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JANUARY 1988

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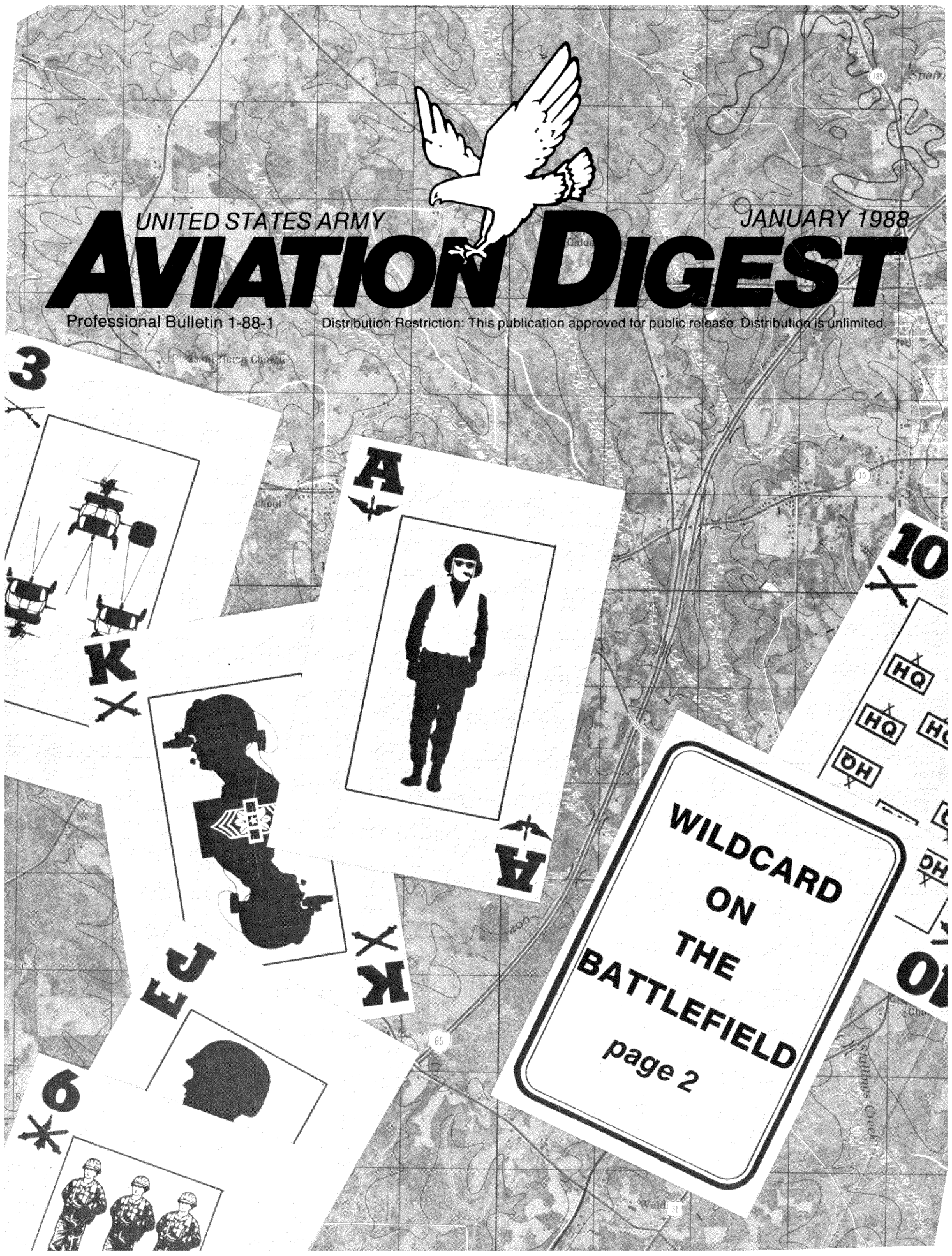

WILDCARD ON THE BATTLEFIELD

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PROFESSIONAL BULLETIN

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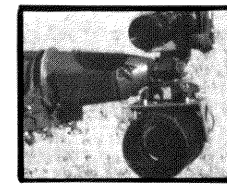

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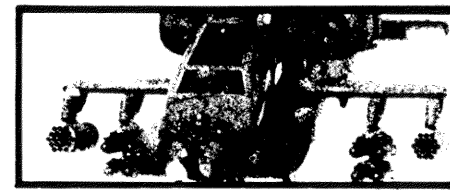

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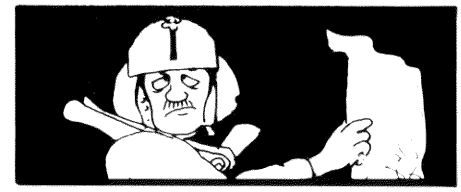

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Major General Ellis D. Parker
Commander, U.S. Army Aviation Center

Wille E. Garrett
Acting Editor

By order of the Secretary of the Army:
Carl E. Vuono
General, U.S. Army
Chief of Staff

Official:
R. L. Dilworth
Brigadier General, U.S. Army
The Adjutant General

The mission of the *U.S. Army Aviation Digest* professional bulletin (USPS 415-350) is to provide information of an operational, functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine and other related data. Information contained in this bulletin does not change or supersede any information presented in other official Department of the Army publications.

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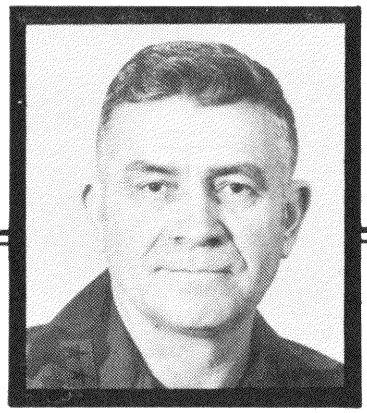
Major General Ellis D. Parker
Chief, Army Aviation Branch



A Challenge to Be Innovative

NOT SO MANY years ago the most sophisticated computer used in Army Aviation was the E6B. Like so many of my fellow aviators, I spent countless hours learning to figure out airspeeds, winds, times and sundry other bits of navigational information. That "whizz wheel" has served aviators well over the years, but the time has come for us to find applications for today's technology in order to improve the efficiency of our combat forces.

Army aviators have always taken pride in their flight planning and performance planning skills and have become very proficient in these time-consuming tasks. However, we can reduce that time expended as computer equipment becomes available. Current computer technology, if put to use in Army Aviation, can permit commanders to establish procedures whereby the entire mission, mission briefing, flight plan, aircraft performance and weight and balance requirements can be computer generated and published prior to flight crews reporting for the flight. Aviators can then spend more time applying their skills in the cockpit, flying missions rather than at a table planning them.

The Army Aviation Systems Command has made significant strides in developing an automated maintenance logbook system that, when fully implemented, will greatly enhance the logistical support for our fighting machines by providing more accurate and current data. The numerous man-days of work required to update equipment status reports will be compressed into hours.

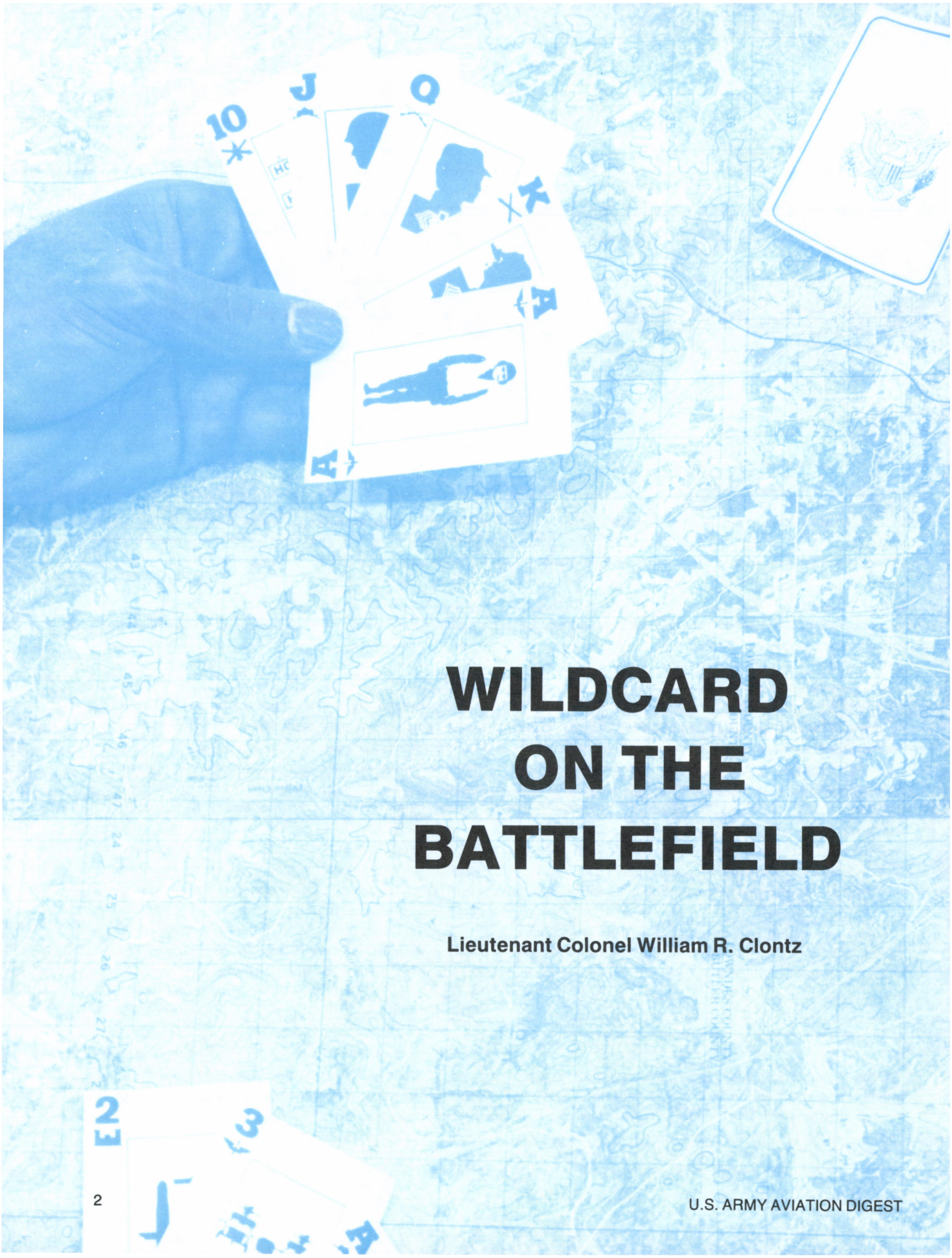
Computerized weather and flight planning services also are available to Army Aviation units as a result of the U.S. Army Aeronautical Services Office's efforts to provide support for units that do not have United States Air Force weather services in their flight operations. These computerized systems display and print the most current weather observations and forecasts for selected routes of flight, destinations and alternates. AR 95-1 authorizes the use of weather forecasts made by these licensed, civil, forecasting services.

An automated flight records system, already used in some aviation units, reduces the amount of work that must be done by personnel involved in maintaining and closing out flight records. Sixth U.S. Army, U.S. Army Engineering Flight Activity and others have expanded their automated flight records system to include maintenance and training records. Currently, the Department of the Army is interested in designing one computer system for use throughout Army Aviation that can accommodate maintenance, training and flight records.

All of these efforts have been directed toward one goal—improving the efficiency of Army Aviation. Automating to better use our manpower and other resources is smart and an absolute necessity if we are to continue to improve our combat forces while facing the reality of congressionally mandated manpower, equipment and funding constraints.

Of course, automation is not the only answer to improving efficiency. Simple refinements in the nonautomated way we have done things for the past 45 years may be necessary. After all, just because we are doing things today as we did them when I went through flight school doesn't mean there aren't better ways available.

I challenge each of you to think of methods to improve the efficiency of Army Aviation through innovations in training and doctrine. We will consider your ideas as we develop changes to the school programs. If it's "broke," we want to fix it. That also applies to those things that are bent or worn out.



WILDCARD ON THE BATTLEFIELD

Lieutenant Colonel William R. Clontz

photographs by SP4 Tonya Dunn and Myra Harrell

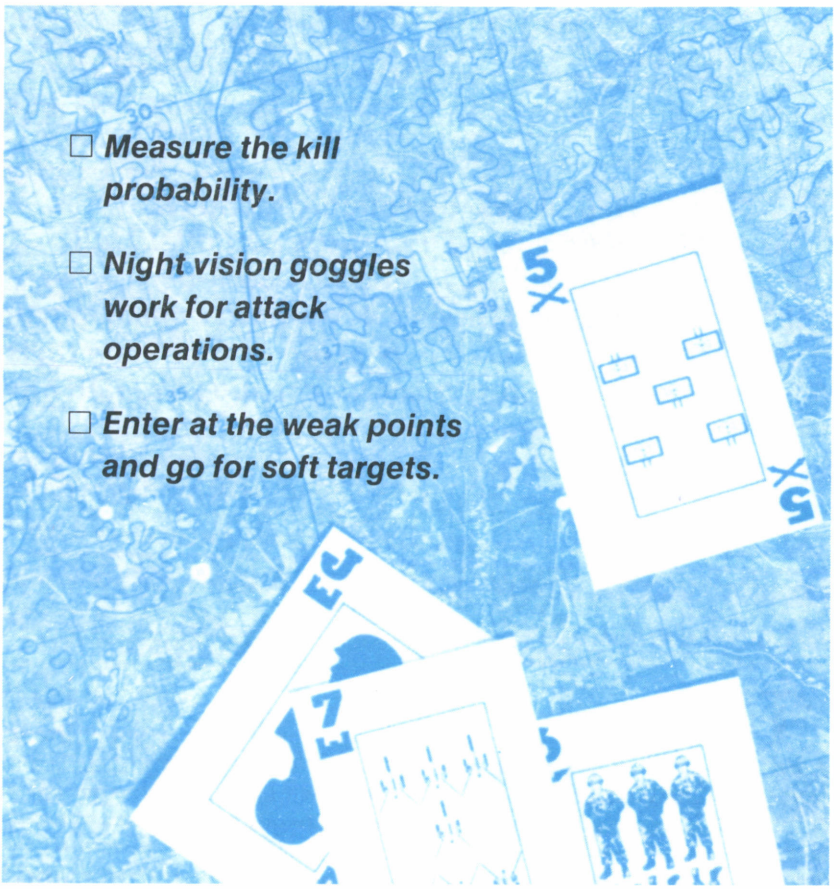
MONTHLY WRITING AWARD

Army Aviation has the speed, mobility and flexibility not only to influence the battlefield but at times to control it, as has been reported in earlier articles in the* Aviation Digest. *A recent National Training Center exercise by elements of the 24th Infantry Division (Mechanized) confirmed this precept and validated how to assure success on the battlefield.

