to stress the importance of a good understanding of the principles on which your aircraft systems operate. The same method could be applied to any other system—tail rotor, power plant, hydraulic, etc. Aircraft systems courses are taught at the Aviation Center to initial entry aviator students, to aviators in every transition course and to those attending instructor pilot courses.

Occasionally students express verbally or through critiques that too much "systems" is taught. "Just tell me what to do when the red light comes on," characterizes their feelings toward the whole block of instruction. The most common problems encountered have given rise to well-defined procedures outlined in the dash 10 and dash 10CL as "emergency procedures." But what about those occurrences that are not covered in "emergency procedures"? For instance, how about a *slow* but steady loss of transmission oil pressure while flying over water or dense forest? In this instance you should be able to effectively monitor your transmission oil temperature and get usable feedback on which to base a decision.

Often systems training is referred to as "maintenance training" which is a misnomer inasmuch as the Aviation Center does not produce maintenance officers. It avoids teaching "nuts and bolts—nitty gritty" detailed maintenance. The Aviation Center's mission is to teach the principles of the systems operation with enough details to aid the aviator when performing a preflight. However, if you insist on calling it "maintenance" go ahead, because the more you know about the aircraft the more clearly you can communicate with the maintenance people who have to keep it flying. They do a good job but they need your help. (During the 2-year period previously mentioned there were 6 AH-1G accidents and 8 UH-1 accidents charged to maintenance.) *You* are an important link in the maintenance chain!

Both operators and maintainers make mistakes and sometimes the machine fails us in spite of our precautions and planning. It pays to know your aircraft as thoroughly as possible. "A little bit of knowledge is a dangerous thing" is not a truism that holds. If you know just enough to realize that when you have a gauge that says "go" and a warning light that says "don't go" your chances are at best 50-50; then you can land, shut down and later ask "the man who does know." The odds at Russian roulette are better than that! The chance you take based on ignorance that springs from an "I don't know" attitude may be just enough to barely kill your crew, your innocent passengers and you. Think about it!

gorski's corner

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*Mishap—Any unplanned event that happens to an aircraft which has been started with an intent to fly. Mishaps are reported in "Crash Facts" messages—i.e., precautionary and forced landings, incidents and minor and major accidents.

If Bullets Could Talk

Continued from page 3

"Now, gentlemen, there is something even I do not understand. I know the helicopter wants to shoot farther than 800 meters and I have done everything I can to help but —well, you judge it. Several years ago, 1967 as a matter of fact, right here in this arsenal they worked on my tracer element. They fixed it so my tracer would burn all the way to 1,500 meters and remain compatible. Compatibility means my non-tracer rounds were never more than four feet away from the tracer throughout the flight. Yet at 1,500 meters the ball round and tracer round had a common point of impact. That little fix more than doubled my maximum effective range yet it has never gone into production."

"Maybe it's because you can't kill a tank," mumbled 30 mm.

"True! True!" retorted 7.62 mm. "But why should I kill a tank? That's not my mission. I can certainly help tank killers, but kill? My job is area fire or suppression. Now if a tank killing weapon is around then use it but use me too. I can sure cause those tankers to button up and if I do that, the tankers' visibility and consequently target acquisition capability is reduced. That helps the tank killer survive. If I clean the infantry up around the tanks, that's a bonus effect."

Standing, 50 cal asked, "Do you have anything else?"

"No sir."

"Well, as you know, I've been around here a long time and this is the first I've heard about your new tracer. It may be a big help so don't feel we are going to ignore you. But I would like to finish this session so let's move on. I realize you are not really next on the agenda 40 mm, but since you and 7.62 mm have worked so closely together for the last few years, let's hear from you."

Brushing himself off, 40 mm stood and waddled to the podium, "I sure am glad the subject of tank killing has come up 'cause just by my size alone I can be the best tank killer in this room. Let's face it, the rule of thumb for a HEAT (high explosive antitank) round is that the armor penetration is directly proportional to the diameter. And since I have the biggest diameter, why I can be the best tank killer."

"Yeah?" shouted 20 mm. "Have you ever hit a tank? That is a prerequisite you know."

"Well," retorted 40 mm and and flushed considerably, "I do remember some testing done a few years ago when I wasn't too successful. But, some of our relatives are talking fire control that computes with ballistic equations and assures first round hits, so I feel with fire control that minor

problem can be licked."

Apparently not going to sit down 20 mm came back with, "Range, baby, range. Why your maximum effective range is only 1,250 meters and at that you have to be fired as a mortar to get there. And your time of flight, ha! By the time you get to where you are going, why the war could be over. Sit down and let's hear from some real contenders."

Loudly, 50 cal banged the gavel. "Gentlemen! Gentlemen! Let's not degrade this session with unwarranted accusations. In defense of 40 mm I must state he really did a job in Vietnam. His lethality was commendable and overall munition and gun reliability was a credit to us all. I feel 40 mm may not have a great future considering the needs but he did a grand job for what he was designed. I want to thank you 40 mm for your presentation. 20 mm! You seem to be talking more than anyone else. You are a relative of mine and I do not intend to show favoritism but in the interest of harmony you can have the floor next."

At this time 20 mm walked to the podium and said, "I apologize, 50 cal, and I will attempt to control myself. But being a three-service round and getting all the attention I have gotten recently plus great promises, I just feel I have a few things to say."

"Wait," said 50 cal. "I can already see you getting out of control again, so for the benefit of those gathered here let me give them the background. Gentlemen, several years back, 1944 to be exact, after the beachheads were established in Normandy, fighter aircraft armed with me were sent out to find and destroy enemy ground targets. At ranges beyond 500 yards I did little or no damage to enemy tanks. The cry went out for a better aircraft antitank gun.

"I was all they had, thus using me as a model, a 60 cal gun was worked on. Obviously, a bigger shell casing was needed to hold the powder to drive the bullet farther and faster. This was done. The program continued for several years and several guns and rounds of 60 cal were developed. Finally in 1947, without ever going into production, the program was terminated. Remember the U.S. Air Force was the U.S. Army Air Forces, so this aircraft gun development was done right here. Some of the work was in this very room.

"I'm sure 60 cal would have been a fine weapon (sigh) but we must proceed. Soon after the Air Force became a separate service it was determined those high flying jet fighters needed a gun. Lo and

behold, the 60 cal shell casing and powder charge were resurrected. Now high up there where the jets flew, aerodynamic design of the bullet was not nearly as important as what the bullet did to the target. The new bullet, 20 mm, was flat in the back—just as he is today. This design allowed for more explosive inside or a bigger bang when hitting a target. It worked pretty well, too. Then, as the years passed, good old 20 mm was employed not only air-to-air but as an air-to-ground weapon. Now some of the initial design (nonaerodynamic) is back to haunt 20 mm. I hope this puts things in better perspective. You may continue, 20 mm."

"Yes sir," said 20 mm meekly. "I have been used quite a bit in the air-to-ground role and as you have indicated, there have been some complaints . . . but," more enthusiastically now, "there are fixes and I can have a new shape if needed and, more important, new fuzing is already on the way. Why, with some of the promises of a new fuze my reliability at 2,000 meters will be just grand and if . . . "

At this point 50 cal again interrupted, "Fixes are fine, just fine, but I'm not sure if you are aware that fixes can be as long a lead time and as expensive as new developments. Don't hang your future on fixes—a brand new development may just pass you by. Meanwhile, we are aware of your fixed wing uses, how about on the helicopter?"

"As you are aware, sir, I am standard on the Marine AH-1J. True, my recoil is pretty big but I can do it. To be totally honest, gunners tend to fire me more straight ahead than full left and right deflection. It seems at full deflection the effective range is reduced somewhat because the impact pattern on the ground is greater. I am also standard on the Army HueyCobra as a wing stores weapon. I am far more accurate and easier to shoot than other wing stores weapons."

"Just a minute," interrupted 50 cal, "don't overload yourself. You may get a cracked shell casing or blow your primer. You have, as you have said, been mounted on helicopters but your range still isn't what I have heard they want. We can continue to go round and round but I think you have said what is needed to this point, let's hear from our visitor, 30 mm."

"Thank you, gentlemen," said 30 mm as he rose, removed his glasses to polish them and moved to the podium. "I really do not know why this meeting has been called. I personally feel the important decisions have been made and we are wasting our time. However, even though I am far advanced and most of you are obsolete, I will graciously inform you about me, where we are and what is going to happen in the future.

"I have several 30 mm relatives enjoying great success throughout the world but I am unique in that I have been designed for the helicopter. Though I am bigger than 20 mm, my recoil is certainly no greater, so compatibility is no problem. I am next in diameter to 40 mm thus my HEAT is excellent. I have had minor fuzing problems but as 20 mm stated, these problems are readily resolvable. As far as numbers of rounds carried, that is a laugh. Why, singly I am so superior to anyone else in this room that there is just no way you can compete. I am complementary to all other helicopter weapons in the inventory. Not only do I suppress, I kill. So why go on and on? The decisions are made. Let's terminate this meeting by saying I hope you enjoy your retirement years. I will carry on in your place."

"Congratulations," said 50 cal, "but I think there are a few questions to be asked yet. You may have wondered why I put myself last. You will soon find out. Don't leave, 30 mm. I will not take long. Then we will have questions.

"It is well established I have seniority in this room. I caution all of you that just because I am not new you will not have an easy time beating me. Each of you has stated his advantages and you know what? They all apply to me. Consider,

if you will, size. There are two smaller and the rest larger. Certainly enough of me could be carried when the carry capability is limited to weight and size.

"Is range a consideration? Gentlemen, I was designed to be fired on the surface. Ballistics are my strongest point. My speed in flight decays less than anyone else's in this room.

"Defeat armor, you say? I can defeat light armor at close ranges. At longer ranges I don't need to. That's the job of antitank designed weapons. I can certainly suppress at all ranges. No high explosive you say? Well, I am not convinced it is really needed. I recall several of your stories, 7.62 mm, where you said you saved the day on so many occasions. Friendly troops on the ground got into a fire fight and called for support. Is it really true they called for 7.62 mm and asked not to use other weapons? They did this because any other weapon was high explosive and if fired where needed would get the friendlies too. Maybe the discriminatory fires available to the helicopter need some ball-only ammunition. That's where I belong. If you want a growth option I have heard of several HE 50 cal efforts so I will use 20 mm's argument and say a fix is available.

"Let's talk about something else that has not been mentioned. Suppression at extended ranges needs to occur now, not after the fact. Now 30 mm, if my facts are right—if a TOW [missile] and a 30 mm are fired together, then at 3,000 meters the TOW will get there first. Is that correct?"

"Yes sir."

"Well, well, maybe your designers are not so perfect but let's continue. You are all aware of what a helicopter is, how it flys, how the attitude of the helicopter changes as flight accelerations or velocities are called for. Right? You are also aware that we have

not been able to tell the engineers where to locate their gun turrets.

"Consider the location of the turrets on current and future attack helicopters. How much elevation is available to the gun? How high can the gun be pointed? Now if the helicopter is at all nose low and must go lower to accelerate, how far can you shoot? 30 mm again! I understand the turret elevation can be, say, 15 degrees. more advanced helicopters only 11 degrees. What elevation do you need to get to 3,000 meters?"

"I need 10 plus almost 11 degrees and by your own facts there is enough elevation for me in the turret!"

"Yes," said 50 cal, "that's true if the helicopter nose is not pointed down as it is at a hover or even farther down in forward flight or accelerating maneuvers. It hasn't been demonstrated yet but I contend I can shoot farther than you and more often than you based upon my much flatter and faster trajectory."

There was a silence in the room. Finally, 40 mm cleared his throat and stood up. "Gentlemen, since I am the closest to retirement, I feel I am the most unbiased. It would appear to me certain things should be done prior to more decisions. The actions to be taken in priority are:

> Check out the extended range 7.62 mm tracer, use it now on the current weapons fleet. The guns are there. Maximize the lethality.
>
> There should be a firing evaluation of 50 cal, 20 mm and 30 mm. This evaluation must consider the full maneuverability of the helicopter. If maneuvers are not considered the gun employment cannot be evaluated."

Standing, 50 cal said, "40 mm, I appreciate your thoughts and I think I speak for the group when I say we agree so let's . . . "

Too bad inanimate objects cannot talk.

CHAI

ITS USE

Prepared by the Test and Evaluation Division
Deputy for Developments, U.S. Army Aviation Center

MILITARY RESEARCH and development is characterized by potential adversaries attempting to gain technical advantages one over the other. As one side gains an actual or perceived advantage, the other will immediately launch efforts to negate or overcome that advantage.

And so it goes with the measures, countermeasures and counter-countermeasures race. A most vivid example of these types of technological races is in the field of radar electronics and the investigation of the use of chaff to help offset these capabilities.

Radar electronic warfare (EW) has been and continues to be a most fluid and fertile area for technological research and development. U.S. Air Force experience over North Vietnam, and also during the 1973 Mideast War, has sharpened U.S. military interest in and support for electronic warfare hardware and techniques to optimize its use.