THE OPPOSING FORCES (OPFOR) commander walked away from his command track into the cool night air, his head full of thoughts about the coming battle. He had fought enough actions like this one in recent months and was confident that he had prepared as fully as possible for tomorrow's action. Still . . . this time *was* different; the Blue Forces were using their aviation in disturbing and unpredictable ways. The Army helicopters were proving increasingly effective in recent days, seldom striking the same way twice. Losses were mounting at an unacceptable rate, without a corresponding loss of helicopters. The aviation element had "broken the code" of the battlefield and the OPFOR was paying the price.

The 24th Combat Aviation Battalion went to the National Training Center (NTC) with the goal of setting a battlefield tempo as described above. We found that the application of well-established principles and techniques, modified to take advantage of ever-changing opportunities, yielded repeated success. Our experience at NTC demonstrated clearly that simple analysis of problems and opportunities before committing assets kept the enemy off balance and led to victory. The following is a review of major lessons learned by the soldiers of the Victory Division.

Measure the Kill Probability. Commitment of assets should be predicated on a reasonable chance of inflicting significantly more damage on the enemy than he can expect to inflict on you. Aviation assets are incredibly effective but they also are incredibly expensive and are fielded in low density; use them accordingly. An important example is provided by employment of attack aviation assets against dug-in hard targets, especially at short ranges. This is a no return operation, sure to result in high aircraft loss rates, as the risk to thin skinned aircraft is high while the probability of a tank kill is near zero. A useful variation is to move in behind the enemy positions and engage as he moves off the position or makes a lateral movement. A more conventional head-on attack will prove too expensive. Find the rear attack opportunity or wait for another battle. This is a relatively high risk option that demands the right conditions to suc-



ceed. Excessive loitering or choosing the wrong position can be fatal. Pursue this option with the greatest of care and on rare occasions.

Night Vision Goggles (NVG) Work for Attack Operations. Shooting with goggles is difficult at best, particularly with TOW missiles, and is generally not a best use of resources. However, the goggles are absolutely invaluable in executing high speed, low level night movement across the forward line of own troops (FLOT), assuring strike elements will be in position for first light attacks. Our NVG teams were consistently successful in breaking the rhythm of enemy attacks and in disrupting his formations from the rear. They were also of great value before first light for spot reports and to call in artillery at maximum ranges.

Enter At the Weak Points and Go For Soft Targets. Good templating tells you where the enemy boundaries are. Crossing the FLOT at these points lowers the risk of taking fire, and even of discovery. Small groups of aircraft or individual aircraft moving under cover of darkness at high speed and blacked out, using multiple and varied routes, are difficult targets for OPFOR gunners. We received feedback from the OPFOR that they could sometimes hear these aircraft but could not see them, nor track them with any precision.

Once through the FLOT, tactical situation permitting, go deep to strike previously identified and templated soft targets such as rear services units and communications assets; then proceed forward to command and control targets, artillery positions, and helicopter laager sites, engaging forward hard targets last. This technique maximizes the range and types of damage inflicted. Rolling up targets from the rear offers advantages in terms of target numbers versus risks. This represents something of a reversal of the normal procedure that calls for attacking hard targets first. It should not be construed as a reversal of priorities, however; it is simply coming at these same targets from new directions and engaging other valuable assets as the attack moves forward. If we were to concentrate only on the hard targets and only in a dogmatic order, we would deny the value of destroying support echelons. A greater number of targets are available with a lessened concentration of air defense artillery attuned to the helicopter threat. It also makes counterattack more difficult as the aircraft do not remain in any one area long.

An attack of this sort, a running attack in a zone as opposed to a pinpoint attack on specified targets, will not completely destroy many targets but will render many targets combat ineffective and confuse the enemy as to just how many aircraft are attacking him from how many positions. This concept should be employed when mission, enemy, troops, terrain and time (METT-T) and intelligence support its use. Vary this attack concept with more conventional approaches as necessary to get to the targets and to complicate OPFOR security planning.

Plan On Poor Communications. You are not likely to be disappointed! Communications between attack aviation and ground elements are often tenuous at best, especially back to brigade or division. Rough terrain such as is found at NTC frequently eliminates communication entirely for

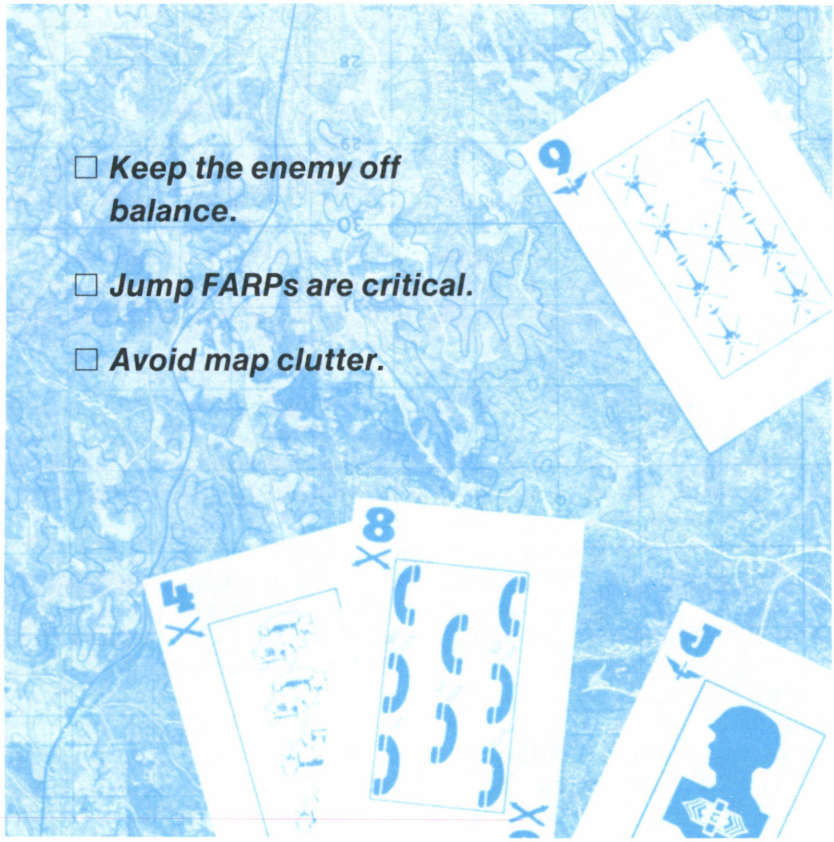
brief periods. This may require additional aircraft, dismounted scouts or relays on the battlefield to pass information and to assure that artillery, Air Force and other assets are smoothly integrated into the battle. Where feasible, dedicated aircraft for airborne forward air control and fire support officer personnel pay dividends in terms of syncronization and the ability to place key players at one place for face to face coordination. Aviation elements en route back to the forward arming and refueling point (FARP) or rear areas must routinely take advantage of reduced distances to talk to higher headquarters, provide updates and pass on requests. It's an informal and impromptu system that is essential to keep everyone abreast of the situation. Just remember to keep such transmissions short, perhaps by use of brevity codes, and to terminate them early to avoid electronic warfare targeting of the FARP or command posts.

Know Who You Work For and Who Your Friends Are. Attack assets are best employed at division level, orchestrated by the aviation brigade, although METT-T may dictate otherwise for specific situations. Assets may be OPCON (operational control) at times to ground maneuver brigade level on a mission basis, but this is the lowest level at which aviation assets should be allocated. Operation below this level negates the speed, mobility and surprise that are inherent in aviation. Employment without these elements only serves to diffuse combat power rather than concentrate it; what could be an opportunity becomes a problem; a risk.

This does not negate the requirement to talk to battalion or company level forces on the ground, exactly the opposite. Forward ground elements usually have the most current information as to specific targets and dangers in their zone. Ground and air plans, as well as execution, must dovetail or they are wasted, even mutually defeating. Supporting and direct fires also must be coordinated to achieve the synergistic effect required. The brigade headquarters is the ideal place to effect most of this coordination initially, followed by direct conversation on FM (frequency modulated) during the battle.

Keep a Clear Channel Open to the Artillery. Do this at the lowest possible level. The combination of aerial scout and artillery is powerful but only if it functions quickly. Distance, terrain and communications availability will determine the best option. One possible solution is to have the attack aviation commander work through the fire support element net of the closest ground battalion task force, assuming the commander does not have an airborne fire support officer. Use of a digital message device in the aircraft to tie into the artillery net is an obvious and excellent solution when available. Keep other options open; this is not a link you can afford to lose. It often means the difference between surviving a battle and winning it. The best option is to at least secure priority of fires during critical phases of the battle. Where possible, request fire support via a dedicated battery (or more) and discreet frequencies during critical peri-

WILDCARD ON THE BATTLEFIELD



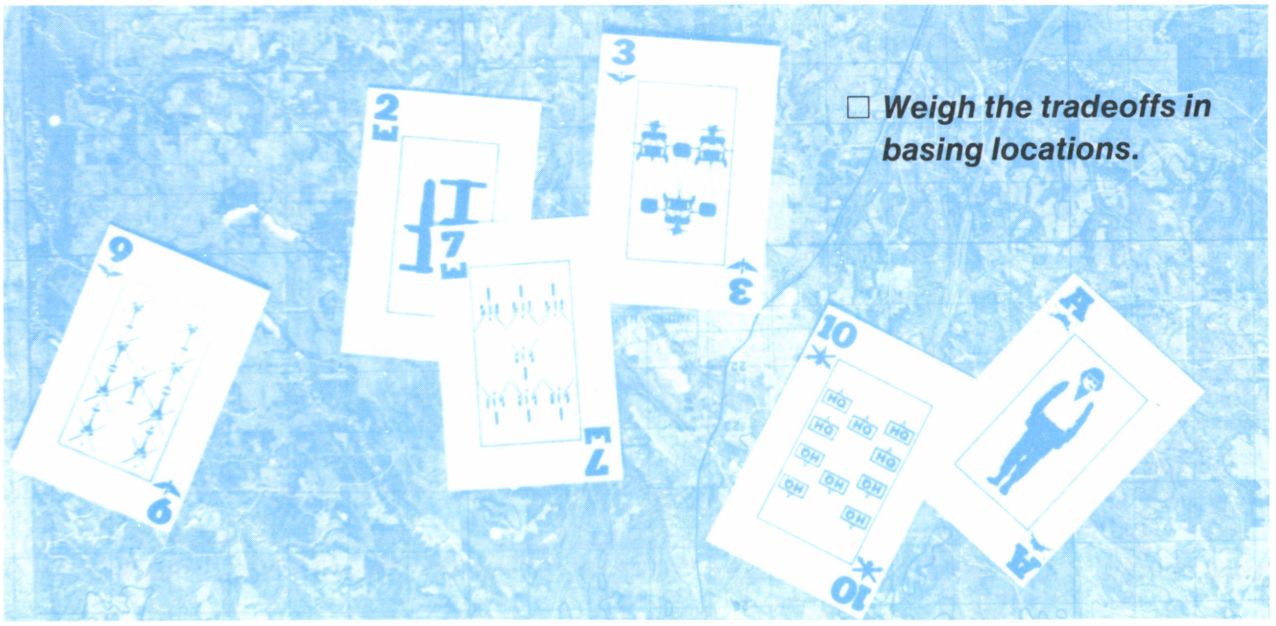
ods. These dedicated assets are essential when fighting well forward of the FLOT.

Keep the Enemy Off Balance. Successful techniques should be repeated but not excessively to the point of predictability. As an example, we went from deep attacks with TOWs on a given day, followed by massed fires 5,000 meters to the rear with rockets the following day. Aviation practically owns the mobility aspect of the battlefield. Failure to use this advantage is unacceptable. Make the enemy spend inordinate amounts of time, resources and energy trying to counter your moves. In this way, you defeat him and make it easier for the other members of the combined arms team to do their job. The proper use of mobility is directly connected to the ability to mass fires. Don't automatically use the one-third rule for continuous coverage. There will be times when it pays to let coverage deplete, even lapse, to ensure sufficient mass of fires at the critical opportunity.

Jump FARPs Are Critical. We found it necessary to move FARPs often; various techniques worked. We relied on slingloading of forward area refueling equipment systems and blivets, with crews carried in the same UH-60s. Securing the equipment to Air Force pallets facilitated the movement process and reduced setup times. Maintaining a spot decontamination capability is essential at every FARP. The FARP also must have an independent means of communications and some means of ground and air defense. Insist on equipping your FARPs with Stinger antiaircraft missiles. In mechanized warfare, the FARP is subject to being overrun with great speed. This danger requires an integrated mobility and communication capability, as well as a plan to relocate at a given time; i.e., when enemy elements reach position X the FARP will displace. This assures the safety of the FARP even if communications are disrupted or if key leaders are out of touch. Obviously, fielding of the heavy expanded mobility tactical truck will radically alter the possibilities for FARP operations and movement.

Avoid Map Clutter. Maps are often obscured with massive amounts of data. All of it essential to every crew. Consider splitting up what is posted between crewmembers in the same aircraft, but do keep complete graphics in the cockpit. Cobra lead may be called upon to fulfill the duties of scout 1, etc. Therefore, no shortcut on graphics is acceptable. Just knowing your piece of the action is not enough; crews must have an understanding of the larger concept of the battle.

Weigh the Tradeoffs In Basing Locations. A good case can be made for placing your assets as far forward as possible, thus reducing deployment times and facilitating coordination. However, placing these assets toward the rear, even in the division support area, greatly facilitates crew endurance (usually involving fewer displacements) and better aircraft maintenance, as aircraft aviation unit maintenance and aviation intermediate maintenance are closer together. The subject of crew endurance is one that deserves emphasis. It is a leadership and a management issue that cannot be casually waived without unacceptable costs. Assuring crews get adequate rest in terms of quantity and quality is a command responsibility. Recognize the variables such as intensity of the battle and physiology, and enforce procedures accordingly. Aviation commanders have to lead



☐ ***Weigh the tradeoffs in basing locations.***

the way on this issue. The risks of enemy attack and targeting are present in both options, though with different specific types of threat. A judicious mix might consist of rearward basing with a jump tactical operations center, FARPs and flight elements ready to displace on a mission basis at any time. Prepositioning of fuel facilitates use of this option. The central issue to be addressed is the tradeoffs in security versus responsiveness, in quality maintenance and rest versus reaction times. Battlefield conditions and aviation mobility will give you several possible equations. Don't assume only one answer is always correct; be prepared to execute different options at all times. If nothing else, this flexible approach makes templating more difficult for the OPFOR.

The above discussion covers only a few of the issues that duty at NTC raised for the 24th Combat Aviation Battalion. The center provides an unparalleled opportunity for training that should be seized. The NTC is essentially geared to combat at the ground battalion task force level and currently limits aviation play substantially. Nevertheless it's great training. As aviation continues to increase its impact on the battlefield, NTC rules and procedures will expand to more realistically employ our resources; the cadre at NTC is hard at work making this a reality. Whatever external limitations apply, aviation leaders should remember the real limiting factor is our own imagination and daring. Audacity and innovation teamed up with good judgment and professional skills will win the battle. FIRST TO FLY!

ABOUT THE AUTHOR

At the time this article was written, LTC William R. Clontz was the commander of the 24th Combat Aviation Battalion, 24th Infantry Division (Mechanized) at Hunter Army Airfield, GA. He now commands the newly activated 24th Attack Helicopter Battalion of the Aviation Brigade, 24th Infantry Division (Mechanized). He is a Senior Aviator, a Senior Parachutist and is Special Forces qualified. He is a graduate of the Infantry Officer Advanced Course, Special Forces Officer Course, Command and General Staff College, Foreign Area Officer Course, and the French Ecole Superieur de Guerre Interarmee. He has a master's degree in public administration and is rated in AH-1, UH-1, UH-60 and OH-58 aircraft.

"Decompression Sickness? Heck, I Don't Even Scuba Dive!"

THAT STATEMENT summarizes the average Army Aviator's attitude toward decompression sickness. Unless he or she is a scuba diver, the last time an Army aviator thought about decompression sickness was right after altitude chamber exposure during the first week of flight school.

However, altitude induced decompression sickness remains a serious threat to aviators who fly above 18,000 feet, mean sea level (MSL), and aviators who scuba dive. Just because you are not a member of either group, now is not the time to skip on to another article. Besides, how many of you have totally given up on receiving a fixed wing transition, and you're never too old to learn to scuba dive.

Altitude induced decompression sickness is no different from decompression sickness induced by scuba diving. Whenever there is a sufficient reduction in atmospheric pressure, bubbles of nitrogen will evolve from body tissue. This is similar to opening a soft drink bottle that has been shaken. These bubbles may then settle in the joints and tendons causing the bends, or maybe in the central nervous system causing a central nervous system disorder. Either one of these disorders could have a serious effect on an aviator's career. Even simple or type I bends will require the aviator to be grounded for a short period of time. A case of type II decompression sickness (central nervous system involvement) requires an aviator to be grounded until an aeromedical summary is prepared and reviewed by the Aeromedical Consultants Advisory Panel at the U.S. Army Aeromedical Activity, Ft. Rucker, AL. We in the Army are more fortunate than aviators in the U.S. Air Force who are permanently grounded for type II decompression sickness.

The maximum altitude below which not enough bubbles will evolve out of solution to cause decompression sickness is unknown. For most of the 20th century it was thought to be 18,000 feet MSL. This altitude is based on the theory proposed by Commander J. S. Haldane in his report to the Lords Commissioner of the Admiralty on deep diving in 1907. Haldane postulated that a drop of about one-half of the original gas pressure would be safe whatever its value; i.e., 132 feet deep to 66 feet deep; 66 feet deep to sea level; sea level to 18,000 feet mean sea level. It was Haldane's 2:1 Rule on which all early diving tables and the 18,000 feet MSL theory were based. Current studies by National Aeronautics and Space Administration and Brooks AFB, TX, have proven that Haldane's 2:1 Rule is not conservative enough. These studies have shown that the true critical ratio is about

Major John McNamara, M.D.
Major Robert A. Mitchell

1.54:1 or about 12,000 feet MSL.

To better protect the Army aviator flying high altitude unpressurized missions, Army Regulation 95-1, "General Provisions and Flight Regulations," was changed. Effective 22 August 1985, the altitude at which 30 minutes of prebreathing 100 percent oxygen at ground level is required was reduced from 20,000 feet MSL to 18,000 feet MSL. The current edition of AR 95-1, dated 1 October 1987, continues to reflect this change. When the change was being staffed no one could determine a physiological reason why 20,000 feet MSL had ever been established. However, there is numerous evidence supporting 18,000 feet MSL.

Most of the data and studies supporting the reduction to 18,000 feet MSL comes from the U.S. Air Force. This is a paradox since the U.S. Air Force does not have an Air Force wide regulation requiring prebreathing prior to unpressurized flight up to 25,000 feet MSL. However, there are numerous operational procedures requiring prebreathing prior to exceeding 18,000 feet MSL.

The authors could find only two documented cases of altitude induced decompression sickness in Army aircraft. This is not because the Army experiences so few cases of altitude induced decompression sickness. The problem is twofold. First, the Army did not centrally collect data on decompression sickness. Second, most cases of decompression sickness are simple pains only bends and are not reported. Some aviators who experience a nonspecific joint pain after a mission tend to ascribe it to age, exercise or other muscle strain rather than consult the flight surgeon. It's usually a case of, "My shoulder always hurts after I've flown at 23,000 feet MSL for 4 hours, but the pain always goes away after two aspirins and a couple of beers." The Army does, however, have substantial data collected in its altitude chamber that support the reduction to 18,000 feet MSL.

Most aviators feel that altitude induced decompression sickness is an Air Force problem because they fly so much higher than the Army. The U.S. Air Force had 90 decompression sickness mishaps in the 10 years, 1975 to 1985; 76 or 85 percent were at altitudes below 25,000 feet MSL. Of special note are the 15 mishaps (17 percent) at altitudes below 18,000 feet MSL. Current studies at the U.S. Air Force School of Aerospace Medicine at Brooks AFB, TX, by Gene Dixon, have demonstrated reproducible bends in test subjects as low as 16,500 feet MSL. These altitudes are well within the operational flight levels of many Army missions.

It is important that we dispel the myth that bends are not that serious, and they are just the cost of doing business in high altitude unpressurized flight. As already mentioned, they can have a direct effect on an aviator's flight status. Even a temporary loss of such a valuable asset as an aviator cannot be tolerated with today's manpower constraints. More important, simple type I bends, which are not career threatening, can progress to more serious medical problems. Temporary serious loss of vision has been documented as low as 20,000 feet MSL and death in two cases at 20,000 and 22,000 feet MSL.

Who is at greatest risk in the Army Aviation community?

There are two groups of Army aviators that are at greatest risk. First, are those crewmembers who repeatedly fly high altitude unpressurized missions. Second, are those crewmembers who scuba dive as a sport. The two operational cases of altitude induced decompression sickness reported in the Army were pilots of an OV-1 and a U-21 flown at 19,000 and 21,000 feet MSL respectively. Additionally, aviators need to be observant of the "pseudo" aviation group, HAHO and HALO parachute jumpers, who are at equal if not greater risk of decompression sickness.

A study of altitude chamber operations at the U.S. Army School of Aviation Medicine revealed some important facts that directly relate to operational missions. This study showed that technicians who were routinely exposed to altitude had a 10-fold greater risk of decompression sickness than students. The most active technician made only 41 chamber flights per year, which is considerably less than the number of flights per year made by most pilots in some Army units. The median age of the technicians fell into the 31 to 35 years old bracket as opposed to the 21 to 25 years old bracket for students. The average age of the crewmembers who fly the high altitude missions is considerably higher than that of the average aviation unit. Age is a *proven factor* contributing to decompression sickness.

Scuba diving less than 24 hours prior to flight is a *major contributing factor* to decompression sickness. When people scuba dive, they supersaturate their body with nitrogen while breathing compressed air at depths greater than one atmosphere. When they come to the surface nitrogen bubbles will evolve out of solution. If they obeyed the U.S. Navy diving tables, they have less than a 5-percent chance of developing decompression sickness. However, if they should fly within the next 24 hours with the excess nitrogen in their body they are at *much greater risk* of developing decompression sickness. There are numerous documented cases of decompression sickness at altitudes less than 8,000 feet MSL in crewmembers who had been scuba diving in the preceding 24 hours. A major cause of crewmembers' flying after less than 24 hours is that most sport scuba diving courses teach a period of only 12 hours for the removal of residual nitrogen. This time period is in direct contradiction to AR 40-8, "Temporary Flying Restrictions Due to Exogenous Factors."

How to Prevent Decompression Sickness

First, we must educate the unit commanders. The U.S. Army did not start altitude chamber training until 1971. All Army aviators were not trained in the altitude chamber until 1975. There are senior Army aviators who have never had altitude physiology training and a greater number who have only had a U.S. Air Force 4-hour passenger class.

Unit standing operating procedures should adhere to ARs 95-1 and 40-8. High altitude flights should be scheduled 24 hours apart if possible but never less than 12 hours apart. Personnel should never fly less than 24 hours after scuba diving. Personnel must prebreathe 100 percent oxygen for 30 minutes at ground level prior to flight at or above 18,000 feet MSL. Prebreathing 100 percent oxygen for 30 minutes will reduce the nitrogen level in the body by 30 percent, greatly reducing the chance of decompression sickness. Encourage crewmembers to remain on 100 percent oxygen throughout landing roll and until engine shutdown. This extended oxygen period will continue to facilitate removal of nitrogen to reduce the risk of decompression sickness. An additional benefit of remaining on 100 percent oxygen during night landings is that the oxygen will improve night vision.

Another important factor to consider is exercise; this is not covered by regulations. A review of the literature shows a correlation between exercise and an increased rate of decompression sickness. It has been a long standing policy in both the Air Force and Army to prohibit any exercise for 12 hours after an altitude chamber exposure. Another useful suggestion for commanders would be to restrict vigorous exercise immediately prior to a mission since the subsequent dehydration may provide some additional risk.

The current weight control policy of the Army eliminates the major contributing factor of obesity. *Body fat holds seven times the amount of nitrogen as muscle.* Therefore, it would be beneficial for commanders to encourage an individually oriented exercise program that will increase lean body mass and decrease body fat. Such a program is outlined in DA Pamphlet 350-18, "The Individual Handbook on Physical Fitness," or consult the flight surgeon or dietician.

Treatment

As serious as decompression sickness can be, it is easily treated. The important factor is early detection and treatment. With early detection and treatment, decompression sickness is of minimal threat to an aviator's flight status. At the first sign of symptoms the aviator should be placed on 100 percent oxygen through an aviator's mask and should remain on oxygen until treatment by the flight surgeon.

RIGHT (left to right): MAJ Mitchell, SFC Lacey and SSG Olsen are testing the hyperbaric chamber.

BELOW: Inside the chamber, SGT Schweyer (left) is administered treatment for decompression sickness by SFC Yeager (right).

The normal treatment for decompression sickness is recompression in a hyperbaric (diving) chamber. With expeditious recompression, 100 percent resolution of the decompression sickness can be expected. Expeditious recompression does not happen by accident. Hyperbaric chambers are not located near most Army airfields. Coordination should be made with the local flight surgeon to form a decompression sickness evacuation plan. The local flight surgeon must be aware of all units in his patient population with a high altitude mission.

An Army aviator is too valuable a combat multiplier to be lost to decompression sickness. This is especially true since decompression sickness is so easily prevented by good leadership, obedience of regulations and good common sense. So, if you or a member of your unit develops symptoms of decompression sickness, alert your flight surgeon right away. It is important that a flight surgeon be notified. Regular doctors do not receive the same training as flight surgeons in the diagnosis and treatment of decompression sickness.

Remember, early diagnosis and treatment is the key to successful resolution of decompression sickness.

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ABOUT THE AUTHORS

Major Robert A. Mitchell is a Medical Service Corps Senior Aviator. Until August 1986 he was chief of the Aeromedical Factors Division, U.S. Army School of Medicine, Ft. Rucker, AL. He attended the U.S. Air Force Clinical Hyperbaric Physiology Fellowship, Brooks AFB, TX.

Major John McNamara, M.D., is an Army flight surgeon with past assignments in Korea and Honduras. He has treated the only two reported cases of operationally induced altitude decompression sickness in Army aviators.

U.S. ARMY SAFETY CENTER

WIRE DETECTION: History and Future

Mr. Alfred Kleider

The views expressed in this article are those of the author and are not necessarily those of the Department of the Army, the U.S. Army Avionics Research and Development Activity or the Army Safety Center.

This is the final article in a four-part series on detection and avoidance of wire hazards. In the first three articles, CW4 Robert J. Rendzio addressed people and equipment limitations that affect our ability to cope with this hazard to safe flight operations. In this article, Mr. Alfred Kleider, an electronics engineer with the U.S. Army Avionics Research and Development Activity, discusses the history of wire strike protection for Army aircraft, the evolution of wire detectors, and what the future may hold in wire avoidance systems.

RECOGNITION OF wires as a class of obstacle, and as the ultimate obstacle for nap-of-the-earth (NOE) helicopter operations, dates back to 1960. The proliferation of this class of obstacle and the lack of an adequate detection device continued until the late 1970s when wire cutters were introduced as the proposed solution to this problem. Before then, wire detection was near the top of the Army's priorities in regard to barriers in NOE operations. After the introduction of wire cutters, the priority of wire detection devices fell to place 389 out of 400 in the Army's list of needs. It was ironic that this occurred at the very time when the solution to detection of 3 mm (1/8-inch) wires at ranges of more than 300 meters finally became something that could be realized.

In the early 1960s, tests demonstrated X-Band radar could not provide reliable reflections from wire obstacles. Experiments with shorter wavelength radar devices were conducted at the U.S. Army Electronics Command at Ft. Monmouth, NJ, in the late 1960s with similarly disappointing results. In 1964, the first laser-based wire detection device was proposed by Honeywell: the laser inflight obstacle detector (LIOD). This proposal was the first time wire size and minimum range of interest were defined (1/8-inch diameter at 1,000 feet), and this was the first time a laser-based solution to this problem was offered. The LIOD used an Nd YAG laser operating at a wavelength of 1.06 microns (infrared). The LIOD failed to provide the necessary field of view (FOV) in a reliable manner. This was for the most part a condition directly related to the infancy of laser devices.

Results of the short wavelength (3 mm to 4 mm) radar devices revealed that the wires were highly specular at this wavelength (i.e., the illuminating signal is reflected into space and not back toward the receiver), and the reflected signals were received only when the wires were close to perpendicular to the signal emitted from the transmitter. These results reinforced the theories that supported use of devices whose illuminating radiation was of much shorter wavelength, such as visual optical and infrared wavelengths. In this class of devices, the laser (an acronym for light amplification by stimulated emission of radiation) was seen as the best source for these purposes.