This brings us to a short discussion of a common cause for concern for all Army aviators and those commanders who will benefit from the added capabilities Army aviation can provide. This concern deals with radar directed antiaircraft artillery and surface-to-air missiles.

Radar has been around since the beginning of World War II, and since that time potential enemies have sought ways to counter the other's radar while making his own more immune to countermeasures. The method for countering radar is to employ some form of jamming. This falls into two general categories—*active and passive.*

Active jamming involves the transmission of radio frequency (RF) energy to *overpower* or *deceive* a radar receiver. The vast majority of U.S. radar electronic countermeasures (ECM) research and development efforts center around active jammers. (For an unclassified overview of U.S. and foreign radar jammer programs see the 27 January 1975 edition of ***Aviation Week and Space Technology.***) These active jammer programs, most of which are being sponsored by the Air Force and U. S. Navy, are very complex pieces of hardware. Their applications to Army aircraft are constrained by four very large limiting factors: size, weight, cost and internal power requirements to drive them.

Passive jamming involves the reflection of that RF energy which was transmitted originally by the radar set to deceive the radar operator with a false target or clutter his scope with multiple targets. One of the best sources for achieving this reflectivity is chaff. This is nothing more than millions of tiny strips of metal or metal coated fiberglass which are cut to one-half wavelengths of the specific radar frequencies in order to maximize its reflectivity.

The initial employment of chaff was quite effective in denying the use of radar to the enemy. Unfortunately it also affected the use of our radar. As usual in the game of countermeasures, modern technology soon resolved this problem in part by development of a moving target indicator (MTI) for radar sets.

MTI is a capability built into a radar set to allow the operator to eliminate ground clutter and stationary targets, displaying only a moving target. The overall effectiveness and success achieved with MTI is dependent largely upon operator training and skill. At a minimum, chaff will be effective in forcing the radar operator to go through additional steps to choose the correct target from among several radar readings or from amidst a large radar return.

The Army is exploring several methods of dispensing chaff to protect aircraft. One is a mini-chaff system. This involves expelling small cartridges of chaff from a dispenser externally mounted to the airframe. They present several small chaff clouds to decoy or cause a radar operator to choose the correct target from among multiple radar returns. These devices are intended primarily for

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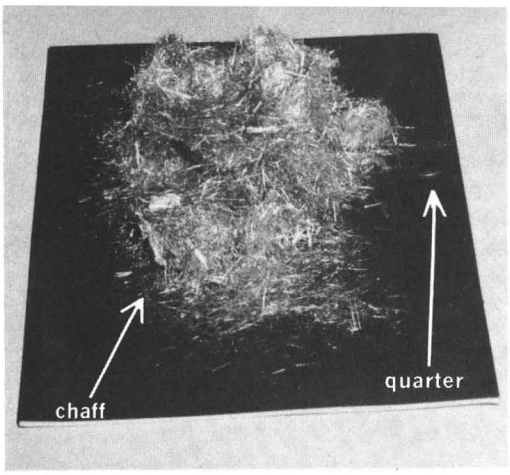
lividual aircraft self-protection d to buy time for the aircraft seek more substantial cover of errain mask.

Another method being explored to dispense large quantities of aff with the 2.75 inch rocket. ıese quantities, when mixed with tural terrain clutter, may provide fficient screening to electronically nceal aircraft that must be exsed for longer periods of time ıile conducting combat operaıns.

One note of caution to keep in ind when using chaff (or any her electronic countermeasure) is at threat air defense systems ıve some redundancy in their rget acquisition/tracking capalities. Specifically, radar usually not the only means by which rcraft are detected, acquired or ıcked. Therefore, to be truly fective, electronic countermeases must be employed in connction with other countermeases which limit/degrade optical or ectro-optical air defense obsertion.

Even though chaff represents a -year-old technology (see "Chaff It's Effect," on this page), there room for improvement in the ethods for dispensing and utilizg its effects. Any ECM, no matr how old, which shows promise improving aircraft survivability serves full consideration. Chaff receiving that consideration!



Relative size of aluminum chaff compared to a quarter and the turbine shield assembly showing chaff buildup

ITS EFFECT

LTC (Ret.) Porter Dillon
Former Test Officer
MASSTER

CHAFF, A REFINEMENT of the World War II practice of dropping scrap material from aircraft to confuse radars, has been tested recently for its effects on Army aircraft by Modern Army Selected Systems Test, Evaluation and Review (MASSTER), at Fort Hood, TX. The test was considered necessary because, even though a great deal of experience exists regarding chaff and Air Force aircraft, information was lacking in the case of Army aircraft with their smaller engines and other differences. The test was conducted by then Major Porter B. Dillon and Captain Dennis V. Williams.

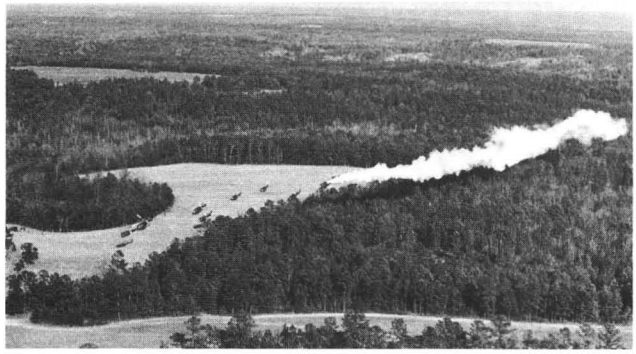
Composed of tiny metallic or metallic coated fiberglass strips that are used to reflect signals to radar receivers, the chaff strips are of varying lengths and cause different responses to electronic frequencies. Because aircraft may be forced to fly through falling chaff, tests were conducted in two phases on that probability.

The first phase of the test was conducted by the U.S. Army Aviation Systems Command (AVSCOM) and involved the two most common types of Army aircraft engines. The results were favorable in that both engines were able to tolerate large amounts of chaff before experiencing any adverse effects.

The second test phase was conducted by MASSTER and involved testing of the total aircraft to include its various subsystems. Four different types of Army aircraft were used in this test phase. To simulate near-flight conditions on the ground, chaff was dropped over stationary aircraft while engines, rotors, propellers and all onboard equipment were operating, and with an OV-1D Mohawk providing propblast to simulate relative wind flow of an inflight aircraft.

The chaff was dispensed over a series of 10- and 20-minute periods from a hovering helicopter above and upwind of the target aircraft. Results were highly favorable and the target aircraft experienced no degradation in their performance during the second phase of testing.

It was concluded that the aircraft can perform very effectively and safely when exposed to chaff densities similar to that likely to be experienced in an operational environment.



Continued from page 1

Korea seeing many instances where entire smoke generating battalions were deployed in support of tactical operations. World War II also saw the first smoke delivered by aircraft. Two operations which best typify this usage occurred in the South Pacific.

The first was near Lae, New Guinea in September 1943, when 1,700 paratroopers descended and captured the Japanese-held Nadgab airstrip. This operation began with the Japanese being awakened by the sound of seven Boston bombers coming over the mountaincrest. Each bomber was equipped with two M-10 smoke tanks under each wing. Skimming along the valley floor between the airstrip and the bivouacked Japanese security forces, these planes trailed heavy lines of smoke which first settled to the ground and then rose to form a screen 400 feet high and 4,000 feet long, effectively screening the closely following transports dropping the paratroopers into the clearing. Before the screening smoke had dispersed, the paratroopers had safely landed and organized for a successful attack.

Similar results were realized during a bombing attack on the Japanese shipping in Simpson Harbor at Rabaul on 2 November 1943. The harbor was protected by massive antiaircraft batteries along either shoreline. In this instance, a formation of American bombers came in fast over the harbor, split into two flights, and dropped 100-pound white phosphorous bombs along the shoreline, literally "walking" through the antiaircraft gun positions. The attack left multiple casualties and formed tall, dense walls of screening smoke along both sides of the harbor. Other closely following bombers flew down this corridor and brought swift destruction to Japanese shipping caught in the harbor.

The antiaircraft positions were denied visual targets and were forced to fire blindly and inaccurately. What might have been suicide raids against heavily defended enemy targets proved successful because of protective smoke screening.

Combat operations in the Republic of Vietnam included protective screening with the introduction of the smoke helicopter. Here the technique of generation and delivery was very simple. Large tanks of fog oil were installed internally in the cargo/troop compartment of a UH-1 Huey helicopter. Electrical fuel pumps forced the fog oil into a spray ring which, in turn, directed jets of oil into the hot exhaust stream of the aircraft engine. This fog oil, upon vaporization, produced a dense white smoke which then trailed the aircraft, forming an effective screen.

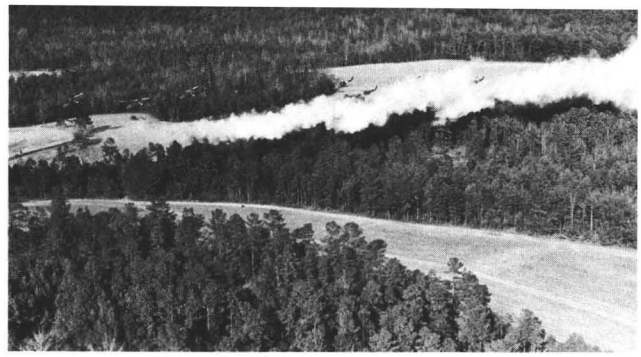
Tactical employment was normally in conjunction with the airmobile assault. Experience determined the best technique was to position the smoke ship just ahead of the lead troop ship when in proximity to the landing zone. On final approach, the smoke ship would coordinate with the gunship leader, descend to low level and position itself for the smoke run. Then, following closely behind the gunships to take full advantage of their suppressive fire, the smoke ship would emit the smoke to form the screen between the enemy position and the planned landing zone.

This protective screen denied the enemy the visual contact required for pinpoint target acquisition. With this reduction in accuracy of delivered enemy firepower, the assault aircraft invariably sustained fewer hits and were able to insert their troops with less incident of aircraft damage and subsequent injury. Further benefits were realized in the protection given the inserted troops during their initial reorganization for the attack after debarking from the lift ships.

If we are to learn anything from history, it should be that smoke can benefit the tactical operation when it is dispensed judiciously to provide concealment yet not create the unwanted safety hazards associated with restricted vision.

The use of rotary wing aircraft for airmobile operations will be the "name of the game" for quite some time. While our experience in Vietnam should be remembered, we cannot afford to ignore the prospects of airmobile operations in a high threat environment and in other than jungle terrain.

Could we use smoke in future helicopter operations? Consider a heliborne assault on relatively flat terrain with sparce vegetation. Hill or vegetation masking may be out of the question and helicopter noise may significantly reduce the surprise gained by terrain flight. What could the commander do to deny the enemy the visual contact needed for pinpoint target acquisition? A wall of screening smoke between his position and the intended landing zone may provide one solution. This smoke could possibly be safely delivered by artillery, Air Force tactical aircraft, helicopters armed with smoke rockets or by smoke helicopters when not face-to-face with the enemy.



Although the enemy has become rather sophisticated in his air defense weaponry, he has not eliminated the optical and visual capabilities; in fact, the weapons which are a threat to helicopters all have visual/optical devices and some have electronic/infrared tracking devices. Smoke will not affect electronic acquisition and tracking equipment and may only marginally degrade infrared. Some weapons which rely on infrared for tracking require visual acquisition. The sophisticated weaponry of the enemy force has not replaced the antiaircraft machineguns nor the machineguns and small arms in the hands of the frontline troops.

Smoke is an effective countermeasure for use against the weapons which depend upon the human eye. To discount the less sophisticated weapons as a threat to Army aircraft would be to grossly underestimate the enemy's capabilities to acquire, track and engage Army aircraft. It is necessary to pursue a program of suppression of those enemy weapons that are a threat to helicopters whether they utilize electronic, infrared or visual/optical means. A combination of countermeasures will be required for total suppression of these weapons and smoke is still the best suited for degrading the visual/optical spectrum.

Although the effects realized from smoke are dependent upon meteorological conditions, a thorough understanding of these limiting factors and the necessary precautions the user must take to avoid adverse effects on friendly elements makes smoke a suitable adjunct for air defense suppression. Terrain flying techniques greatly reduce the vulnerability of Army aircraft to the threat, but all missions that aircrews must perform do not allow the aircraft to remain masked. At some point in the mission the aircraft normally will present a target to the threat weapons. Even though these may be only fleeting glimpses, the exposure could result in acquisition, engagement and loss of personnel and equipment.

The smoke helicopter has been highly responsive and capable of laying down smoke screens in areas not easily accessible to artillery. With the emergence of the sophisticated air defense system, the employment of the smoke helicopter may be limited. Artillery can provide effective screening smoke; however, the time required to attain the desired effect may not satisfy an air defense suppression role.

Since the success of air assault operations is virtually based upon aircraft survivability, smoke can be used to provide the masking not inherent in the terrain. Visualize a team of attack helicopters in a firing position popping up from their terrain masking to engage a tank. The enemy doctrine, much like ours, relies upon security in numbers, making it highly probable that while the attack helicopter is engaging one target, a number of enemy forces will observe it and will be capable of engaging and destroying it. Smoke placed on or near the enemy could effectively degrade the enemy's observation and selective use could allow friendly elements to engage the enemy with a reduction in the number that could return fire.

One aspect of smoke usage often overlooked by both the ground and aviation commanders is that the helicopter smoke ship is ideally suited to the support of the ground elements. Because of its versatility, the smoke helicopter can respond rapidly to any number of situations in addition to having the capability to lay smoke screens or curtains along selected lines not necessarily accessible to support by artillery. Support by smoke helicopter would be available to the ground element commander on relatively short notice, thus increasing its value.

Since smoke can be used in conjunction with Army aviation operations in virtually any terrain, the only real limitation to its use is the imagination of the commander and meteorological conditions. To assist the commander in visualizing usages of smoke, a study entitled "The Use of Smoke to Enhance Aircraft Survivability" has been conducted by the Deputy for Developments at the U.S. Army Aviation Center, Fort Rucker. This extensive study brings together a description of all known or anticipated means for generation and delivery of smoke and proposes concepts of employment and doctrine for use of smoke in conjunction with aerial operations. The study answers many questions about how smoke can best be used on tomorrow's battlefield.

When one contemplates the future employment of the helicopter in airmobile, air cavalry, medical evacuation and resupply missions over various kinds of terrain, he can readily see that there is a need in Army aviation for the employment of smoke to gain a superior tactical advantage.

Continued from page 7

most conditions. During a 2½-day period during Solid Shield IV, while the 82nd was waiting for good weather to begin airmobile operations, the Ghostriders flew 150 hours with less than 100 foot ceilings and visiblity of about one mile to move the 101st Division's 3rd Brigade. This was made possible by the intense training of low level navigation. It also was proof to us that the training was valid because we were doing it in a new area off our own military reservation and for distances up to 80 and 100 kilometers (km). On 8 September 1974, Company D led an aviation task force of 20 UH-1s and 20 CH-47 Chinooks which lifted elements of the 3rd Brigade during Orbiting Eagle II and flew more than 120 km in IMC (instrument meteorological conditions) using terrain flying from Smyrna, TN, to Ft. Campbell, KY.

A need existed to penetrate a medium to heavily defended FEBA

Realizing that an air assault division would be involved in raids behind the FEBA (forward edge of the battle area) Company D began looking for tactics which would give minimum loss of aircraft and troops and successfully accomplish the mission. If a high threat environment presented an intelligence picture of a lightly defended FEBA, the present tactics for formations of aircraft penetrating the FEBA still would be sound. However, a need existed to penetrate a medium to heavily defended FEBA. One such tactic was developed by the Ghostriders and, as previously mentioned, was called combat assault by infiltration.

The friendly troops never could figure out what size force was near them

CABI started in phase I from 20 October to 10 December 1973. Five helicopters were used in each contour terrain flight taking advantage of terrain features to provide cover and concealment. The plan used individual multiple flight routes departing from a common PZ and either a common LZ or multiple LZs as the infantry required. Utilizing the best terrain possible, each aircraft penetrated the FEBA with about 2 km lateral separation between aircraft. Each crew flew its own route using time, distance and heading (or terrain contour) to a point behind the FEBA where joinup could be accomplished. This was done at a previously appointed RP and was accomplished without having to orbit. Phase lines were used to ensure that each aircraft maintained proper alignment for the linkup at the RP. As we developed proficiency in new techniques, more aircraft were added until the mission was run using 20 helicopters from two assault helicopter companies. In November 1973, the test was run against the 1st Battalion (Vulcan) 3rd Air Defense Artillery, 101st Division which placed 10 Vulcans in their normal tactical configuration directly across our route of CABI. The gun crews also were briefed on our approach direction but were not given the time that we were to cross their area. They were given white smoke to use for target sighting and yellow smoke for an engagement. The aircraft crews were not told the positions of the Vulcans and picked their best routes through this area. The end results were that three guns were able to sight aircraft as they penetrated the area, however, only two could engage. The controllers of these guns only assessed one aircraft destroyed. The test was run a second time with the same results.

Since CABI utilized both terrain and NOE flight techniques, it appeared to present a workable solution to the antiaircraft threat of a sophisticated enemy in a mid-intensity conflict. Again the test for its possible application became the North Carolina battleground of Solid Shield. The main task force of the 3rd Brigade was the 2nd Battalion, 503rd Infantry commanded by LTC Stan G. Bonta. Since his battalion provided platoon-size groups of aggressors

against the 82nd Airborne Division, most of our flights were in five-ship formations. This provided the opportunity to test all the tactics we had practiced. Most of our flights were over long distances from 40 to 60 kilometers so all involved terrain flight and low level navigation. We varied the techniques of close formations. CABI and NOE were used depending upon the mission of insertion or extraction and of the enemy threat, location, disposition and supporting air defense equipment. After small battle actions had taken place, we found from debriefs of commanders (82nd & 101st) that our CABI insertion of troops behind enemy lines was most effective. The friendly troops never could figure out what size force was near them because they never saw more than one helicopter, yet may have heard sounds of more.

Again taking a page from the 11th Air Assault Division, we know that supporting the infantry over long distances was all part of an assault helicopter company's mission. Also the concept of aircraft staying massed in one area was not good in a high threat environment in which air superiority was uncertain. As the 11th had done in its mid-intensity training, we developed a company training area where all the vehicles, maintenance, supply and tents were to stay. We converted a ½-ton platform (MULE) to carry radios, a generator, two tents (general purpose smalls) and other equipment to be used to set up a forward operations with maintenance capabilities. The concept called for locating this forward command post (CP) with the reserve force of an infantry battalion (out of mortar and, if possible, artillery range). Since it was small and could be moved by slingload, its position was changed every day as the battalion moved its troops and changed reserve forces. The assault helicopter company's aircraft were dispersed in three groups of five each. Within each group, they would separate into possible hover holes and use mud, covers and trees to break outlines and camouflage their positions. Communicaton was established back to the jump operations by radio. After dark, the aircraft would recover into the reserve force's location to give the infantry battalion commander a fast way of committing his reserve, and for him in turn to provide security for the aircraft.

This tactic of forward support to the infantry was worked on by Company D and the 501st Infantry's 1st Battalion, commanded by LTC Warren T. Lillie (a former 11th Air Assault Division company commander). Again realizing that one tactic cannot be used continually, we found that this dispersion plan was most effective. It fit the concept of "attrition defense" that was developed by the 101st Division's 2nd Brigade, commanded by COL Louis G. Menetrey. Aviation became the mobility factor employed to achieve this type of defense as we were operating in terrain that we had previously owned. In offensive operations, the jump operations and aircraft had to remain farther behind so that enemy stay-behind or bypassed forces could not raid our aircraft sites.

Another area that needed attention was night operations. In September 1973, the Ghostriders began night training three to four nights a week. The goal was to obtain low level, minimum light operations to insert troops with minimum exposure to enemy weapons. We experimented with various lighting configurations and the taping of lights. We worked up to 16 aircraft landing simultaneously with minimum lighting and again using light signals in place of voice communications to indicate changing situations. As we developed proficiency in tactical night operations, we lowered altitudes until we flew at about 200 feet on dark nights and at lower altitude when the moon was one-half or more full. However, once again we learned that proficiency in tactical night operations goes down sharply when not practiced and maintained. We practiced landing to "bean bag lights" (infantry-held hooded flashlights) and with some moon configurations (no lights at all on the ground). This training again was to pay off in Solid Shield as we conducted a night operation with 10 aircraft and landed without lights in a area in the vicinity of an 82nd Airborne battalion CP. The result was a complete surprise when LTC Bonta's troops captured the CP and its commander. In addition, we made 10 sorties of a false insertion which succeeded in the diversion of the opposition forces.

A new area of recent training for the Ghostriders has been the possible ways of flying an assault helicopter company IFR to a safe area behind friendly lines at the FEBA. This concept (called "Red Dog") was accomplished by the 11th Air Assault Division. One possible way of doing this recovery is the utilization of two FM (frequency modulated) radios and the FM homing capability of the UH-1H. Unfortunately, funds and flight training time restrictions imposed on the 101st aircraft have delayed further testing. Instrument flight proficiency has remained our standard way of maintaining our aviators' qualifications.

As we look back at our training program and the results, it is easy to recognize that without the dedication, enthusiasm and innovation of the aviators, crewchiefs, maintenance personnel and the entire company that the attempt to find ways of improving on tactics in a high threat environment would have failed.

A RECENT STUDY of rotary wing low-level mishaps shows that the majority of our low-level accidents occur under uncontrolled conditions and are caused by a breach of flight discipline on the pilot's part.

This emphasizes the point that the increased risks inherent in low-level flying must be balanced with sensible controls. The trouble begins where supervision ends.

Certainly this is true when it comes to tactical NOE training. This exacting type of flying demands peak performance of crews at all times and the degree of difficulty increases immensely during night operations. Accidents are virtually assured when human error is compounded by inadequate supervision as in the following case.

The aviation section normally reported for duty at 1900 hours. However, on the day of this accident, crewmembers were to report at 1700 hours to prepare for two periods of night flying. The mission was to end by 0500 hours the next morning. Some crewmembers were late and all personnel did not arrive until 1930 hours. This set the stage for the hurried activities that followed.

After preflighting the aircraft, the crews were briefed by the OIC on the mission. It was explained that these particular flights would be used to establish a baseline of the lowest altitude to fly during a "high light condition" which would then be compared with low altitude flight during a "low light condition." It was stressed that there was no specified altitude or airspeed. This was left up to individual crews based upon what they felt to be safe and comfortable flight conditions.

During the briefing, pilots of the command and control (C&C) aircraft returned from a daylight NOE reconnaissance of the routes to be flown that night. The C&C crew, having started an hour and a half late, was only able to complete a daylight recon of one of the two routes. The C&C observer hurriedly marked the obstacles noted during the recon on the briefing map overlay and gave a cursory description of those obstacles he considered important.

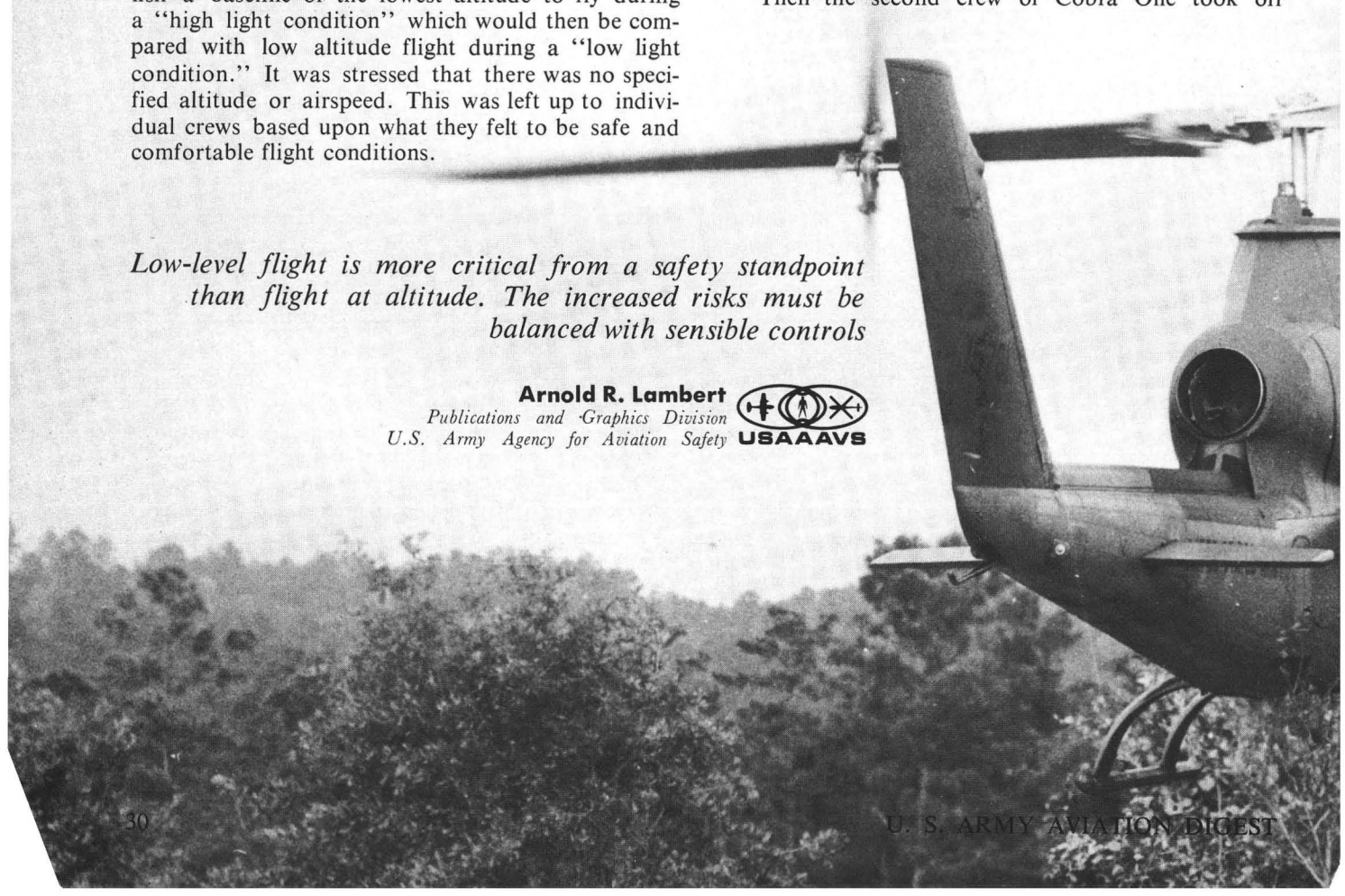
At 2230 hours, night NOE operations began with the C&C aircraft and Cobra One. Cobra Two became airborne a short time later.