GLOSSARY

AHIP	Army Helicopter Improvement Program
AMC	Army Materiel Command
AVRADA	Army Avionics Research and Development Activity
CCD	charge-coupled device
FOV	field of view
HELMOR	heterodyne laser multifaction optical radar
LHX	light helicopter experimental
LIOD	laser inflight obstacle detector
LOTAWS	Laser Obstacle Terrain Avoidance Warning System
NOE	nap-of-the-earth
TV	television
WOWS	Wire Obstacle Warning System

FIGURE 1: Gated low light level TV system in conjunction with a GaAs laser illuminator is shown strapped to an XM-23 gun mount on a UH-1 helicopter.

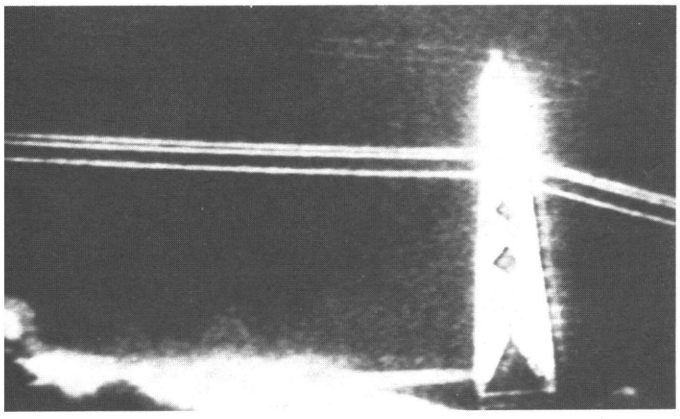


FIGURE 2: While a helicopter hovers, wires as small as 1/8-inch can be seen on the screen in the cockpit at a range of up to 1 kilometer.

The properties of lasers—high intensity, small beam divergence and high degree of monochromaticity—made them ideal sources for attacking the problem.

In 1973, tests were undertaken with a gated low light level television (TV) system operation in conjunction with a GaAs laser illuminator[1] as shown in figure 1. The device was strapped down to an XM-23 gun mount on a UH-1 Huey. Wires as small as 1/8-inch were observed on a TV screen in the cockpit, at a range of up to 1 kilometer, while hovering (figure 2).

Also in 1973, a dual approach to the wire detection problem was undertaken at the Avionics Laboratory at Ft. Monmouth. In one case, development of a single-purpose wire detection device based upon the incorporation of a charge-coupled device (CCD) was instituted. Simultaneously, as a means of providing a more cost-effective approach, wire detection was included as one of several functions that could be provided by a heterodyne carbon dioxide laser operating at 10.6 microns. This latter system, Laser Obstacle/Terrain Avoidance Warning System (LOTAWS)[2] (figure 3, page 14), was eye-safe and operated in an atmospheric window that provided better transmission and reception in inclement weather. The CCD-based Wire Obstacle Warning System (WOWS)[3] [4] provided automatic wire detection and recognition without an attendant crewmember. Figure 4 (pages 14 and 15) illustrates the WOWS.

Costs were the decisive criteria for further developments; and a new, lighter-weight, multifunction CO_2 laser system was designed and fabricated by United Technologies Research Laboratories in East Hartford, CT, in 1980. The heterodyne laser multifunction optical radar (HELMOR)[5] [6] was designed to provide terrain follow-

[1]Kleider, A., "Wire Obstacle Detection Techniques for Rotary Wing Aircraft," Proceedings 9th Army Science Conference, West Point, NY, 1974.

[2]DelBoca, R. and Mongeon, R., "Multifunction CO_2 Heterodyning Laser Radar for Low Level Tactical Operations," National Aerospace and Electronics Conference '79, May 1979.

[3]Kleehammer, Hunt, and Kleider, "Applications of a Charge-Coupled Device Sensor for Automatic Detection and Recognition of Wirelike Objects," Proceedings SPIE (Smart Sensors), April 1979.

[4]Kleider, A., "Wire Obstacle Warning System," U.S. Patent No. 4,068,124, 10 January 1978 (Assigned U.S. Army).

[5]Silverman, Green, et. al.; "Multifunction CO_2 NOE Sensor," Technical Report AVRADCOM 85-E-1, May 1984.

[6]Kleider, A. "A Multifunction CO_2 NOE Sensor System—An Overview and Status Report," IRIS Conference, White Oaks, MD, October 1982.

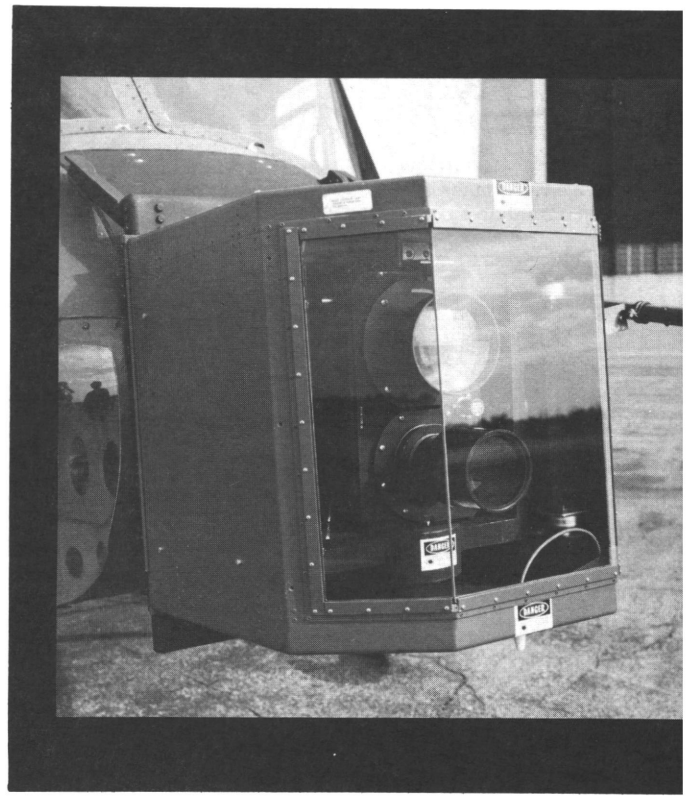
FIGURE 3: Laser Obstacle/Terrain Avoidance Warning System (LOTAWS).

ing, precision Doppler navigation, precision hover and wire detection for helicopters operating in an NOE regime (figure 5, page 16). Ground tests demonstrated the wire detection capabilities of the HELMOR, and the unit was installed in a UH-60 Black Hawk. Ground tests with HELMOR demonstrated detection of 1/4-inch wires, both electrical conductors and nonconductors, at ranges of 300 meters. The laser system was flight-tested and shown to be operable in the vibration environment of a helicopter; however, lack of funds precluded completion of the flight tests.

In the first half of 1986, two events caused renewed interest in wire detection devices: A message was received in Army Avionics Research and Development Activity (AVRADA) from Eighth Army in Korea requesting information about the availability of wire detection devices, and an AH-64 Apache was heavily damaged in a wire strike. The level of interest in wire detection devices was elevated to the Army Materiel Command (AMC). As a result, detailed briefings on wire detectors were conducted for the deputy commander and deputy chief of staff for readiness at AMC.

The task for developing a program to provide the Army with a wire/wire-like obstacle detection and avoidance system has been assigned to the Center for Night Vision and Electro-Optics at Ft. Belvoir, VA. The need for such a system has been established clearly in the product improvement plans for the Army's light helicopter experimental (LHX) and the V-22 Osprey tilt rotor aircraft. It is most likely that the system to be fielded initially will be a single-purpose device for detection and avoidance of a broad class of obstacles, including wires. Weight and size along with functional parameters relating to range, FOV, signal processing rates and display requirements are other essential elements to be considered in designing such a system.

Weight of the system is the driving design parameter. For an obstacle avoidance system to be given serious consideration, its weight should not exceed 45 pounds, with a design goal of less than 30 pounds. It is clear that some form of laser device is necessary if wires and wire-like objects are to be included in the list of obstacles. The exact laser technology that will be used has not been fixed; however, the need for covertness and efficient operation, along with the requirements for eye-safe operation, restrict the lasers to be considered as candidates. The CO_2 laser, which operates at a wavelength of 10.6 microns, is the most mature technology at this time. These lasers have advanced to a point where a 5- to 10-watt, air-cooled system can be constructed in a package weighing less than



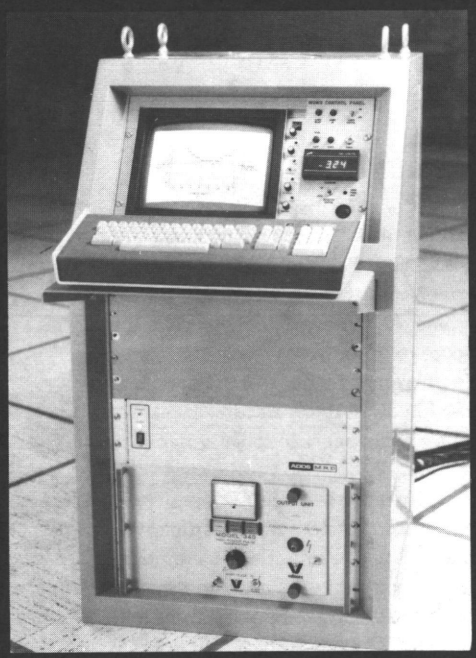
8 pounds. Operational life and shelf life of these lasers have been established and verified in practice.

Other laser technologies including Raman-shifted, neodymium lasers that operate at an eye-safe, 1.5 micron wavelength also are being looked at with interest. This particular technology is less mature than the CO_2 but has great potential for lightweight system uses.

The impact of weight restrictions upon system performance for an obstacle detection/avoidance device is twofold. The operational detection range is directly related to the laser power output. Laser power is strongly weight dependent since higher power usually involves liquid cooling and large heat exchangers. The second factor that is most affected by weight consideration is the optical FOV. The greater the FOV, the larger the optics and the scanners. Larger implies heavier. Thus the range (laser power) and FOV are the principal areas of compromise in a weight-limited system.

When the entire set of factors is considered in a tradeoff study where operational performance, weight, size and cost effectiveness are the principal parameters, the results show that a high degree of protection against wire strikes can be provided with today's technology. Realistically, 100-percent protection cannot be achieved; however, wire detection devices coupled with wire cutters are a realistic solution to today's wire strike losses. When used concurrently, there is no reason that a 90-percent reduction in wire strike accidents cannot occur. Training missions that include NOE in both daylight and nighttime environments are conducted in special areas where obstacles and wires are clearly indicated on mission maps. In the case of wire obstacles, highly colored spheres (about 12 inches in diameter) are strategically placed on each span of wire. For long spans, several such "attention grabbers" are included to ensure visibility. In the real-world situation, and especially in the combat environment, no such pilot aids can be expected to be present. If the Army helicopter is to survive in an NOE environment, a wire obstacle warning and avoidance device must be included in the mission equipment package.

The problems of wire strikes are real, and they are sure to increase in the future. The tactical dictates for NOE operation are well understood. The emergence of new and highly sophisticated aircraft such as the Apache, AHIP (Army Helicopter Improvement Program) and the LHX family of next generation helicopters makes the acquisi-



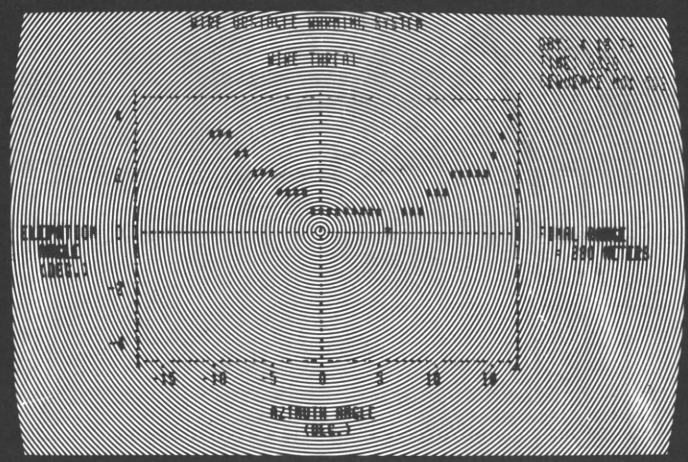
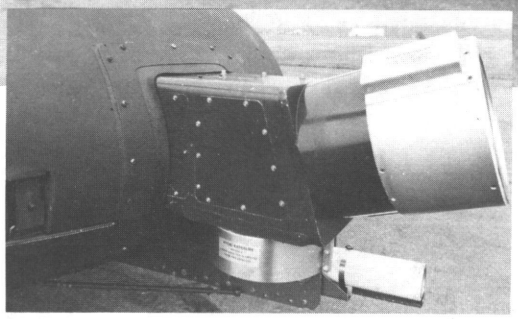


FIGURE 4: Wire Obstacle Device Warning System (WOWS) (far left), WOWS control unit (left) and closeup of WOWS control unit screen depicting a wire threat.



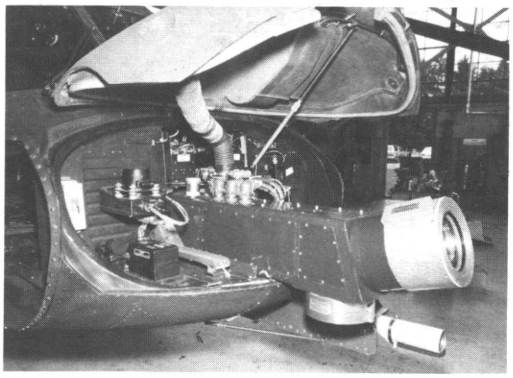


FIGURE 5: Heterodyne laser multifunction radar (HELMOR) (top), a closeup view of HELMOR (center) and an inside view of UH-60 avionics compartment showing mounting of HELMOR (bottom).

tion of an obstacle warning and avoidance system a priority item. The costs of these aircraft and the survival of their crews will depend heavily on providing such a system. Wire cutters are cheap insurance, but as shown in the article in the December 1987 issue of *Aviation Digest*, they are not the state-of-the-art solution. A laser-based device that provides a warning to the pilot and, in instances where adequate displays are available, actual locations for such obstacles relative to the aircraft heading can complement the wire cutters by providing the capability of avoiding wires entirely.