Cobra Three was unflyable and it was decided that after the first crew of Cobra One completed the mission the other crew would fly the course in Cobra One.

The first crew of Cobra One flew the course using a new reversed seating position with the pilot up front and the navigator in the back. It was felt that this arrangement allowed crews to go lower and faster because they didn't have to transmit obstacle and terrain avoidance. The pilot in the front seat cleared himself and the man in the back seat navigated.

For most of the route they were at or below treetop level. Altitude varied from 4 to 100 feet. They flew the course with no problem and returned to the heliport at approximately 2350 hours.

Then the second crew of Cobra One took off



Low-level flight is more critical from a safety standpoint than flight at altitude. The increased risks must be balanced with sensible controls

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USAAAVS

using the same seating arrangement. Following the preplanned NOE route, Cobra One was flown on course with the predesignated check points reported as required. The C&C crew monitored the progress of the flight by acknowledging reports at the check points.

While confirming the location of Cobra Two which was following along on the same course, the C&C aircraft lost visual contact with Cobra One. After failing to reestablish visual contact, the C&C aircraft transmitted three times on both UHF and FM radios but failed to receive a response from Cobra One.

Flight operations dispatched a crash rescue helicopter to the vicinity where Cobra One was last seen. By the time this helicopter arrived, the C&C aircraft had located the wreckage.

Investigation revealed that the aircraft was on course at 17 feet agl, airspeed approximately 25 knots, when it struck a single strand of steel cable suspended between poles. The aircraft crashed and both crewmembers were killed.

Available data indicate several causes for this mishap.

- Surrounding terrain and low light conditions tended to mask both the cable and the poles, making it nearly impossible for the pilot to see and avoid the cable.
- Command and control pilots did not mark this cable on the master briefing map, nor did they conduct an adequate in-depth route and major obstacles/hazard briefing.
- Crewmembers did not mark obstacles on their maps nor were they familiar with all the wires along the course, in particular this cable. The reason for this can be attributed to overconfidence in their familiarity with the area.
- The absence of command supervision in clearly establishing and ensuring compliance with firm guidelines and policies to control and minimize the risks involved in NOE operations definitely contributed to the cause of this accident.

Also, aviators in the night training program felt they were not getting the command support they needed. Air conditioning units in their BOQ rooms were not working and the crews were not sleeping comfortably because of the heat and noise of daytime activities. Mess facilities were serving only cold foods at night and the pilots were trying to prepare meals in their rooms.

The extreme degree of concentration and alertness required in low-level night flight causes considerable fatigue. Any prolonged night program requires the complete inversion of the normal day-night chronological cycle.

Commanders must see to it that their crews' sleeping quarters are comfortable and segregated from those of personnel not on the inverted schedule and that messhalls and athletic and other post facilities support night NOE participants.

The young and not so young Army aviator will sometimes attempt more than he is capable of successfully accomplishing. When it has been determined that pilots have not had the benefit of positive supervision, pilot error may well be supervisory error.

It is the supervisor's job to correct safety errors before the fact.

where trouble begins

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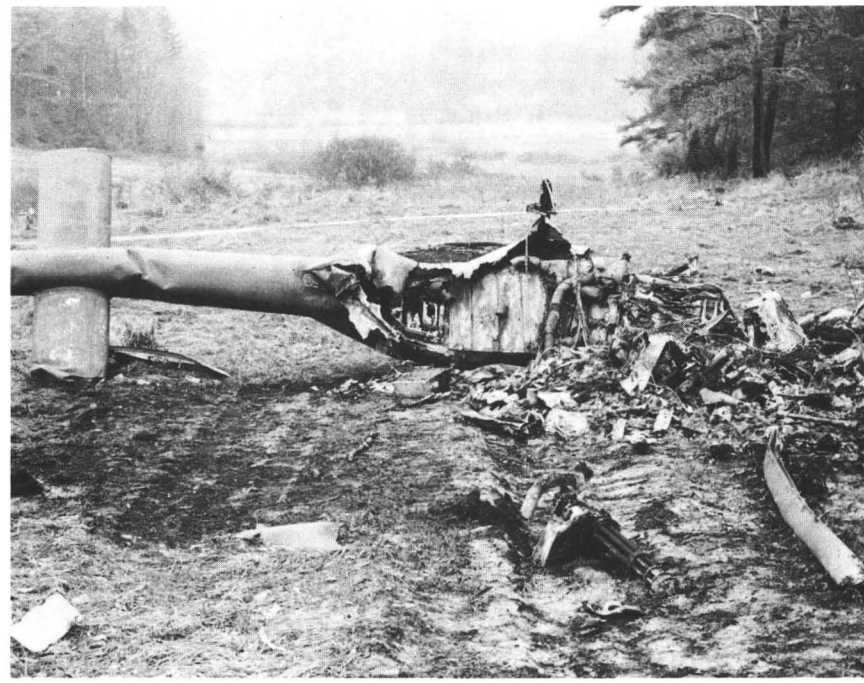


During the 2-year period ending July 1973, approximately 74 aircraft mishaps resulted from battery malfunctions. Since then, more than 90 similar mishaps have been reported

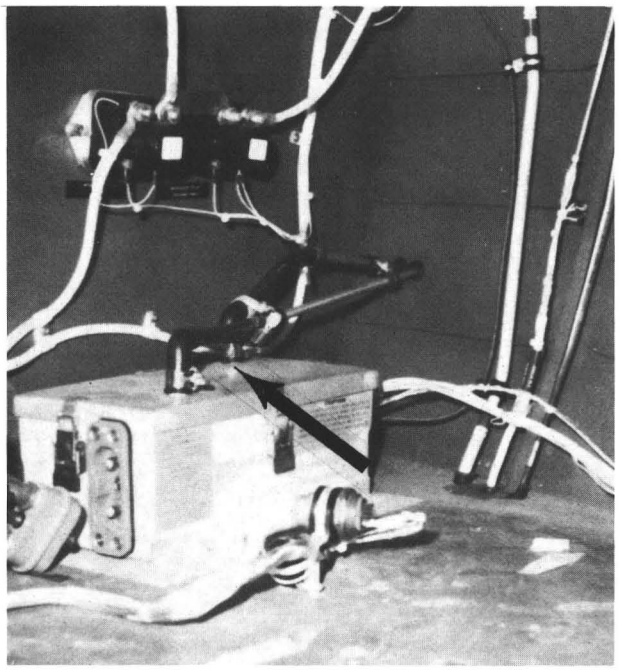
NICAD BATTERIES-FROM A TO V

"A" STANDS FOR amperes, and "V" for volts, and somewhere in between lies the letter "R" for resistance; and unless someone has recently repealed Ohm's Law, the relationship these three units have enjoyed with each other in the past remains unchanged. If the voltage stays constant while the resistance in an electrical circuit increases, current flow (amperes) will decrease. Conversely, if resistance decreases, current will increase. This bit of knowledge, elementary as it may be, plays an all-important role in the safe operation of aircraft equipped with nickel-cadmium batteries.

The nicad battery is one of the most efficient storehouses of electrical power presently available. It is compact, rugged, provides a high current output for its weight, recharges rapidly, has excellent low temperature performance characteristics and maintains a relatively constant voltage output until it is almost completely discharged. But despite these attributes, it sometimes performs some highly undesirable antics such as warping, melting, rupturing and, on occasion, exploding. The culprit is heat that sometimes gives rise to a phenomenon known as thermal runaway—a definite no-no.

During normal aircraft operation, the generator feeds current at a constant voltage to the battery. Depending on its state of charge, the battery offers a certain amount of resistance to this charging current, limiting it. If the battery is in a low state of charge, its resistance will be low, and the charging current high. As the battery becomes charged, its internal resistance increases, and the charging current decreases. Theoretically, current flow should drop to zero when the battery is fully charged. In reality, it will decrease to a value of about two to four amperes. During the charging process, heat is generated; and since the battery cannot dissipate heat readily, its temperature begins to rise. At this point, other factors such as ambient temperature and heat previously generated by battery drain enter the picture and collectively determine how high the battery temperature will rise.

Curiously enough, an overheated battery is not necessarily in a thermal runaway condition. When thermal runaway occurs, heat buildup within the cells causes the internal resistance of the battery to decrease. In accordance with Ohm's Law, this reduction in resistance causes an increase in charging



Above photo shows OH-58A battery installation. Arrows point to neck of vent line found plugged from a combination of spilled electrolyte and dirt accumulation

current which causes a further rise in temperature. This, in turn, results in even less resistance, causing a greater increase in charging current that generates still more heat. Once this cycle becomes established, it is only a matter of time before serious, perhaps catastrophic, damage will occur—unless the process can be immediately halted by disconnecting the battery from the circuit. Unfortunately, the pilot may remain completely unaware of the events taking place until it is too late.

The whole process mimics the old story about Zeb's son. The tale goes something like this:

"Hear about Zeb's son?"

"Nope."

"Well, he was out flying and his plane caught fire."

"That's bad."

"Not too bad. He had a parachute."

"That's good."

"Not too good. The parachute didn't open."

"That's bad."

"Not too bad. There was a haystack beneath him."

"That's good."

"Not too good. There was a pitchfork sticking up in the haystack."

"That's bad."

"Not too bad. He missed the pitchfork."

"That's good."

"Not too good. He missed the haystack, too!"

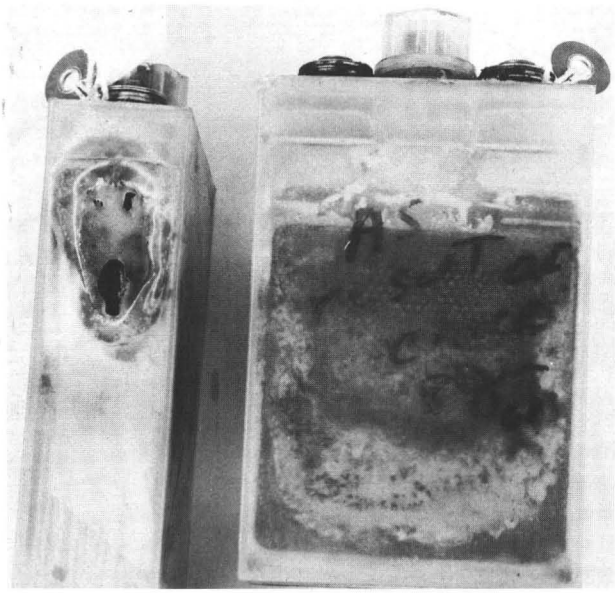
Nicad batteries are great, but it's bad they can be readily overheated. At the same time, it's good that not every overheated nicad battery will encounter thermal runaway; but it's bad if it does. But even if it does, it's good that we may prevent aircraft damage by disconnecting the battery from the electrical system; but it's bad we have no way of knowing when to do this. Fortunately, our story doesn't have to end like that of Zeb's son. We can do something about the problem right now. The main requirement is cooperation between maintenance personnel and pilots.

High temperatures, plugged filler cap vents and failure to service and maintain the battery as specified in the technical manuals have contributed to the present nickel-cadmium battery problems

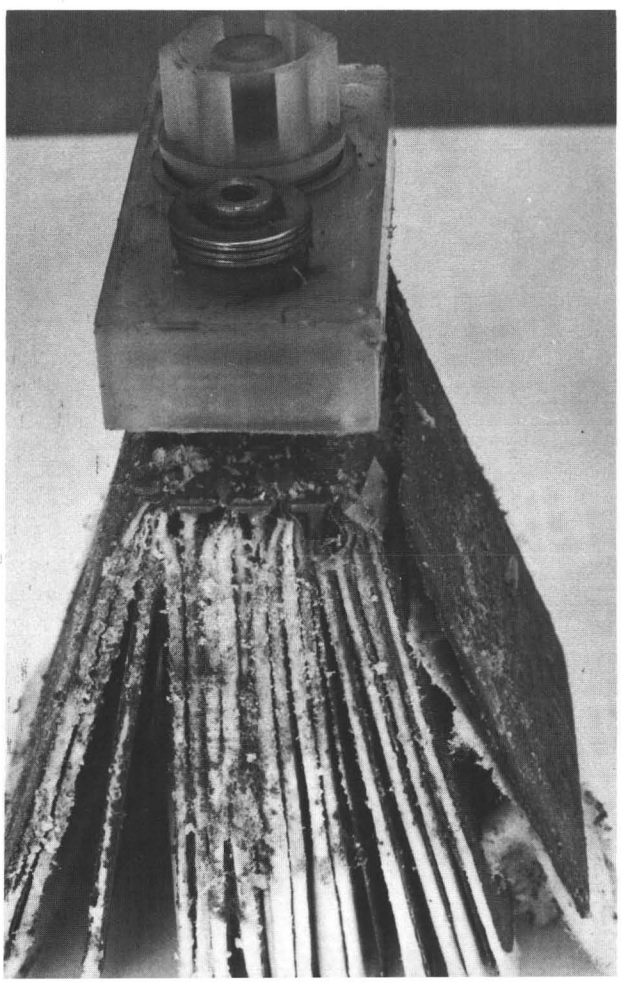
The first step toward preventing thermal runaway lies in the care and maintenance of both the aircraft's electrical system and the battery. The voltage regulator must be precisely adjusted by the book and functioning properly. The battery must be correctly maintained, kept clean, and properly installed, with the vents clear. All battery servicing and charging should be accomplished in an approved battery shop. External power sources should be used when making prolonged ground operational checks of aircraft systems, during troubleshooting procedures and, when possible, for engine starts, especially if a series of flights of short duration are scheduled.

During battery starts, prolonged starting attempts should be avoided. If repeated attempts cannot be avoided, a "touch" test should be made by placing a hand against the battery case. If the battery is too hot for a hand to be held against it, it should be allowed to cool before another start is attempted.

In addition to these preventive measures, the pilot can use certain indicators to warn him of impending battery problems, including thermal runaway. For example, during a battery start, a healthy battery should readily accelerate a gas turbine engine above 15-20 percent rpm. If it can't, have it checked. During flight, the pilot can use the loadmeter to periodically monitor the battery. Should the loadmeter indicate an increase of approximately 10 to 20 percent above the normal stabilized indication, the pilot can suspect a battery problem. To verify it, he can then turn off the battery switch. If the loadmeter shows a sharp decrease in load, he should leave the battery switch



Cell and plates show extensive damage caused by overheated battery



off, land at the nearest airfield and have qualified maintenance personnel check the battery.

WARNING: Special caution should be exercised before removing or servicing an overheated battery. If conditions permit, the battery should be allowed to cool before any maintenance is performed. Spewage of electrolyte and the possibility of an intercell explosion pose a serious threat to personal safety.

In September 1972, the Federal Aviation Administration (FAA) issued an airworthiness directive (AD 72-19-4) concerning nickel-cadmium batteries and the potential hazard from thermal runaway. By February 1974, it became mandatory for all civil aircraft equipped with nicads that could be used for engine starts to incorporate some type of system for sensing thermal runaway as well as some provision for removing the battery from charge. The need for this directive stemmed from several major incidents and at least one fatal crash attributed to battery fire or explosion. During the past 2 years, Army pilots were involved in more than 90 mishaps that resulted from battery or battery-related causes. In 84 of these, battery problems occurred aboard UH-1 aircraft. The following three different types of systems were developed by independent manufacturers:

1. A battery charging rate control system.
2. A battery sensing and overtemperature warning system.
3. A battery failure sensing and warning system.

All three types are FAA approved and each has certain advantages and disadvantages.

The first type represents the only method that can presently prevent thermal runaway. While it is expensive, heavy and complex, it is the system selected for use by most major airlines.

Although the second type cannot prevent thermal runaway, it enjoys certain advantages in that it is light and relatively inexpensive, and gives a positive warning of a possible thermal runaway condition. Depending on configuration selected, this system may not only warn the pilot to remove the battery from charge but also may automatically disconnect it from the circuit. But regardless of configuration, a manual override is provided.

The principal disadvantage of this system is that it gives an initial warning when the battery housing (case) reaches a temperature of approximately 140 degrees F., and a nicad battery can reach this temperature as a result of causes other than thermal

runaway. These include high ambient temperature, state of charge and prolonged use of the battery during ground checks or engine starts. Further, the battery could be in the early stages of thermal runaway and the battery case temperature not yet be high enough to activate the warning system. As a matter of fact, several batteries have reached the advanced stages of thermal runaway before this type warning system activated. However, in every instance the warning occurred in time to prevent aircraft damage from fire or explosion.

The desirability of the third type of warning system lies in that it can detect the first stages of thermal runaway. This system is presently undergoing additional testing.

Early in CY 1975, meetings were held at the U.S. Army Aviation Systems Command and at the U.S. Army Electronics Command to determine a solution to the nicad battery problem in Army aircraft. The use of some type of temperature warning device was recommended and, at present, various configurations are being evaluated for possible use. But until some type of thermal runaway safety device is incorporated aboard Army aircraft, we must rely on the human element to prevent thermal runaway, when possible; detect it should it occur; and take corrective measures before damage and injuries can result.

In summation, the following procedures are recommended:

- Ensure the voltage regulator is correctly adjusted and functioning properly.
- Perform all battery maintenance and inspections by the book.

NOTE: USAAVSCOM message 131030Z Mar 75, subject: Maintenance Advisory Message, Maintenance of Aircraft Nicad Batteries (GEN-75-7), contains a number of changes to TM 11-6140-203-15-2. The information contained in this message is intended to revise and supplement that found in chapters 4 and 5 of the above TM until a revision is published.

- Ensure the battery is properly installed, clean and the vents are unobstructed.
- Avoid prolonged use of the battery for troubleshooting the electrical system, performing avionics checks and making frequent or prolonged engine starts.
- Use an external power source, if available, for engine starts when a series of flights of short duration are scheduled (unless this procedure is prohibited for a particular type aircraft).
- Monitor loadmeter(s) periodically during flight and switch off battery if loadmeter indicates a higher than normal load. Land aircraft as soon as practical if switching off the battery confirms a battery problem.
- "Touch test" batteries subjected to repeated engine starts or unsuccessful start attempts, or when overheating is suspected.
- Allow a heated battery to cool before attempting an engine start.

In addition, should you note electrolyte spewing or detect battery fumes in the cockpit during flight, and conditions permit, immediately turn off the battery switch, make a precautionary landing and have qualified maintenance personnel check the battery.

IMPROVEMENTS ON THE WAY

In the past few years, the need for nicad batteries with their advantages over standard batteries has been more demanding than the need to provide adequate servicing equipment. However, effort is underway to improve servicing support. Development of new modern facilities is in progress. As part of this effort, two newer type charger/analyzers are scheduled for user tests very shortly. One is the Air Force RF80GT capable of charging nicad's in approximately one hour without overheating the battery. The other one is the Navy AN-ASM 490, capable of charging nicad's in 2 to 3 hours. The AN-ASM 490 has a cell scanning feature which monitors the voltage of individual cells during charge.

A user test scheduled for this month will determine which of the two is best suited for future Army use. Also the new shelter facility for servicing nicad's is in development. It is semiself-contained and self-supportable. It will have the capability of being air-transported intact by airmobile units as well as being able to move on the ground. Two prototype units are being developed by the Electronics Command and are 90 percent complete. These units should be ready for user test in the very near future. With these modern facilities and additional safety devices to monitor the condition of nicad batteries while in flight, the problems experienced today should be almost nonexistent tomorrow.

PRECAUTIONARY LANDING—WHY NOT?

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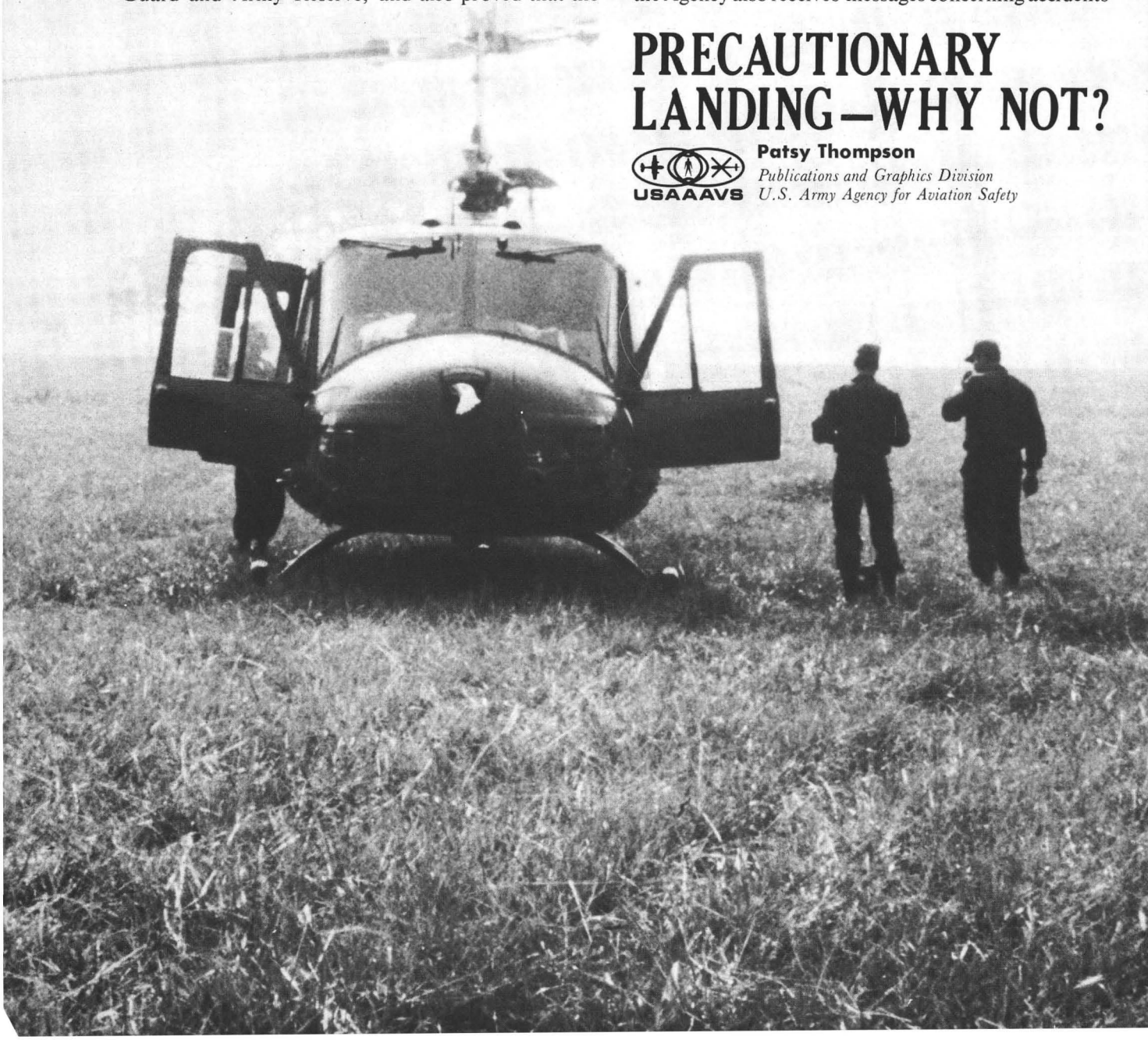
IS THERE ANY proof supporting the logic that a higher precautionary landing rate has a significant effect on the accident rate? In an attempt to test this logic, USAAAVS, in 1971, analyzed the worldwide rotary wing precautionary landing rate as compared with the accident rate for active Army. This analysis, covering the period 1 July 1967 to 31 January 1971, supported this logic by revealing a ratio of precautionary landings to accidents of 5:1.

To determine whether this hypothesis held true for a longer time frame, USAAAVS again analyzed the two rates for the period 1 July 1967 to 28 February 1975. This analysis included active Army, National Guard and Army Reserve, and also proved that the higher the precautionary landing rate, the lower the accident rate. The ratio of precautionary landings to accidents during this period was 10:1. This does not mean that high accident rates are caused by low precautionary landing rates, nor does it mean that accident rates may be reduced by simply making more precautionary landings. It merely means that during periods of high precautionary landings we can expect a decrease in the accident rate.

USAAAVS receives many reports of precautionary landings which were made because of illumination of warning lights and some because the aviator felt his aircraft just wasn't performing properly. Yet, the Agency also receives messages concerning accidents



in which pilots could have made precautionary landings, but didn't. Why not? Let's look at just a few of the reasons some pilots have given.