ABOUT THE AUTHOR

Mr. Alfred Kleider is an electronics engineer with the Advanced Systems Branch of the Integration Division, AVRADA, at Ft. Monmouth, NJ. Mr. Kleider has been with this activity since 1972. Prior to that time, he spent 19 years in industry in research and development of lasers and laser systems. His first experience with the problems of wire obstacle detection dates back to 1964, and since that time he has been deeply involved with this problem area.

Mr. Kleider is a graduate of the University of Oklahoma where he earned a BS in engineering physics and an MS in physics. He is a member of the Optical Society of America and the American Association for Artificial Intelligence. Mr. Kleider has published 15 technical articles and holds several patents. One of these patents is for a wire obstacle system.

PEARL'S

Personal Equipment And Rescue/survival Lowdown

ALSE School News

The instructors at the aviation life support equipment (ALSE) school, Ft. Eustis, VA, are going to be busy in fiscal year (FY) 1988. The current schedule calls for 20 ALSE specialist and 14 supervisor classes. FY 1988 students will benefit from the new training on the helicopter oxygen system and the M-43 mask. Other new training may include the PRC-90-2 and PRC-112 survival radios, the TS-24B test set, the new survival vest and the aircraft modular survival system.

Slots for the school can be secured from the Total Army Personnel Agency (TAPA) on DA Form 4187 through your chain of command. Requests should specify either course number, 600-ASIQ2, or course title, Aviation Life Support System Supervisor. Enlisted personnel requests should go to the Commander, TAPA, ATTN: DAPC-APT-F, 200 Stovall Street, Alexandria, VA 22332-0400. Warrant officer requests also should go to TAPA, ATTN: DAPC-OPW-AV, 200 Stovall Street, Alexandria, VA 22332-0400. Civilian personnel desiring this training should submit requests through their servicing Civilian Personnel Office.

Commanders are reminded that the ALSE program needs your full and enthusiastic support in order to function properly as outlined in AR 95-17, "The Army Aviation Life Support System Program."

Shoulder Harness Injury

A recent OH-58 Kiowa helicopter accident revealed that the shoulder harness did its restraint job too well. The shoulder harness was tightly held against the lensatic pocket in the survival vest pocket and caused a painful bruise to the injured person's clavicle bone. A "fix" recommended by Natick Research and Development Engineering Center (NRDEC) was to insert a 1/4-inch foam rubber pad, national stock number (NSN) 9330-00-573-7379, into the compass pocket to alleviate and minimize such problems from occurring in the future. Point of contact (POC) at NRDEC is Mr. Chuck Braga, AUTOVON 256-5449.

ALSE/AEROMED Newsletter

Please notice the title of this new publication. It is another much needed publication that is put out by the HQ AMC POC.

Several months ago we announced that LTC McClelland was the HQ AMC POC for ALSE. This action is a distinct advantage as now we have one more contact to assist in the ALSE area. PEARL's will still function as always for worldwide information and data in the *Army Aviation Digest's* PEARL's articles.

You can reach LTC McClelland by calling AUTOVON 284-9891/9892 or by writing AMCRE-AV, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Your participation in this new newsletter is encouraged.

Shipping Flight Helmets as Baggage

Flight helmets are being damaged when shipped as airline baggage. Aircrew personnel are using the aircrew kit bag with the flight helmet placed inside with clothing. We must stop this practice to preclude further damage to a vital item. Flight helmets will be carried as carry-on luggage and stowed in the overhead baggage compartment. The helmet bag *will* be used to carry the helmet from locker to aircraft, TDY or any other time it is required.

Jacket, Flyer's, CWU-45/P, Heavyweight

Effective 1 May 1987, the Defense Personnel Support Center (RIC S9T) accepted funded requisitions for the jacket, flyer's, CWU-45/P, heavyweight, NSN 8415-00-310-1111 series. This jacket replaced the jacket, flyer's, N2B, heavyweight, NSN 8415-00-118-7569, 7573, 7574 and 7587, sized S, M, L and XL. The CWU-45/P, made of Nomex fabric, provides flame resistance

that the N2B did not. The unit price of the jacket is $110.00, and the unit of issue is EA. NSNs, sizing and recommended tariff are as follows:

Jacket, Flyer's	*Size*	*Tarriff per 1,000*
8415-00-310-1111	S—34-36	151
-1123	M—38-40	363
-1133	L—42-44	325
-1140	XL—46-48	161

The basis of issue for jacket, CWU-45/P, is identical to that of the replaced jacket, N2B, found in CTA 50-900 under LIN L14978. The CWU-45/P jacket, flyer's, is to be worn with the hood, flyer's, NSN 8415-01-167-7242 series.

Controlled Medical Items/Components of Aviation Survival Kits

AR 40-61, paragraph 3-62, gives aircrew personnel good guidance on how subject items are issued and controlled. In summary, controlled items must be in the survival kits at all times to ensure availability for use by crewmembers when emergency survival situations occur. Replacement of expired controlled items is authorized by supply officers who are accountable for the kits. At unit level these kits normally will be in the possession of personnel authorized kits for aviation operations. Kits will be secured in the same manner as prescribed for other ALSE; such as in a locked room, crate or individual locker preferably in the aircrew personnel survival vest/first aid kit.

ELT Finds/Saves

Early afternoon on 24 September 1987, the Missouri Wing, Civil Air Patrol (CAP), was alerted by the Scott Air Force Rescue Coordination Center, Scott Air Force Base, IL, of a missing, downed aircraft in southeast Missouri, the Bootheel area.

A student pilot on a cross-country flight had become disoriented and radioed back to his instructor for help. While the instructor was trying to help, the student ran out of gas and was forced to land in a corn field. Although the student was not hurt the aircraft did sustain damages.

The student was told to activate the emergency locator transmitter (ELT) onboard the aircraft. CPT McDowl from the Bootheel stationed CAP aircraft was told by MAJ Garner to take off and search for the downed aircraft. After CPT McDowl flew for about 30 minutes he picked up the ELT signal. With the special homing equipment onboard he flew directly to the downed aircraft. At about the same time, Scott AFB Rescue Center alerted MAJ Garner of a faint signal emanating from the southwest St. Louis County area. Knowing that the downed aircraft had been found, they flew back to the St. Louis area and began to search for the faint ELT signal. They found the signal was coming from a landfill off Sulpher Spring Road, south of Big Bend. A ground search party arrived at the landfill and, using portable homing equipment, found the signal was coming from under the ground. They asked landfill employees to take a bulldozer and remove some of the landfill. Soon a stronger signal was heard. Digging in the dirt and trash by hand, the transmitter was found and turned off. Apparently, someone thought the discard information on the battery meant the ELT itself should be discarded. The ELT certainly did its thing even after it was discarded. Treat your ELT with tender loving care and it will certainly take care of you. (Credit for this article is given to THE INSIDER, GROUP II NEWSLETTER, Missouri Wing/CAP.)

Technician Offers Tips for Effective ALSE System

As aviation equipment becomes more sophisticated, the demands on the ALSE system will increase.

Yet no military occupational specialty (MOS) exists in the U.S. Army for an ALSE technician. Often, it is an additional duty assignment.

As a result, if a soldier isn't school trained in ALSE, there's not a lot of guidance to help in establishing or maintaining an ALSE shop.

For those persons, Minnesota's only school-trained ALSE technician working in the ALSE field—Sergeant Nyleen Mullally—offers several tips on setting up and maintaining an effective and efficient ALSE system.

The 12-year National Guard veteran supports about 185 persons on flight status in the Minnesota Army National Guard.

Her ALSE shop received a glowing report during a recent Regional Accident Prevention Survey by the Austin, TX, Army Aviation Support Facility.

SGT Mullally has worked in ALSE for 5 years. In 1984, she attended the 6-week ALSE course at Ft. Eustis, VA. She is also MOS-trained as a flight operations specialist, in utility helicopter repair, and has attended the Cold Weather Survival School in Ely, MN, and the Overwater Survival Course in San Diego, CA.

As an ALSE technician, she handles survival radios, survival vests, flight helmets, cold weather survival kits, aircraft first aid kits, personal flotation devices, flight

Any ALSE technician would enjoy working in this well-organized ALSE shop. How effective your ALSE shop is depends on how efficient your system is maintained.

photographs by Benjamin Martel

clothing and survival training. She handles property book transactions for flight clothing, trains ALSE personnel, and instructs on the use of survival equipment. In addition, she is responsible for issuing, inspecting, repairing, replacing and turning in survival equipment.

"Since there's no MOS, it's really difficult at times to find help—to know who to call or how to get advice," she explained.

First and most important, she said, is to get the commander's support and assistance for the ALSE system. This includes having properly trained personnel, and not having untrained people working on survival equipment.

The next step is to attend the ALSE course.

Organizing the ALSE shop is also important, so "you can find what you need and not waste time," she said. This includes setting up a library of reference material, a file system and parts inventory.

In her ALSE shop, rows of survival equipment components line the shelves. In the center are work desks and a large, handy workbench.

Her reference library occupies shelf space near the desks, and the filing system is also easily accessible.

"I finally sat down and did it, and I can't believe how nice and organized it is. If you don't have adequate working area, start asking for it," she stated.

Since there are no annual gatherings of ALSE personnel, an informal network of ALSE technicians has evolved. This network can prove valuable in learning more about the ALSE system and in solving related problems.

"A good source of support on the ALSE system is the ALSE Center at the Aviation Systems Command in St. Louis, MO. Regional Army Aviation offices also can render assistance," she said.

More emphasis should be placed on the ALSE technician's familiarity with survival training, not only how to use the equipment, but what to do.

SGT Mullally recently taught a week-long course to Minnesota National Guard personnel on the basics of the ALSE system. One day was devoted to a survival exercise, where participants set up shelters, broke out survival kits, shot flares, used radios and built fires.

Sometimes, she said, she may be perceived as "Chicken Little," warning about following proper safety and survival procedures. But an apathy can develop about following proper safety measures. "That type of attitude is probably the biggest obstacle. There are times when that can be just as much of a detriment as not being able to get the supplies you need," stated SGT Mullally.

If you have a question about personal equipment or rescue/survival gear, write PEARL'S, AMC Product Management Office, ATTN: AMCPM-ALSE, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798 or call AUTOVON 693-3817 or Commercial 314-263-3817.

Consolidation of 95-Series Army Regulations

Mr. James P. Wall
Directorate of Evaluation and Standardization
U.S. Army Aviation Center
Fort Rucker, AL

AR 95-1 AND some other 95-series regulations have been revised during the past year, and another revision of these regulations will be published in the near future.

Consolidation of 95-series Army regulations, a goal of Army Aviation for more than 2 years, will become a reality when all but the joint Army, Air Force and Navy regulations are consolidated in three volumes: AR 95-1, AR 95-2 and AR 95-3.

This effort should not only reduce the number of aviation regulations to three, but should bring about some other changes that have long been desired. For example, aviators have asked which Federal Aviation Regulations (FAR) apply to the Army. AR 95-1, Change 6 (paragraph 4-1a), indicates that specific paragraphs in FAR Part 91, subparts A and B, that do not exempt military aircraft or flight crewmembers, apply to flights in the National Airspace System. This forces aviators to search through FAR Part 91 to find those paragraphs that do not exempt the military. There is always a possibility of overlooking applicable paragraphs, so why not provide a list of those that do apply to prevent this unnecessary search. Therefore, appendix B of the new consolidated AR 95-1 will include an extract of all applicable paragraphs of FAR Part 91.

AR 95-1, as we know it, will be purged of all administrative-type provisions, e.g., operational support airlift (OSA) and standardization, and will pick up applicable portions of AR 95-17, "Aviation Life Support Equipment," and AR 95-16, "Weight and Balance." It will become a regulation that will be used on a day-to-day basis by aviators and it will be renamed "Flight Regulations."

AR 95-2 will combine six regulations to become the publication that is most applicable to air traffic control, airspace, navigation facilities and airfields. Each of the old regulations will become a chapter of the new regulation and, except for paragraph numbers, remain virtually unchanged. Organizations that are the proponent for individual regulations will continue as the proponent agency for individual chapters within the consolidated regulation.

General provisions, aviation life support equipment, weight and balance, safety of flight messages, flight violations, OSA and standardization, those things that relate to the management of the Army Aviation program, will appear in AR 95-3. In general, the material in this regulation will be used by command and staff to establish and manage programs that are essential for aviation training, standardization and maintenance. In addition to consolidating existing regulations, a chapter will be added to provide guidance for scheduling and managing Army OSA assets.

Each of the new regulations will be printed in the *UPDATE* format, thereby eliminating the need to post changes. Changes will be made on cycles established by user needs.

DES welcomes your inquiries and requests to focus attention on an area of major importance. Write to us at: Commander, U.S. Army Aviation Center, ATTN: ATZQ-ES, Ft. Rucker, AL 36362-5000; or call us at AUTOVON 558-3504 or Commercial 205-255-3504. After duty hours call Ft. Rucker Hotline, AUTOVON 558-6487 or Commercial 205-255-6487 and leave a message.

EDITOR RETIRES

Mr. Richard K. Tierney, editor, *U.S. Army Aviation Digest*, since April 1968, will retire from Federal service in February 1988 after 28 years with the U.S. Army at Ft. Rucker, AL.

In January 1960, Mr. Tierney joined the *Digest* as a writer. Almost immediately, he drew upon his wartime experiences and personal vision of the potential application for Army aircraft. He had served in Korea as a Marine infantryman and had seen first-hand the value of helicopters and light aircraft in support of ground combat units in wartime. After these wartime experiences, he had become a newspaper journalist, working as a sports reporter, sports editor and a copy editor. Writing for the *Digest*, he developed a series of articles on the need for armed helicopters on the battlefield, which appeared first in the May 1960 issue.

An early leader of efforts in the 1960s to protect a handful of deteriorating Army aircraft of historical value, Mr. Tierney was responsible for actions that led to the establishment of the U.S. Army Aviation Museum. He is also credited with being the "impetus" for the Ft. Rucker Historical Society. In addition, in 1962, working with Dr. Stetson Conn, then Chief of Military History at Department of the Army, Mr. Tierney developed the first Ft. Rucker Historical Report. This report has become an annual report of significant activities.

Mr. Tierney compiled and wrote "The Army Aviation Story," published in book form in 1963, providing the first comprehensive history of Army Aviation. In the early 1970s, he published "The Armed Helicopter Story" in a series of *Aviation Digest* articles. As an early advocate of helicopter capabilities beyond ground combat, he published an "Air-to-Air Combat" article in the *Digest* in the July 1974 issue. In 1978, he developed a series of articles that were to pave the way for the establishment of Army Aviation as a separate branch. These articles addressed the key issues related to that development.

In 1982, Mr. Tierney published *Forty Years of Army Aviation*, a booklet covering the developing concept of Army Aviation, a concept born on 6 June 1942 when the War Department approved organic aviation for U.S. Army Field Artillery units. Included is a history of the growth of the Army Aviation training program, which started in July 1942; the establishment of the Army Aviation School at Ft. Sill, OK, in January 1953; and the school's new home at Camp Rucker, AL, in December 1954. He vividly describes Army Aviation's entry into combat in November 1942, in North Africa, and its part later in the Korean and Vietnam Wars. He then discusses the Army's various armed helicopter experiments conducted in the late 1940s through the early 1980s with the emergence of the AH-1S fully modernized Cobra and the AH-64 Apache attack helicopter. Concluding with the roles and missions of Army Aviation of more than 40 years, he writes, "People of Army Aviation are continually dedicated to accomplishing their missions in a professional manner. It all spells success. Such is Army Aviation today—Above the Best."

The *Aviation Digest* has become more than a mere chronicle of developments in Army Aviation through Mr. Tierney's 20-year leadership. Recently decorated by the Secretary of the Army John O. Marsh Jr., on 18 November 1987, in ceremonies at the Pentagon, Washington, DC, with the Department of the Army Decoration for Exceptional Civilian Service, Mr. Tierney was cited for his long dedication and major contributions to Army Aviation. Through his efforts as staff writer, editor, managing editor and historian, he not only distinguished himself but enabled the magazine to become a spearhead for evolutionary concepts such as armed helicopters, helicopter close air support and, more recently, helicopter air-to-air combat.

Mr. Tierney will remain in Ozark, AL, after his retirement and continue to compile and write the history of Army Aviation. The staff of the *Aviation Digest* and his many friends in the Army Aviation community wish him much success in his retirement and these endeavors.

AVIATION PERSONNEL NOTES

Warrant Officer (WO) Personnel Policy Changes

Effective 1 October 1987, WO policy was changed to establish a mandatory Regular Army (RA) integration point. This means that other than Regular Army (OTRA) CW2s selected for promotion to CW3, Army of the United States, will be automatically considered for an RA appointment by Headquarters, Department of the Army. Eligible officers tendered an RA appointment will be required to accept or decline the office prior to promotion to CW3. Warrant officers who decline RA integration will be separated from active service if their Active Duty tour as a WO started on or after 1 October 1987. Those who decline will not be separated if their WO Active Duty tours started before 1 October 1987, and they have completed less than 20 years of active federal service (AFS).

Other policy changes include an increase in obligated voluntary (OBV) service periods for nonrated WOs. All newly appointed WOs now incur a 5-year OBV period upon appointment. This action aligns all WO OBV service at 5 years, both rated and nonrated.

Another change is the elimination of the conditional voluntary indefinite (CVI) process for WOs. Now all WOs will be considered automatically for voluntary indefinite (VI) status during the last year of OBV service. Warrant officers who have already been selected for CVI have been sent letters indicating that their status has been changed to VI.

A final change of note involves the separation policy for OTRA WOs. There is now no fixed maximum service point for OTRA W01s and CW2s; separation will be a function of VI and promotion to CW3. All OTRA CW3s and CW4s whose Active Duty tour as a WO started before 1 October 1987 and who have not integrated into the RA will still be released mandatorily from Active Duty at 20 years AFS.

Emphasis on Reenlistment Needed

Reenlistment of first-term soldiers in Aviation Branch military occupational specialties (MOSs) may be a critical factor in the continued health of the branch for fiscal year 1988. The Army Recruiting Command may not be able to meet all of the aviation requirements this year due to severe budget cuts. Recruiting Command shortages can be effectively offset, however, by increasing the reenlistment of first-term soldiers in aviation MOSs.

Currently several aviation MOSs are below the Army average in reenlistment rates. With emphasis at all command levels, each aviation related MOS can exceed the average. To assist in retaining quality soldiers, the Aviation Branch Chief has approved actions designed to balance the promotion opportunity across the enlisted structure of the branch. Reenlistment options also help retain quality soldiers. The Aviation Branch has 10 MOSs eligible for reenlistment bonuses. Some aviation soldiers can qualify for degree completion if study is specifically related to their MOS. The station-of-choice option is another popular tool successfully used to reenlist aviation soldiers.

These reenlistment options, when combined with the balanced promotion opportunity and stressing the new

and innovative technology used by Army Aviation, will convince first-termers to stay in the Aviation Branch. The branch has quality soldiers; the challenge this FY is to keep them.

Army Aviation Personnel Plan (A^2P^2)

The initial copies of the newly completed A^2P^2 were distributed at the Aviation Commander's Conference held at Ft. Rucker, AL, 1 to 4 December 1987. The A^2P^2, while complementing the Aviation Modernization Plan, is a tool the Aviation Branch is using to review the past, realistically evaluate the present and logically project future needs respecting personnel issues.

The Aviation Branch and the Army are now better able to be proactive when making decisions in the personnel arena because of A^2P^2. Standardization of accession and professional development programs, as outlined in A^2P^2, will help stabilize actions within those programs and bring about a better managed aviation force.

Regulating the accession or professional development programs alone will not solve personnel management problems and is why A^2P^2 addresses all eight of the life cycle functions of personnel proponency (to include structure, individual training and education, distribution, deployment, sustainment and separation).

Although much of A^2P^2 is a "how to" for the personnel proponent business, much is useful for commanders at brigade and battalion levels. For example, the career progression models in the professional development chapter are valuable guides for mentoring.

Commanders who have yet to obtain a copy of A^2P^2 can do so by writing Commander, USAAVNC, ATTN: ATZQ-DAP-PS, Ft. Rucker, AL 36362-5000; or calling Mrs. Jean Roebuck or CW4 Clifford Brown at AUTOVON 558-5706/4313, Commercial 205-255-5706/4313

Flight School News

An October 1987 message to the field clarified the age requirement for Active Duty flight school applicants. The message notes that flight school applicants must be 18 years of age but not older than 29 years of age (must not have reached their 30th birthdate).

A new Flight Aptitude Selection Test (FAST) was mailed to the field in October 1987. Called the Alternate FAST (A-FAST), it replaces the current R-FAST. In essence it is a revised and updated version of previous tests and comes in two versions, A and B. Applicants who fail the A-FAST will be allowed to take the alternate version once, as a retake, but not sooner than 6 months from taking the initial test. Applicants passing the A-FAST the first time are not allowed any retakes to obtain a higher score.

Army inservice aviation warrant officer candidate accessions are increasing. In the past, "high school to flight school" (civilian) applicants were accessed at a rate of about 75 percent, whereas inservice applicants were accessed at about 25 percent. The accession mixture will now be 50 percent/50 percent in order to access equally from both groups.

U.S. Army Class A Aviation Flight Mishaps

	Number	Flying Hours	Rate	Army Fatalities	Total Cost (in millions)
FY 87 (through 31 January)	11	511,893	2.15	13	$32.4
FY 88 (through 31 January)	6	511,893*	1.17	0	$10.6

*estimated

AH-64

A TOTAL SYSTEM FOR BATTLE

This seventh article in the series on the AH-64A Apache aircraft addresses the electrical, digital automatic stabilization equipment and utility systems. The information contained here is for familiarization only and must not be used to operate or maintain the aircraft.

Mr. Ron Brunelle

Mr. Philip A. Mooney

Electrical Power Generation and Distribution System

THIS SYSTEM (figure 1) supplies all the alternating current (ac) and direct current (dc) power required to operate the systems on the AH-64 Apache. It provides power to the bus of a failed generator or transformer/rectifier (T/R) unit via automatic switching, and it automatically connects the battery to the dc emergency bus if total electrical failure occurs.

The two self-excited ac generators are mounted to the forward left and right sides of the main transmission. They are driven through the accessory gearbox (AGB) by either the auxiliary power unit (APU) or the main transmission, and their outputs are controlled by generator control units (GCUs). Each generator powers one ac bus. If a generator failure occurs, then the operational generator can supply all power required by both ac buses. The GCUs, located in the electrical power distribution center, monitor and control generator operations and isolate a faulty generator. Once a GCU isolates a faulty generator, it will latch that generator into the *off* position (anticycling) and illuminate the respective *generator* failure light.

The pilot controls the generators by using the generator control switches located on the electrical power control panel. Selecting the *test* position will test generator output without putting the generator under a load condition.

The squat switch, located on the left forward avionics bay (FAB) just

AH-64 A TOTAL SYSTEM FOR BATTLE

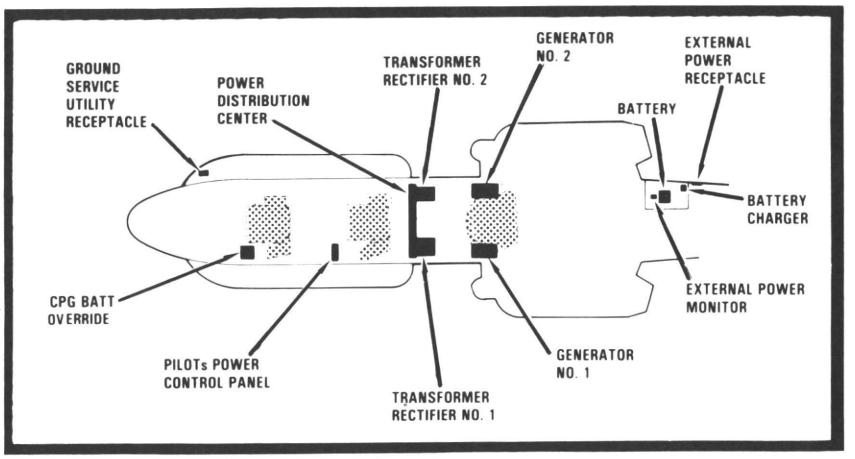


FIGURE 1: Electrical component locations.

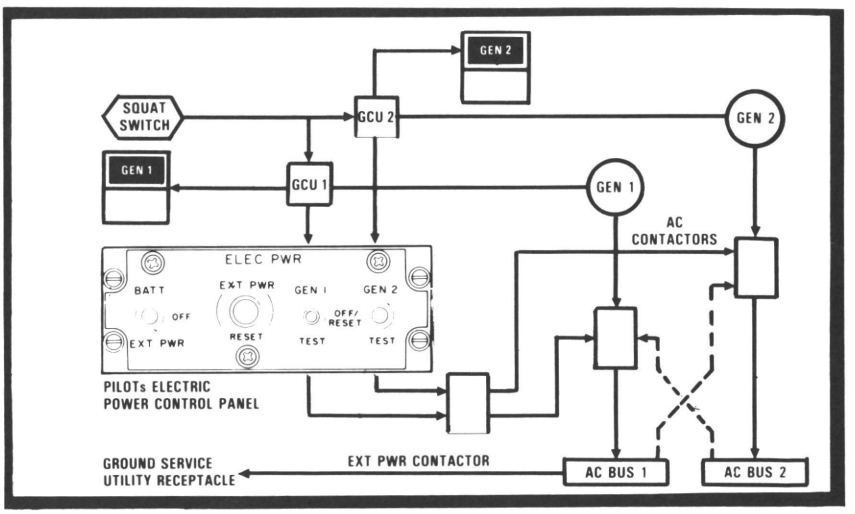


FIGURE 2: Alternating current section operation.

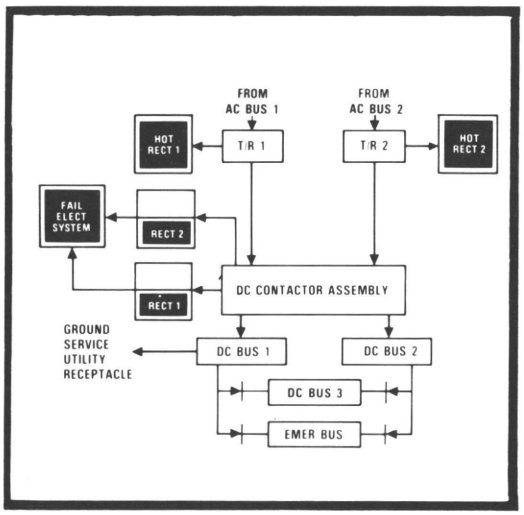


FIGURE 3: Direct current section operation.

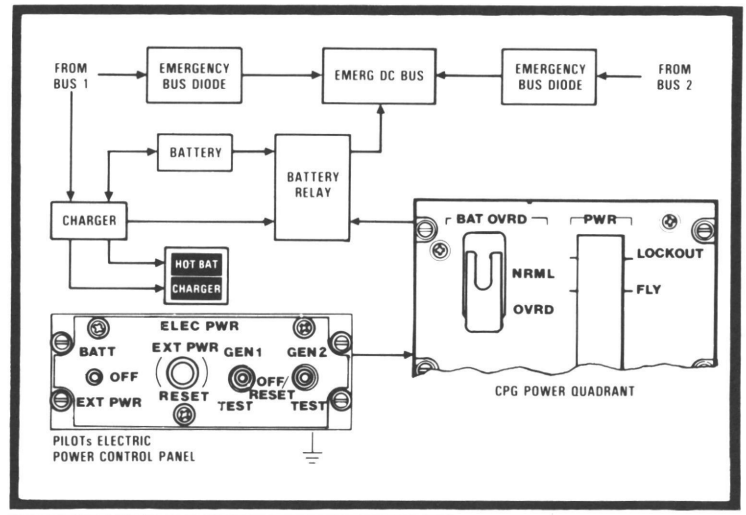


FIGURE 4: Direct current emergency section operation.

forward of the left main landing gear trailing arm pivot point, indicates to the aircraft systems when the aircraft is on the ground. This information is then used to enable/disable underfrequency protection. The squat switch is activated when the aircraft weight is on the main landing gear.

Aircraft electrical power is available externally for maintenance tasks by activating the ground service utility receptacle, which is located on the forward underside of the right forward avionics bay.

There is one caution light for each generator. These lights are illuminated by the respective GCU when a generator has failed or has been turned off.

In the ac section operation (figure 2, page 25), generators are controlled by individual, three-position toggle switches. The GEN position enables the GCU to control generator output, while the OFF position disables/resets the GCU. If a generator is isolated due to a fault condition, the switch is then moved from the GEN to OFF/RESET and back to GEN position. This commands the GCU to retest the generator output and, if good, to put the generator online. The momentary TEST position allows the pilot to check generator output without connecting the generator to the bus. If the GEN caution light goes out while the switch is held in the TEST position, the generator and GCU are functional under a no-load condition. If the generator will not go online, there is a fault in the electrical power distribution system.