- The Old Man doesn't like to fill out the paperwork that's required if we put the aircraft down out here.
- Oh, don't get upset. I can handle it!
- Happy hour starts soon and, besides, we're close to home. We'll make it!
- That light comes on all the time, so just ignore it!
- The troops will think I've lost my piloting technique.

Now, let's look at a few emergencies which resulted in senseless and preventable accidents.

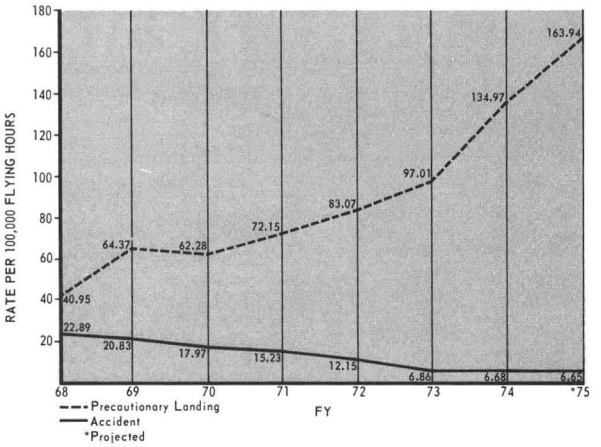
A UH-1 pilot entered autorotation when the engine rpm dropped to 5200. The rpm then increased and the pilot made a power approach to the ground. Once on the ground, he decided that since the engine was still running, he could make it one more mile to an airfield. En route, however, complete engine failure occurred and the aircraft crashed.

An OH-6 was not developing full power so the pilot put the aircraft down to see what was wrong. While performing a hovering check, he decided the engine was performing normally. Instead of having maintenance inspect the helicopter, he attempted to continue his flight. The engine failed at 100 feet during takeoff, the helicopter crashed and two lives were lost.

Another OH-6 pilot radioed that he was having trouble controlling excessive engine rpm. For 10 minutes this problem continued when finally the pilot said, "I think I just lost everything." Witnesses said that the engine and rotor had revved up and then was followed by relative silence. The main rotor severed the tail boom and the aircraft fell from approximately 1,500 feet. The pilot was killed and the aircraft was destroyed. The pilot had failed to land after numerous indications of a malfunction.

Ten minutes after takeoff, another helicopter pilot reported his engine chip detector light was on and that he was returning to base. The last radio transmission heard was that the turbine outlet temperature was "out of sight," that the aircraft was vibrating severely and that he intended to land at the closest helipad. A witness stated that he saw flames coming from the rear of the helicopter and then the engine quit. The aircraft hit a 60-foot tree and sank in about 8 feet of water. The three occupants were killed and the aircraft was destroyed. This accident might have been avoided had the pilot made a precautionary landing rather than try to return to home base.

Why did these pilots continue to fly rather than stay on the ground or land? It's hard to say, but any



Army Rotary Wing Rates, Worldwide
(Includes ARNG and USAR)

reason given would fail to justify their decisions to continue flight and jeopardize lives and aircraft.

Maintenance officers aren't immune to accidents either and are no more qualified than a pilot to fly a substandard aircraft even when there may be only a "suspected" malfunction. For instance, a pilot had determined that his helicopter was unflyable due to an increase in egt whenever power was applied. Black smoke was seen pouring from the tailpipe, oil vents and particle separator. The unit maintenance officer made a 15-minute runup with the same indications of a malfunction, but then decided to fly to the maintenance area. As he made a downwind, near maximum performance takeoff, black smoke was seen pouring from the tailpipe and the engine failed. The aircraft rolled and slid 280 feet down a railroad track. This is an example of poor judgment on the part of this maintenance officer. Either towing or slingloading the helicopter would have been much safer.

These accidents actually happened. They could have been prevented had the pilots used good judgment and heeded the warning signals. After all, warning lights are designed to alert you to a failure, apparent impending failure or malfunction of engines, systems or components. Regardless of any excuse, whether it be pride, mission accomplishment, comforts of home base or coercion by supervisory or maintenance personnel, it's safer to put that aircraft down at the first sign of trouble.

USAAAVS strongly recommends that precautionary landings be made when, in judgment of pilots, further flight is inadvisable. This must be accomplished before situations deteriorate beyond the capabilities of pilots to prevent accidents. And, by regulation, maintenance personnel are charged with the responsibility to determine the cause of the malfunction before further flight is resumed.

from the Society of Air Safety Investigators Forum

the role of analysis in

Gerard M. Bruggink

the fact-finding process

By what mysterious process do we determine which evidence is relevant in the probable sequence of events which caused the crash?

ACCIDENT INVESTIGATION has been defined as "the gathering together in an orderly manner of factual information relating to an aircraft accident."[1] Although the validity of this simple definition cannot be questioned, there is no concensus on the answers to two questions it raises: (1) What constitutes an orderly fact-gathering process, and (2) how does one determine which information is related to the cause of an accident?

The "orderliness" of an investigation is sometimes synonymous with the degree of control that the state, or the organization involved, exercises over the flow of factual information. At best, an autocratic form of control lengthens the investigation and shortens tempers; at worst, it jeopardizes the thoroughness and objectivity of the investigation. Needless to say, order should find expression in a democratic team structure that allows for the methodical utilization of all available talent and resources in an atmosphere of mutual trust, respect and objectivity. In a well-run investigation there is no room for jurisdictional squabbles, professional jealousies or parochial views. Accident causes are discovered by the interaction of searching, and analytical minds—not by edict.

The most fundamental aspect of every investigation deals with the question: By what mysterious process do we determine which evidence is relevant in the probable sequence of events? The word mysterious in this context is not used to suggest that our occupation has the aura of mystique which, presumably, is one of the characteristics of a true profession but, rather, to stress the lack of a universally accepted method for the identification of essential evidence. Investigation courses and textbooks have not been very helpful in this regard. Most of them concentrate on the techniques of observation and documentation of hard facts while neglecting the analytical reasoning process that forms the basis for the development and integration of promising avenues of investigation. It is conceivable that our preoccupation with facts, and nothing but the facts, could lead to an occupational disability, best described as the computer-age syndrome of knowing everything but understanding nothing. The irony of that situation is that infatuation with facts may interfere with the discovery of elusive but vital evidence. Like Copernicus, who shook mankind's sense of self-importance by demoting the earth from the center of the universe to just another planet, the investigator must know how to work with assumptions and how to draw inferences from incompletely understood phenomena before he can put a conglomeration of facts in perspective. It is the intent of this article to highlight some of the related reasoning skills.

The most controversial myth surrounding the "air crash detective" in action is that he does not indulge in hypothesis and analysis until all the facts are in. An investigator will invariably lean on this myth when he tries to keep the news media "off his back" by remaining tightlipped about the direction the investigation is taking. In that regard, the myth serves some purpose, since the working relationships within a team are easily upset by the inadvertent release of sensitive information. Unfortunately, this public emphasis on the purely fact-gathering aspects of our work at the scene may have given some investigators, or parties, the notion that even among team members, open discussion about what could have happened should be shunned. Actually, nothing is more detrimental to the field phase of an investigation than the pretense that all pertinent facts can be discovered without a selective, analytical process.

All investigative activities are based on a presumption: Something or somebody interrupted the routine operation of the aircraft. In his search for potential "interruptors," the investigator collects

[1] Aircraft Accident Inquiry—Annex 13 to the Convention on International Civil Aviation, 3rd Edition, April 1973.

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positive as well as negative evidence. His mind becomes engrossed in a creative problem-solving exercise in which incoming information is compared with previous experience, related to existing knowledge, analyzed, interpreted, stored for future reference, and used to support or refute emerging patterns. This weighing of evidence is an inductive reasoning process: We draw provisional conclusions or inferences from the available evidence, followed by an objective appraisal and testing of their validity. In this discussion, the mind's analytical activities while searching for a meaningful context of our perceptions will be called theorizing.

It is axiomatic that the accident investigator begins to theorize as soon as he learns the first details about an accident, or when he first surveys the scene. The initial theorizing may not produce more than a vague image of the type of accident: an in-flight breakup, an approach accident, a disorientation accident, etc. As more facts become available, the theorizing process becomes more refined and leads to more specific questions which, in turn, orient and sustain further fact-finding activities. In other words, fact-finding and theorizing are so closely intertwined that any attempt to separate the two would negate the purpose of the investigation.

Then, why is it that most theorizing is done in seclusion or in whispers? There may be several reasons. In the first place, blame-sensitive team members look on theorizing as another form of jumping to conclusions. Secondly, most theorizing has the unpleasant connotation that, temporarily at least, a finger is pointed at possible involvement of the product, or services, of one of the participating parties. Thirdly, the threat of litigation puts a penalty on candor and honesty.

To make theorizing a more acceptable and effective tool in accident investigation, it may be helpful to establish working definitions of some of the average investigator's mental activities during accident reconstruction. The following definitions are suggestions only. Hopefully, readership reaction will lead to improvements and, eventually, to an expanded and accepted terminology. *Theorize*: To arrive by reasoning at possible explanations of known or suspected accident facts. The confidence level of these explanations depends on the weight of the available evidence. The following terms could be used to express the confidence level of the results of the theorizing process. In order of increasing confidence,

these terms are: speculation, conjecture and hypothesis.

1. Speculation: Making an educated guess in the absence of tangible evidence. An extreme example of the need to speculate would be the case of an aircraft disappearing on an overwater flight without any indication of a prior emergency. When wreckage and in-flight recorders are beyond recovery, all system safety engineering concepts that were applied to the design of the aircraft, the environmental factors and the background of every person aboard that aircraft may have to be reviewed to arrive at all possible explanations for the sudden termination of that flight. Despite the logic that is used in such a retrospective hazard analysis, it remains a speculative process. This was illustrated by the initial reaction to the disappearance of a de Havilland Comet I over the Mediterranean in January 1954. The day after the accident, a blue ribbon investigative committee convened, consisting of experts in the industry and government. This committee studied the meager evidence in conjunction with the aircraft's past history and listed six "possible main causes"[2] of the accident. Fire was considered the most likely cause. These six speculative, but supportable, explanations prompted extensive modifications of potentially dangerous features and the Comet went back into passenger service in March 1954. Sixteen days later the second Comet disappeared over the Mediterranean under similar circumstances. Shortly thereafter, medical investigation of recovered human remains and reexamination of the Comet's design parameters led to the *conjecture* that some form of explosive de-

[2] ***Civil Aircraft Accident Report, C.A.P. 127,*** published by H.M. Stationery Office, London, England.

compression could have been the principal accident factor.

2. *Conjecture*: "Formation of an opinion or judgment upon what is recognized as insufficient evidence."[3] Compared to a speculative explanation, a conjecture has at least one distinguishing characteristic: Sufficient factual information is available to infer the nature of the accident or part of its sequence of events. As a result, a conjecture has a strong directional effect on the investigation. This was demonstrated by the final development in the Comet investigation. To test the conjecture that the fuselage had failed in explosive decompression, the whole cabin of another Comet was subjected to repeated loading tests in a series of simulated pressurized flights. When these tests produced a fatigue failure in the fuselage skin near one of the windows, it was hypothesized that fatigue in the fuselage structure had precipitated the sequence of events.

3. *Hypothesis*: An unproved theory that serves as the most reasonable explanation of all observed facts and that can be verified by appropriate tests or further investigation. Based on this definition, an hypothesis is a final stepping stone in the analytical reasoning process that governs the gathering of pertinent factual information. It takes one or more hypotheses to even get close to a probable cause. Speculations and conjectures that cannot be developed into valid hypotheses will not lead to a credible cause determination.

An hypothesis should be testable. That is, the explanation it offers should be subject to proof or disproof within the confines of practicability and economy. In the case of the Comet accidents, the British were fortunate. A fisherman happened to retrieve a section of fuselage skin containing the window where fatigue had initiated the crack in the fuselage, similar to the one produced in the fuselage tests.

This layman's explanation of the analytical reasoning process should not convey the impression that the investigator is consciously labeling each of the mental steps he takes when drawing inferences from the facts as they become available. However, he should know enough about the workings of his own mind to realize that every hunch can trigger a thought process that may lead to the development of a vital piece of evidence. Even the unintentional implications of an intentional "red herring" may call the attention to facts that complement an existing theory. The interesting part of this mental process is that a person may grasp the significance of the practical guidance it produces without having to understand the underlying "programming" of his brain.

Freedom to theorize is not a license to drag out an investigation by harping on unsupportable pet theories. When this occurs, it is generally the result of the originator's limited perspective brought about by his inability to look beyond his area of expertise. To ensure that logic and sound judgment temper the theorizing process, every specialist should be kept informed about the overall development of the evidence. When he understands the role of his contribution in the total context, he is in a better position to recognize new evidence in his specialty area.