The ac contactors route the generator output to the buses. If a generator fails, the GCU will command the contactor to apply power from the operational generator to the bus of the failed generator. The contactors prevent the generators from being paralleled, and, by disabling the external power contactor, they also prevent paralleling the external power source with the aircraft generators. GCU control of the ac system is automatic once the generator switch is turned on.

The generator control unit will illuminate the GEN caution light on the pilot's caution/warning (C/W) panel when it senses a generator failure or when the respective generator has been turned OFF.

The two T/Rs located in the main transmission area receive 3-phase ac power from the ac buses and convert it to 28 volts direct current (Vdc), with

a nominal rating of 250 amps for each T/R. Each unit normally supplies one dc bus, and jointly powers a third bus and the dc emergency bus; however, if one T/R fails, one unit can power all dc buses and the dc emergency bus. The T/R outputs are monitored by the dc contactor assembly, which also controls the T/R unit to the dc bus connections.

Individual dc section component failures are displayed only to the pilot as RECT 1, RECT 2, HOT RECT 1 and HOT RECT 2 indications on the C/W panel. If both T/R units fail, FAIL ELECT SYSTEM will be displayed on the copilot gunner's (CPG's) C/W panel.

The operation of the dc section (figure 3) is automatic and the pilot has no direct control. Direct current output from the T/R will energize the dc contactor by routing dc power to the respective dc bus, and dc emergency bus.

If a T/R fails, the dc contactor will isolate the inoperative T/R unit and route power from the operating T/R to the dc bus of the failed T/R. The contactor also will illuminate the appropriate RECT caution light on the pilot's C/W panel.

If a dual T/R failure occurs, the dc contactor will isolate both T/R units from the dc buses. The pilot's C/W panel will illuminate the FAIL ELECT SYSTEM indicator on the CPG's C/W panel when both RECT segments are on.

When the internal temperature of a T/R reaches 190 degrees F, it will illuminate a HOT RECT indicator on the pilot's C/W panel. This is usually an indication of an internal fan failure, but the T/R unit will continue to operate.

The heart of the dc emergency section components is a 24 Vdc, 13 amp-hour, 19 cell nickel cadmium battery that is located in the aft avionics bay. The battery supplies electrical power to enable APU starting (without external power), and for dc emergency operation (figure 4) if total electrical failure occurs.

During normal operations, the battery charger, located in the aft avionics bay, controls charging of the battery, battery to dc emergency bus connections and battery and charger failure indications.

The battery relay, located in the aft avionics bay, connects the battery to the dc emergency bus on command from the battery charger, when the EXT PWR/BATT switch is in the BATT position.

The emergency bus diodes, located in the electric power distribution center, prevent feedback of dc power from the dc emergency bus to the dc buses.

The EXT PWR/BATT switch, located on the pilot's electric power control panel, enables the battery charger to connect the battery to the dc emergency bus when it is in the BATT position.

In an emergency situation, the CPG can disconnect the battery from the dc emergency bus by using the guarded battery override (BAT OVRD) switch located on the power lever quadrant.

A hot battery (HOT BAT) light illuminates on the pilot's C/W panel when battery internal temperature exceeds 57 degrees ± 3 degrees C, when there is a defective cell or when a battery internal heater fails.

When the charger is not charging the battery during a programed charging cycle, the CHARGER light on the pilot's C/W panel will be illuminated.

The CPG's BAT OVRD switch enables the pilot's EXT PWR/BATT switch in the NRML position and disables the pilot's EXT PWR/BATT switch in the OVRD position. If connected, the OVRD position disconnects the battery from the dc emergency bus.

In the BATT position, the EXT PWR/BATT switch enables the charger to connect the battery to the dc emergency bus if loss of input power to the charger occurs.

The battery charger monitors dc bus No. 1 and, when no voltage is present, it energizes the battery relay to connect the battery to the dc emergency bus.

When the charger fails to charge the battery during a programed charging cycle, the CHARGER light will be illuminated on the pilot's C/W panel.

Battery charging is automatic when EXT PWR/BATT switch is in either the BATT or OFF position. In the EXT PWR position, charging is inhibited. It is important to ensure this switch is in the BATT position during normal operations so that the battery is charged for starting at remote locations.

External 115 volts alternating current (Vac) power can be applied to the aircraft for systems checkout and starting. It is applied through the external power receptacle, located on the right side of the aircraft just aft the avionics bay access door.

The power monitor, located on the right-hand side near the external power receptacle, monitors the input external power for voltage, frequency and phase sequence. It also controls the external power contactor.

External power is applied to the ac buses by the external power contactor, which is located in the electric power distribution center. The EXT PWR/BATT switch allows the pilot to enable the power monitor to energize the external power contactor. If either generator is online, the external power contactor is disabled.

The external power reset switch, a monetary pushbutton switch located on the pilot's electric power panel, enables the pilot to reset the power monitor after the external power contactor has been deenergized due to some input power fault. Once reset, the power monitor attempts to reapply external power to the helicopter's electrical system.

The only caution light directly connected to the external power section is the EXT PWR caution light. This light will illuminate anytime the external power access door is open.

Digital Automatic Stabilization Equipment System

The digital automatic stabilization equipment (DASE) is provided to assist crewmembers in the control of the aircraft. This system includes:

- the stability augmentation system (SAS),
- the command augmentation system (CAS),
- the attitude hold, turn coordination, hover augmentation system (HAS),
- and the heading hold, and backup control system (BUCS).

Controls and indicators associated with the DASE are the automatic stabilization equipment (ASE) control panel, cyclic sticks, crewstation C/W panels, squat relay switch and circuit breakers.

The DASE consists of the DASE computer, the ASE panel, two transformers, eight crewstation linear variable differential transducers, four SAS transducers, eight shear pin actuated decouplers, eight BUCS transducers, and tracer wires.

The DASE interfaces with the visual display unit, the multiplex bus and the air data sensor system (ADSS) for ground speed, side-slip and validity information. It also interfaces with the heading and attitude reference set (HARS) for pitch, roll and yaw rates, and for longitudinal velocity, lateral velocity and validity information.

The ASE panel (figure 5) contains the switches necessary for controlling/testing of the numerous DASE functions, and is located on the pilot's left-hand console.

The PITCH, ROLL, YAW, ATTD/HOVER HOLD engagement switches are two-position toggle switches spring loaded to the OFF position. With electrical power from the 28 Vdc bus No. 2 applied to the DASE computer, and a valid built-in tester, movement of any of these switches to the defined position will magnetically latch the switch ON and engage that function.

The BUCS test switch is a three-position toggle switch spring loaded to a center/off position. Holding the switch in the pilot or CPG position will test the respective BUCS components and operation.

There is one ASE release button located on each crewmember's cyclic stick (figure 6). Either button, when depressed, will temporarily interrupt power to the magnetic latching switches in the ASE panel, causing all the switches to drop to the OFF position.

The buttons are a means of emergency disengagement of the DASE functions, excluding BUCS.

The trim feel release switch, previously described with flight controls, permits attitude/heading synchronization when the DASE function is operable and either attitude retention or hover augmentation is in use.

The BUCS select switch is a guarded trigger switch located on the underside of the CPG's collective switch box. It provides the CPG with a means of taking control of the aircraft after control severance between crewstations or failure of a pilot's linear variable differential transformer/transducer occurs.

Three caution/warning segment lights advise the pilot of DASE operation.

- An amber BUC ON segment indicates one or more of the BUCS circuits are activated.

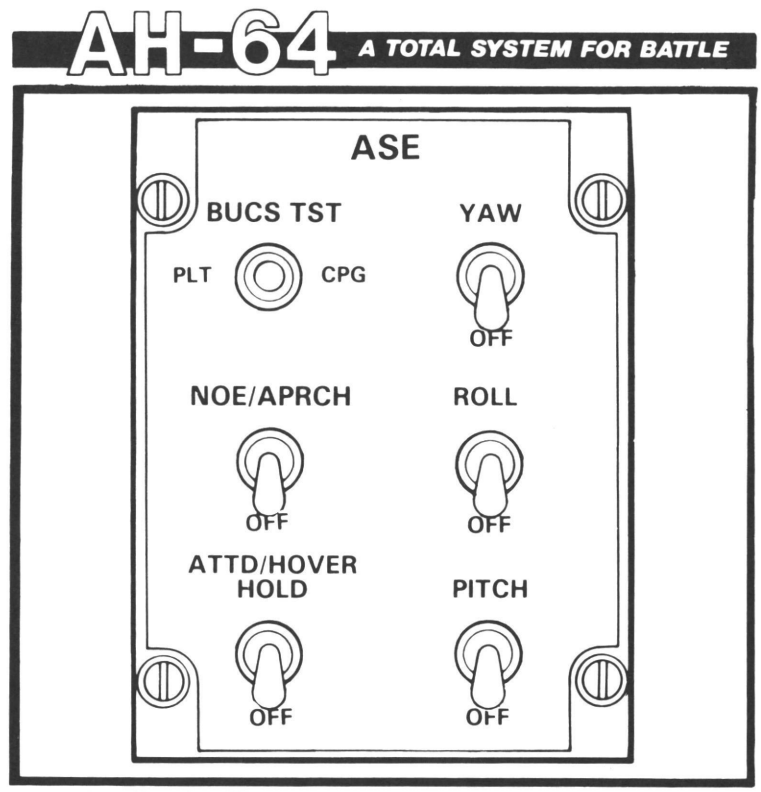


FIGURE 5: Automatic stabilization equipment panel.

- A red BUC FAIL segment indicates that one or more of the BUCS circuits have failed.
- An amber SAS segment indicates that one or more DASE components or functions have either failed or have been turned off.

The CPG's C/W panels contain the BUC ON, BUC FAIL and SAS segment lights.

The squat switch disables yaw CAS functions when the aircraft is on the ground; however, this system will still be present in the pitch and roll axis. If selected, the SAS functions will be present in all axes.

Three circuit breakers (CBs) on the pilot's center CB panel control the power for the operation of the DASE and the BUCS.

The ac circuit supplies the required power to the two transformers for linear variable differential transformer/transducer operations.

Direct current powers the DASE computer and the BUCS circuits.

The SAS provides rate damping in the pitch, roll and yaw axes. This is accomplished by an electrohydraulic servo valve that is an integral part of each hydraulic actuator.

The SAS signal is applied to the electrohydraulic servo value that drives the SAS actuator. The SAS command is also applied to a software model of the actuator (by the DASE computer), and is compared to the SAS actuator position feedback monitored by the SAS linear variable differential transformer/transducer. This feature provides the means to verify the actuator response to SAS command.

When the actuator position and the modeled signal differ by 35 percent or greater, the computer will shut down the axis, disengage the SAS actuator solenoid and the respective ASE panel engage switch, and trigger the SAS C/W light to advise the pilot of an axis disengagement.

Information used to produce SAS actuator signals comes from the aircraft angular rates that are determined by the HARS.

DASE computer monitors the control position established by the pilot/CPG and, based on the HARS reference, will adjust the actuator position to maintain the aircraft at the desired position.

The command augmentation system is used to prevent the aircraft from being sluggish in response to the control inputs required for maneuvering, while not affecting the stability obtained from the SAS.

The gain and shaping of the CAS increases the initial rate response in

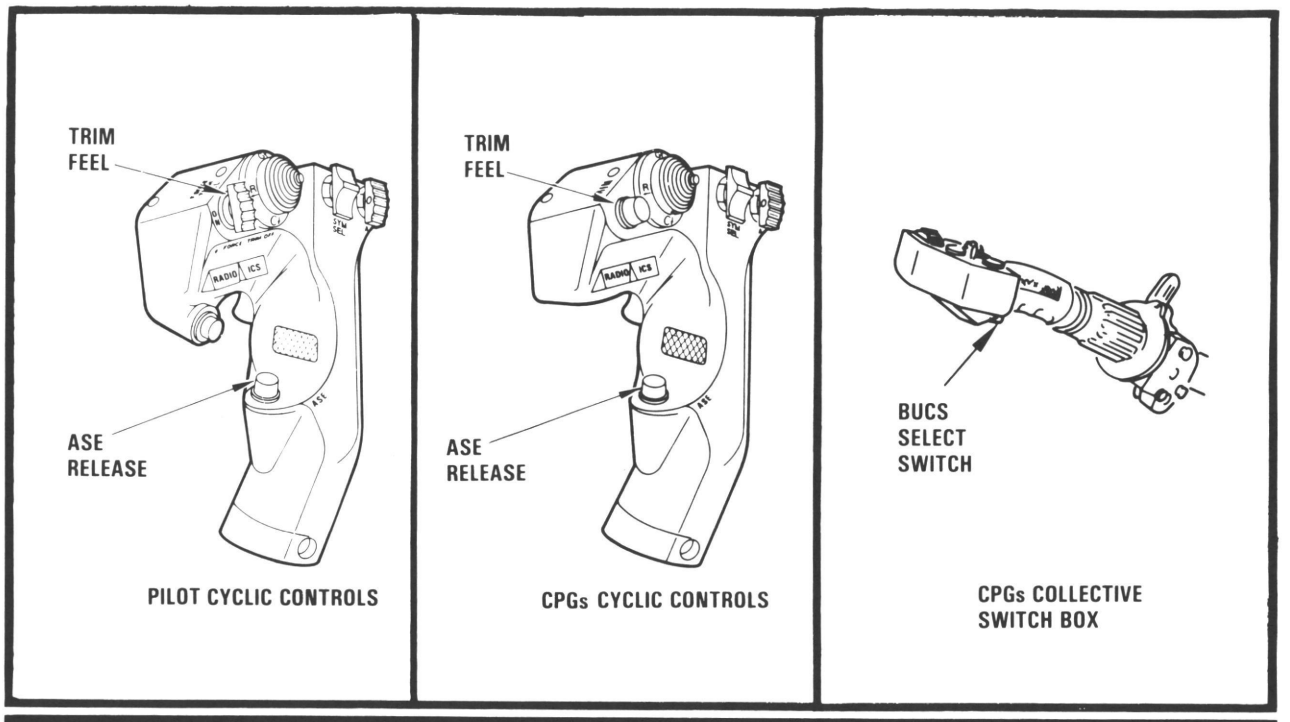


FIGURE 6: Cyclic and collective controls.

The AH-64A Apache, manufactured by McDonnell Douglas Helicopter Company.

the pitch, roll and yaw axes to provide the desired control harmony and quickness of response.

Gain programing of the CAS with airspeed is used when less aircraft response per cyclic motion is desired at higher airspeeds.

The CAS signals are washed out with time, based on control information. Information used to produce command augmentation system signals comes from control position transducers (linear variable differential transformer/transducers).