The retrieval of pertinent evidence from a conglomeration of facts and near-facts is a selective, analytical process governed by the investigator's ability to perceive and pursue all possible explanations of an apparent sequence of events. A better understanding of the concepts of inductive reasoning should make the investigator less reluctant to participate in, or to promote, collective theorizing. The combined minds of all participants in an investigation present an enormous talent pool. This talent cannot be tapped unless all obstacles to a free exchange of theories are removed. It is the principal investigator's responsibility to provide the atmosphere in which this exchange can take place in a methodical, constructive and disciplined manner. Before a team is dissolved and the wreckage released, each member should have had the opportunity to submit his considered thoughts to the team's scrutiny. This is the only way to ensure that potential evidence which is still retrievable at that time is not overlooked or lost.

It seems appropriate to end with a note of caution. Knowing how an accident could have been prevented does not necessarily mean that the actual cause has been identified. Although the investigator's ultimate goal is to promote air safety, he should not let his devotion in this matter interfere with the thoroughness of his investigation. This is especially true in operational accidents where each identified instance of substandard behavior on the part of the crew or traffic controllers may be directly convertible into corrective measures, without any consideration of the underlying reasons for the error mechanism.

[3]Webster's New Dictionary of Synonyms, G. & C. Merriam Co., Publishers, Springfield, MA (1968).

Disaster in the cockpit is
just a jigger away . . .
DEADLY
MIX

Patsy Thompson
Publications and Graphics Division
U.S. Army Agency for Aviation Safety
USAAAVS

DURING THE LAST few years, alcohol appears to have taken a back seat to narcotics in our news media; yet, more than one-half of all deaths and injuries on highways are still caused by drinking drivers. When alcohol is distributed through the body, we find that ordinary cautions are removed, reactions are slowed, coordination is impaired and concentration becomes difficult. In addition, the tranquilizing action of alcohol lessens a person's inhibitions and stimulates a false sense of confidence. Even a small amount of alcohol in the blood makes the senses less acute, particularly that of sight as it reduces the field of vision and causes ordinary objects to become darker and indistinct.

Drinking and flying is even more dangerous than drinking and driving. When flying you have added responsibilities for maneuvering, higher speeds, communication, navigation, wind, density altitude and so on, which require a very high level of performance. An added danger is that the effects of alcohol are greatly increased by altitude. Pilot ability can be affected by only one drink, as it raises the blood alcohol percentage as high as 0.05mg% which is the medical threshold of intoxication and, when adding the effect of altitude to alcohol, a pilot in most cases has stepped over this threshold.

Some drinkers have the idea that a few beers are safe and that the trouble really lies with "hard liquor," but they are mistaken. While the average alcoholic content is generally 4½ percent in beer, 12 to 14 percent in table wines, and 18 to 21 percent in sherry and port, don't let this fool you when comparing it to 86 proof liquor. Proof is only a trade method of stating alcoholic content and it is exactly twice the alcoholic strength. That is, 86 proof liquor contains 43 percent alcohol by volume. This, then, makes beer and wine look a little stronger, but something else must be considered. Beer and wine are drunk from larger containers than straight shots of hard liquor so, consequently, it only takes 1¼ glasses of wine or 1½ mugs of beer to equal a 1½-ounce shot of 86 proof liquor.

Some drinkers also believe that a heavy person can safely drink more than a thin person. True, the effects of alcohol can be theoretically calculated according to body weight. But variation from one person to the next, and even at different times in the same individual, makes this almost an academic exercise when it comes to predicting safety.

When alcohol is taken into the stomach and intestines, it is absorbed and distributed rapidly throughout the entire body fluids and tissues. The body begins immediately to dispose of the alcohol by oxidation, or burning off, but the rate of disappearance may be lower than the rate at which the alcohol accumulates in the system. This places a limit on the amount of alcohol that an individual can consume without showing signs of intoxication. When intake ceases, the body continues to oxidize alcohol into carbon dioxide and water as long as any alcohol remains in the system.

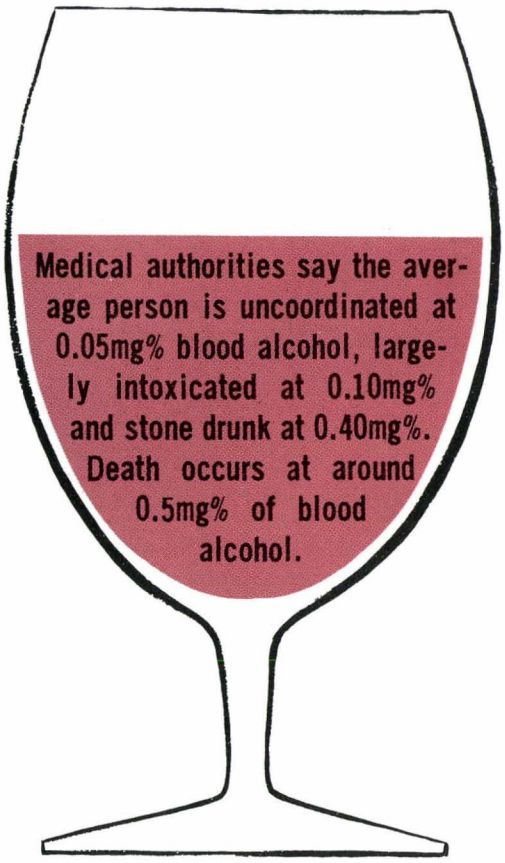
The human body requires about 3 hours to get rid of 1 ounce of alcohol, no matter what you may do. It makes no difference whether you feel the effect or not, whether you eat or not or whether you drink coffee by the hatful. When a person is flying there should be absolutely no alcohol in the blood, as an amount of alcohol which would have no effect at sea level can kill you at 10,000 feet by ruining your judgment and coordination.

It is an excellent rule to allow 24 hours between the last alcoholic drink and takeoff time and, in accordance with AR 40-8, no alcohol should be consumed within 12 hours before takeoff, since the aftereffects are also hazardous. After alcohol is eliminated, there still remains an abnormal physiological condition of the body—"hangover." This is a result of a complexity of reactions by different parts of the body, changes in overall body chemistry and general fatigue. An individual is still not himself for several more hours. It is for this reason that the length of time between the last drink and takeoff is so important. To prove this point, let's review a few accidents in which alcohol played a part.

DEADLY MIX

During a training flight, the IP initiated a 180-degree demonstration autorotation. He knew the helicopter was going to touch down long but thought he could remain on the lane. On touchdown, the aircraft was rapidly approaching the end of the lane, so the IP bottomed collective to stop it, but it continued to slide. He then applied power for a recovery, but this caused the helicopter to yaw to the right approximately 30 degrees. The aircraft struck the sod first with the left forward skid, pivoted to the right and rolled about the broken end of the left forward skid. During this sequence, the main rotor blades struck the tail boom assembly, severing it from the main airframe, and the aircraft rolled onto its left side, with major damage. Neither the IP nor student pilot were injured.

A complete examination was performed on the IP and blood alcohol and carbon monoxide samples were taken. A blood alcohol level of .05mg% was found in his blood, but there was no detectable carbon monoxide. This percent of alcohol is a significant level in aviation to affect a person's judgment and reaction, as altitude prolongs and accentuates the effects of alcohol. The blood was sampled 1 hour after the accident. During this hour, the patient metabolized at least .01mg% to .015mg% alcohol, which means that the level of alcohol during the accident was at least .06 to .065mg% blood alcohol.



This IP violated AR 40-501, paragraphs 4-24d and 4-27f, by attempting to fly with a significant level of alcohol in his blood which impaired his judgment and reaction. That is, he used poor judgment in continuing the maneuver past the prescribed touchdown area and failed to recognize a potentially hazardous situation in time to take corrective action before the aircraft left the overrun.

An OH-58A pilot was on a training flight when his helicopter struck powerlines 60 feet above a river. The helicopter traveled 344 feet after hitting the wires and came to rest inverted on a sand bar in a riverbed. The passenger was killed, the pilot received major injuries, and the copilot had minor injuries. Both survivors professed to amnesia concerning the events surrounding this accident. However, there were several cases of beer aboard and the dead passenger had .035mg% alcohol in his blood. In this accident it could only be surmised that alcohol was a factor.

A pilot not on active duty was killed when his observation helicopter hit a tree on a riverbank and crashed during an unauthorized flight. A passenger aboard sustained multiple fractures, cuts and bruises. The passenger said they were flying the helicopter to determine whether it needed new plugs. Two persons who had talked to the pilot shortly before he took off said they smelled liquor on his breath. The flight surgeon's report indicated that the blood alcohol level of the pilot was 0.215mg% and the passenger's was 0.09mg%. The pilot was not wearing his shoulder harness, and both the pilot and passenger were wearing short sleeve shirts, cotton pants, low quarter shoes and no gloves. Multiple abrasions and lacerations were sustained due to the lack of proper clothing. Both of the occupants lost their helmets, probably because they failed to fasten the chin straps. This was the fourth major accident for this pilot in slightly over 4 years and 1,700 hours of flying. If there was a common denominator in these four accidents, it would most likely be labeled overconfidence.

Flying and drinking are completely at odds with each other and when mixed, they invite disaster in the cockpit. So if you're going to drink, do yourself a favor by allowing your body enough time to return to normal. And remember—confidence feeds and swells on booze!

This recent MAST operation is a good example of supervision and safety working hand-in-hand . . .

SUPERVISION + SAFETY = A WINNING TEAM

Burn victims from an explosion in Eagle Pass, TX, are carried on stretchers by medical personnel from the Institute of Surgical Research at Brooke Army Medical Center to the burn ward at the main hospital

MEMBERS OF THE 507th Medical Company (Air Ambulance), Ft. Sam Houston, TX, in six of their UH-1H choppers, recently airlifted 21 critically burned patients to five San Antonio hospitals. At approximately 1600 hours, a truck-trailer loaded with butane gas overturned and exploded along Interstate Highway 277, sending flames into a nearby mobile home park and an auto repair shop. According to the Texas Department of Public Safety, the accident resulted in six fatalities and 40 injuries, 21 of which were critical. More fatalities were to result in the next few days.

Between 1700 and 1800 hours, members of the 507th learned of the accident, and knowing that MAST at Ft. Sam Houston had the only capability in the area for medevacing patients by air, began to rush back to the heliport. They knew MAST would be needed. Using the unit alert roster, others of the unit were notified of the emergency.

The call for MAST assistance came from the administrator of the Maverick County Hospital in Eagle Pass, located on the Texas-Mexico border, 136 miles from San Antonio. The mission was twofold: Rapid transport of the injured to a hospital and competent medical treatment en route. This could only be accomplished by a real team effort. This is where the united efforts of the Army, Air Force and civilian communities paid off.

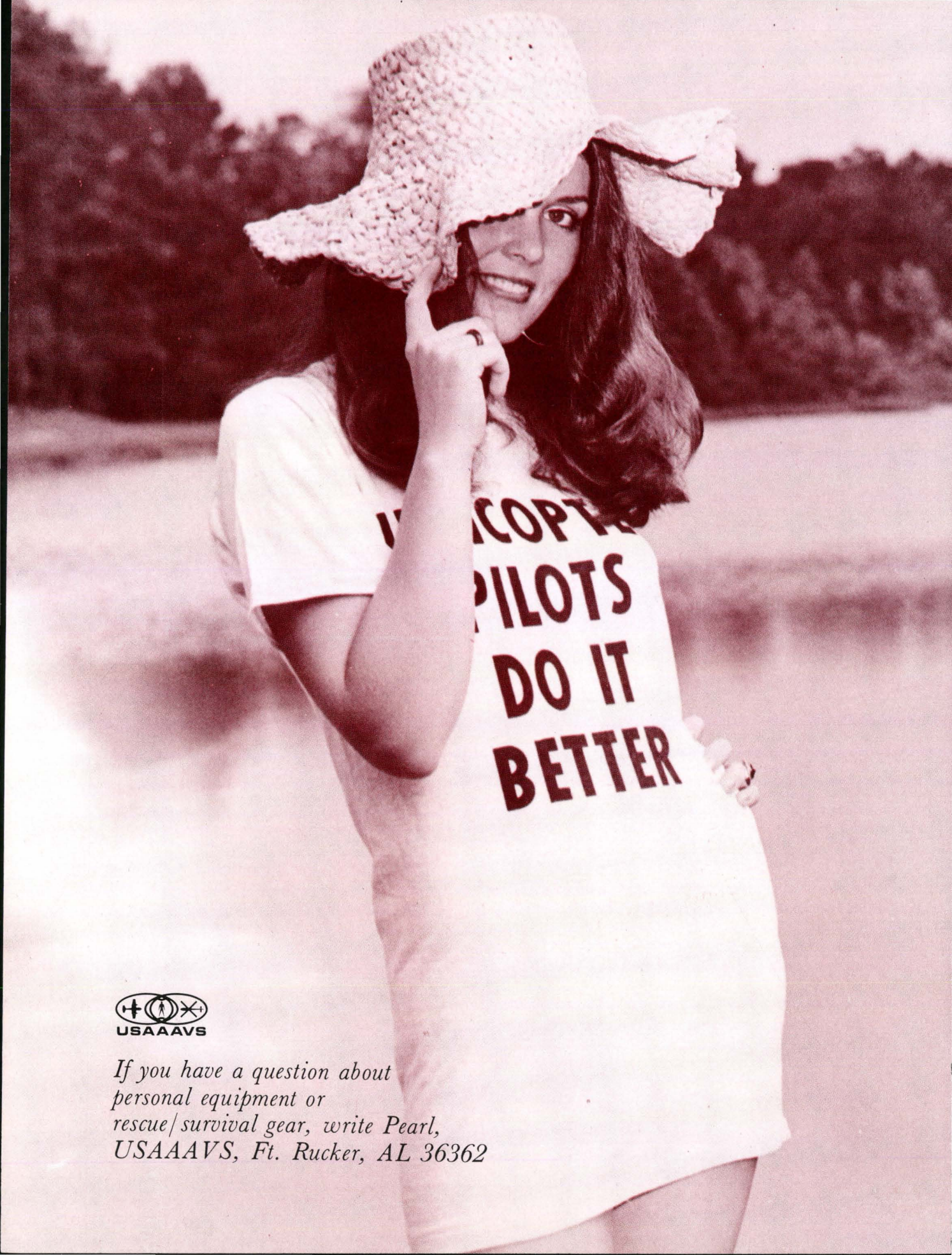
The Air Force at Laughlin AFB, located near the accident site, sent a fuel truck to Eagle Pass to refuel the MAST helicopters. They also sent a team of doctors and nurses to assist the hospital personnel there.

The Institute of Surgical Research at Ft. Sam Houston's Brooke Army Medical Center called in a burn team to send on the MAST flights, and local hospitals mobilized their emergency resources to accept the mass of injured.

LTC Charles Webb, commander of the 507th, supervised the operation, directing the flights between the accident scene and five civilian and military hospitals receiving victims of the disaster.

All patients airlifted were burn victims in critical condition. At 0200 hours, after logging 23.4 flight hours, MAST crews delivered the last patient to a hospital and the night-long mission ended.

This successful operation points up the importance of carefully and thoroughly coordinating military and civilian operations and combining mission accomplishment with full consideration for safety.



USAAAVS

If you have a question about personal equipment or rescue/survival gear, write Pearl, USAAAVS, Ft. Rucker, AL 36362

PEARL'S

Personal Equipment & Rescue/Survival Lowdown

Transfer of Flight Clothing and Equipment

Paragraph 2-30a (11), AR 710-2, reflects items of clothing and equipment that will be transferred with the individual. In reference to this paragraph, which I interpret to include aviation clothing, what aviation gear does a person take with him? Is there a set rule of thumb on what he would take?

There is no set rule of thumb outlining aviation gear transferred with an individual. Common Table of Allowances 50-900, dated 15 November 1973, lists authorized clothing and individual equipment for aircrewmembers. At the end of the item and basis of issue column, a note is inserted, if appropriate, covering transfer of certain aviation gear.

Life Support Equipment Catalogue

I would appreciate it if you could send this section a copy of the latest catalogue listing all personal equipment and rescue/survival gear, or an address where we could obtain it. The only copy we have is over 5 years old, and a more current copy is required.

The United States Army does not publish a booklet listing all life support and survival equipment. USAAAVS provides students attending the safety course at Fort Rucker a reference book. This book is published by USAAAVS yearly and lists widely used life support equipment, including NSN and authority.

Survival Kit

This unit recently received its first shipment of the individual survival vest, but the survival kit listed on the packing list was not included. What is the procedure for obtaining this kit and is it appropriate for use in Germany?

Is there a collective survival kit for use on UH-1 aircraft? Common Table of Allowances 50-900 does not list any such items.

The tropical personnel aid kit, NSN 6545-00-782-6412, was removed as a preassembled component of the individual vest type survival kit (SRU-21/P). Detailed procurement instructions are contained in U.S. Army Support Center Supply Information Letter No. 1-75.

Issuance of the kit through medical channels complies with the Comprehensive Drug Abuse, Prevention and Control Act of 1970, Public Law 95-513. Thus, after issue the aircrewmember should retain the kit in his possession.

USAAAVS recommends that the tropical personnel aid kit and other survival equipment, as appropriate, be worn by individuals during all flights.

The individual vest type survival kit and personnel aid kit were designed for use in a tropical environment. However, most components can be used under all climate conditions.

The United States Army has not adopted the practice of developing survival kits for aircraft by type. All kits have been designed to serve an individual as opposed to one kit per aircraft regardless of the number aboard. Pages II-68 and II-69, CTA 50-900, list available survival kits.

Summer Gloves

Could you supply me with the name and address of any outlet where we could purchase the new flyer's summer gloves, GS/FRP-2, for our police pilots.

The flyer's summer gloves are manufactured commercially by a number of companies, two of which are listed below:

Grandoe Glove Corporation
74 Bleeker Street
ATTN: Mr. William Obenhoff
Gloversville, NY 12078
Commercial (AC 518) 725-8641

Mario Papa & Son, Incorporated
66-72 Division Street
Gloversville, NY 12078
Commercial (AC 518) 725-8811 or 725-0639

USAASO Sez

The U. S. Army Aeronautical Services Office discusses

P's and Fees

WATTA WE DO now, chief? There's a big mean looking so-and-so with a tanker parked in front of our bird and he says we got to pay him 4 bucks "landing fee" before we can bug out."

This subject has come up several times recently so we figured a little education might be appropriate. The aerodrome classification "P" designated in FLIP (flight information publication), IFR or VFR Supplements means "public" in the sense of being opposite to "private." The "P" assures unrestricted operation of facilities and landing rights at locations where public money has been invested under various federally funded aviation development programs. At most "P" fields, an area is provided for free parking of government aircraft if the pilot requests it; however, there is no guarantee that some fee will not be charged. As an example, at one of the major Washington DC airports, if the pilot does not specifically ask for the government ramp (which is way out in the south 40) and "inadvertently" parks on one of the commercial areas leased to the fixed base operators (FBO), he is subject to fees unless a purchase is made. At many locations parking is free unless tie down is required or your stay will be longer than one or two hours.

Other conditions that may generate a landing or user fee to transients is the basing of five or more government aircraft at an airport, or a quota system based either on movements (300 or more) or gross weight (movements X weights in excess of five million pounds) in a calendar month. The key to this type of limitation is usually the official business only, or PPR (prior permission required) note in the aerodrome remarks of joint civil/military fields. The AOPA (Aircraft Owners and Pilots Association) has identified 26 different categories of fees that may be charged to civil aircraft at so-called "public fields." Some of these may be levied on you if you don't ask for the free spot.

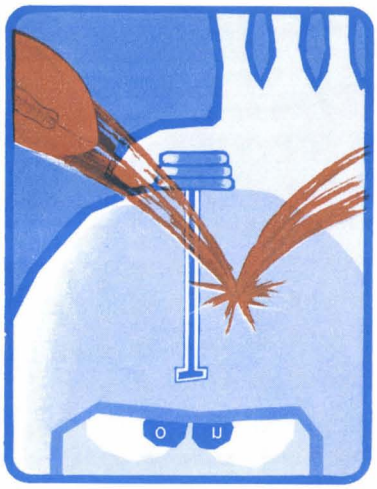
The following may be helpful in avoiding problems with fees:

- Check AIM (Airman's Information Manual) Part II and III and FLIP for fee information while planning your flight. If in doubt, call in advance.
- Contact tower, flight service station (FSS), or FBO (unicom) for information on public (free) parking after landing.
- At civil fields ascertain obligation prior to leaving aircraft unattended.
- When possible, bill landing or user fees to the government. Reimbursement for cash payment may be difficult.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

USAASO Sez—Tell us like it is for a change. We'll investigate, validate and take action in FLIP so others don't get "took."

VIEWS FROM READERS



Sir:
I am enclosing . . . [below] an item of interest which you might desire to publish, as it does concern us all.

R.H.
Major, GS, USAR

Recently an airline captain of many years standing moved into a new home within the flight pattern of a small, but highly active airport. No sooner had he settled down when a USAR [U.S. Army Reserve] helicopter of an assault support helicopter company started making approaches to the airfield and over the house of the airline captain. The helicopter was a Chinook (CH-47A), which literally shattered all peace and quiet of the neighborhood.

After this occurred many times (over a substantial period of time) the neighborhood got together, elected a spokesman—the airline captain—to register a simple request to the unit commander to use an active military base located only 5 miles east.

The airline captain called the company commander and, in short, the airline captain felt he was dealt with in a curt, inconsiderate manner by the company commander. He was told the aircraft would continue to use the airport as it was a public airport and that meant the Army Reserves.

Needless to say such an approach to the somewhat touchy situation caused letters and telephone calls to be sent to senators, congressmen, and the commander of a major numbered army within whose geographical area of control the aviation company was located.

An investigation was instituted, witnesses questioned, surveys made and reports sent. As an end result the commander was given a briefing on "public policy" and the use of the subject airport was discontinued. All of this could have been avoided had thoughtful consideration of public grievances been met tactfully.

As public servants in the largest sense of that term, the USAR must be prepared to justify its programs to the community. The USAR is only as strong, in part, as the support it receives from the community. Gaining public support and acceptance of the USAR goals and programs as well as properly testing their validity in the market place of public opinion should be invited—not shunned. Thoughtful consideration of grievances by the public should be given in a continued effort to gain greater public support and yet meet and obtain those goals existing and required by the USAR.

The discontinuance of the heavy (CH-47) helicopters using the small airport did not affect the training or mission of the aviation company and its members. But it did satisfy the public's complaints of the situation and abated the noise nuisance the community had complained of.

The next time a civilian calls you, think of "public opinion" before you answer. Your unit as well as the USAR goals may well one day depend upon that "public opinion" and support for survival.

Aviation Center Symposiums

THE LAST OF THREE consecutive montly symposiums hosted by the U.S. Army Aviation Center, Fort Rucker, was concluded on the 11th of this month when the National Security Industrial Association adjourned its three days of meetings.

The first—the Staying Power Symposium—was held in July (see August 1975 DIGEST) while last month the 18th Tri-Service Conference on the 2.75 inch rocket system held its two-day meeting.

The theme of the National Security Industrial Association was "Outfitting Army Aviation Units In A High Threat Environment."

Future issues of the DIGEST will carry feature-length articles on topics covered in the symposiums.

Army Air Traffic Controller Of the Year

STAFF SERGEANT Frederick L. Wiesner of the 284th Aviation Company, 1st Signal Brigade, has been selected as the 1975 Army Air Traffic Controller of the Year.

The U. S. Army Communications Command (USACC) Soldier was selected from candidates nominated by major subordinate elements of USACC worldwide, by other major Army commands and by the National Guard. Wiesner was the nominee from USACC's 6th Signal Command in Korea.

This is the second consecutive year that a member of the 284th Aviation Company has earned this distinction. The nominees are considered by the Army Air Traffic Controller of the Year Selection Board under the provisions of Army Regulation 95-37.

The regulation affords "Department of the Army recognition to an individual air traffic controller who has contributed, to an outstanding degree, services, ideas, developments or accomplishments to air traffic control during the preceding year."

Army commanders having either military or civilian air traffic control (ATC) personnel assigned may submit nominations through their chains of command. Major commands review nominations from within their organization and submit a single command nominee to the commander of the Army Air Traffic Control Activity, a part of USACC at Fort Huachuca, AZ.

Wiesner will be the Army representative in the Air Traffic Control Association program later this year to select an Air Traffic Controller of the Year.

SSG Wiesner will receive an engraved trophy and a certificate highlighting the accomplishments which earned him Army Air Traffic Controller.

Wiesner is the noncommissioned officer in charge of the tactical immediate reaction terminal air traffic control team of the 284th Aviation Company. His nomination credited him with being largely responsible within the last year for the organization, training and employment of a highly mobile ATC facility to create an instrumented division base airfield that could rapidly relocate with Army aviation.

He was recognized for being instrumental in formulating a technical and tactical training program that enabled his team to excel in their difficult assignments.

In addition to leading his team in rigorous physical training, SSG Weisner taught classes in escape and evasion, survival, cold weather operations and special night operations. He also arranged for his team to participate in adventure training with the 2nd Infantry Division.

An example of his team's proficiency was cited wherein they were required to completely relocate their landing control central and all supporting equipment to another division base airfield in another tactical zone. Within 3 hours his facility was installed, flight checked and certified for ground control approach and tower operations at an unfamiliar airfield.

During his service in Korea, SSG Wiesner also earned an associate of arts degree from New York State University. He spends much of his off duty time teaching English at Seoul and Yongsei Universities and assisting in various projects with local Korean orphanages. He also has taught Sunday school classes and adult church groups in Korea.

He is a graduate of the Airborne, Ranger and Pathfinder Schools at Fort Benning, GA, the Special Warfare School at Fort Bragg, NC, and several other Army schools and courses.