Yaw CAS functions are disabled by the squat switch while the aircraft is on the ground. More than 60 knots indicated airspeed, with the yaw axis engaged, turn coordination is enabled. When enabled, yaw CAS is inhibited.

A limited authority attitude hold mode is provided in the pitch and roll axis of flight. This will provide the pilot with limited hands-off flying capabilities in cruise or holding pattern flight, allowing more time to concentrate on other duties.

Attitude hold is functional when the ATTD/HOVER HOLD, PITCH and ROLL switches on the ASE panel are engaged, force trim is on, and the longitudinal airspeed of the aircraft is 60 knots true airspeed (TAS) or greater.

The loss of any of the above functional requirements will cause attitude hold to disengage.

A limited authority turn coordination function is provided through the yaw stability augmentation equipment using sideslip information from the ADSS. This function will be provided automatically above an airspeed of 60 knots TAS whenever the yaw SAS is engaged.

Turn coordination is inhibited when the ADSS or HARS failure occurs. Yaw CAS is inhibited during turn coordination.

The hover augmentation system is designed to reduce pilot workload during hover and low speed flight by assisting the pilot in maintaining a desired position.

The hover augmentation function requires that the ATTD/HOVER HOLD switch and PITCH, YAW or ROLL switches on the ASE panel be engaged. This is provided for flights below 50 knots TAS and 15 knots ground speed, and references lateral and longitudinal linear acceleration signals received from the HARS.

Heading hold is provided to reduce pilot workload in maintaining a desired heading below 50 knots TAS. It will be switched in automatically with the HAS engagement.

For heading hold engagement, the yaw SAS must be ON. The command augmentation function of the yaw mode will go into synchronization when the cyclic force trim release switch is pressed or pedals are displaced more than 0.25 inches.

The heading hold mode uses heading reference from the HARS, and no more than 50 percent of the yaw SAS actuator authority.

The BUCS functions within the DASE computer to provide for nonredundant, emergency, fly by wire, backup control operation of the lateral, longitudinal, collective and directional servos if the primary mechanical control path is jammed or severed.

Direct electrical control of the flight control system electrohydraulic actuators is accomplished by using the control position linear variable differential transformer/transducers for generating actuator position command through the DASE computer and SAS servo.

Utility Systems

The exterior lighting system consists of one searchlight, two anticollision lights, three navigation lights and four formation lights.

The controls for all exterior lighting are found in the pilot's station, with the exception of the CPG's searchlight control switches.

The searchlight control switch (figure 7) is mounted on the underside of the right FAB and is controlled by four switches: two on the pilot's and two on the CPG's collective stick switch boxes.

All positions are momentary on the searchlight control switch. Each position uses pilot 28 Vdc EMERG BUS power to drive the searchlight in the desired direction. When released, the searchlight will remain in its last commanded position.

The pilots' interior/external anticollision lights, one on the outboard tip of each wing, are day/night high intensity omnidirectional strobe lights.

Navigation lights are located on each wing tip and on the aft side of the vertical stabilizer top fairing. The lights are controlled by the navigation switch on the EXT LTS side of the pilots' interior/external lights panel.

Formation lights are located on the top outboard end of each wing, on top of the aft fairing forward of the forward tail rotor drive shaft cover, and on top of the vertical stabilizer fairing. The lights are controlled by the FORM rheostat on the pilot's external lights panel.

There is one utility light installed in each crewstation. These lights are selectable red or white, and seven blue-green emergency floodlights that are installed in each crewstation. Their power is from the EMERG DC BUS.

The CPG's interior lights control panel is similar to and operates the same as the pilot's.

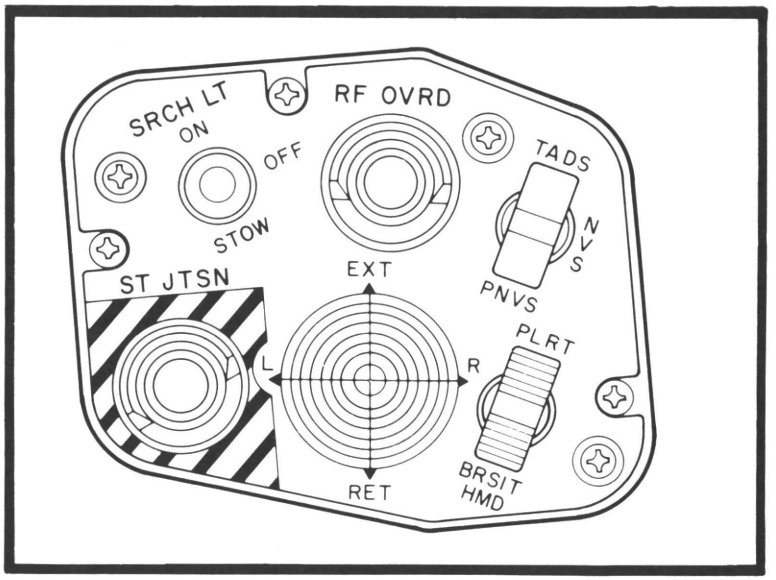


FIGURE 7: Searchlight control.

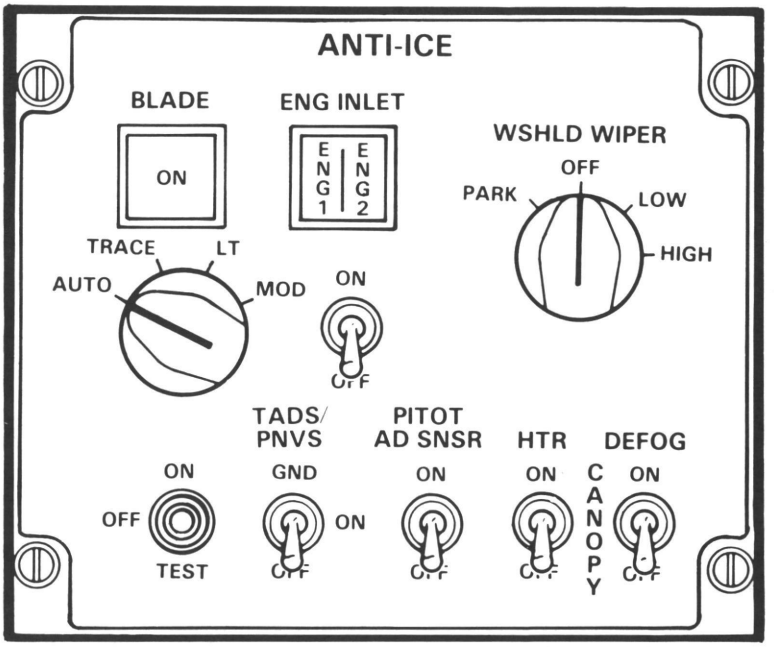


FIGURE 8: Pilot's anti-ice control panel.

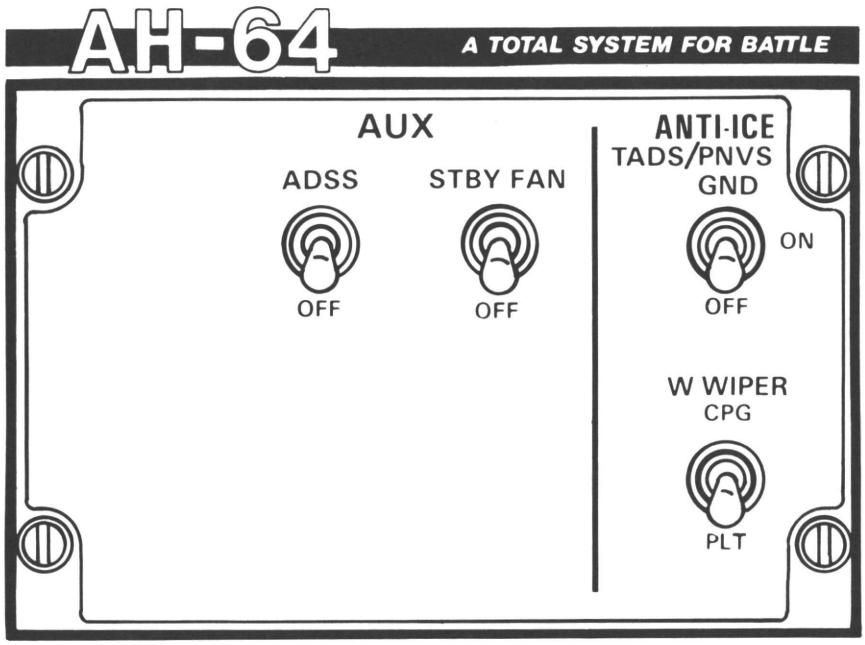


FIGURE 9: Copilot gunner's anti-ice control panel.

The pilot's anti-ice control panel (figure 8) is located on the left console, toward the rear. Except for the CPG's target acquisition and designation sight (TADS) control and windshield wiper, all anti-ice/defog functions are controlled by the pilot.

Three light segments (ENG INLET, ENG 1/ENG 2 and BLADE ON) show the proper operation of these items when they are ON.

The windshield wiper switch controls the operation of both wipers from the pilot's station, to include the PARK position.

The CANOPY ANTI-ICE, DEFOG, TADS/pilot night vision sensor (PNVS), PILOT AD SENSOR switches are located at the bottom of the panel.

The CPG's anti-ice panel (figure 9) is located forward of the CPG power quadrant on the left console. The CPG can manually select low speed

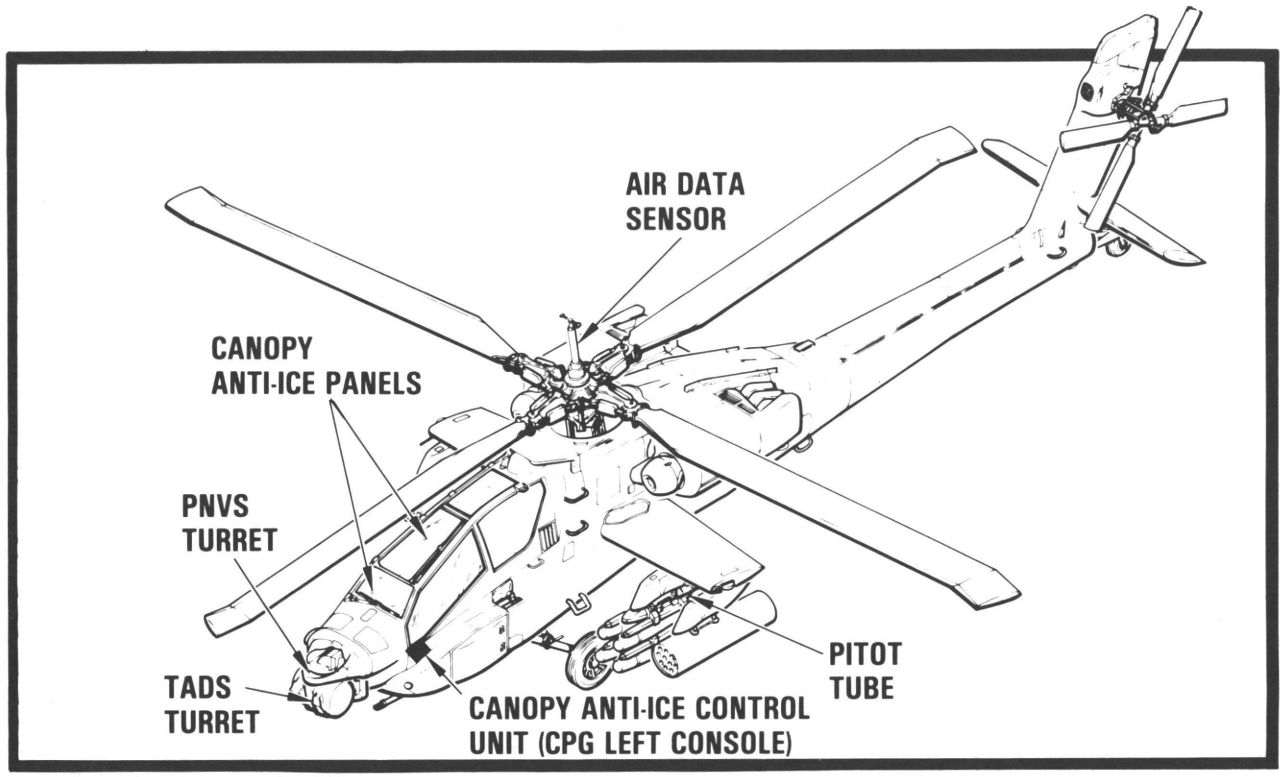


FIGURE 10: Miscellaneous anti-ice systems locations.

for his windshield wiper, but it does not have FAST or PARK capability.

The CPG also has a control for operation of the TADS/PNVS anti-ice capability.

The engine anti-ice system, start bleed valve and tubing are located on the left side of each engine.

The engine anti-ice component provides heated air (fifth stage bleed air) to the swirl vanes, nose splitter and the inlet guide vanes of each engine, to prevent the formation of ice.

The engine anti-ice system includes the engine, the engine inlet fairings, and the nose gearbox fairing anti-ice provisions.

The engine inlet fairing anti-ice system provides heated air to the inlet air plenum to prevent ice formation.

The purpose of the nose gearbox fairing heater is to electrically heat the fairings to prevent the formation of ice.

The canopy, the PNVS turret, the TADS turret, and air data sensor and the pitot tubes contain anti-ice provisions (figure 10).

The purpose of the blade de-ice heater is to prevent the formation of ice on main and tail rotor blades.

Main and tail rotor blades have de-ice heater blankets built into each blade. Each main rotor blade has two heater blankets of five elements. Each tail rotor blade has one heater blanket of one element.

The canopy defog system (figure 11) is installed to prevent ice formation or fogging on the four acrylic side panels.

Two air mixers are installed in each crewstation, one on each side. Hot pressurized air system air is mixed with crewstation air to cause defogging. Defogged air from the PAS system is routed to the crewstations through aluminum tubing.

When the DEFOG switch is OFF, 28 Vdc from the pilot's BUS 2 through the ANTI-ICE CONT circuit breaker is routed to the switch but not to the defog shutoff valve. When the DEFOG switch is ON, 28 Vdc is routed to the defog shutoff valve, causing the value to open.

When the valve is open, pressurized air system air is routed through tubing to both the pilot's and CPG's crewstations. Heated pressurized air system air is mixed with crewstation air and directed onto the acrylic side panels. A low pressure area created inside the air mixers brings in crewstation air to be mixed with pressurized air system air.

The pilot's and CPG's windshield wipers (figure 12) are used to clear

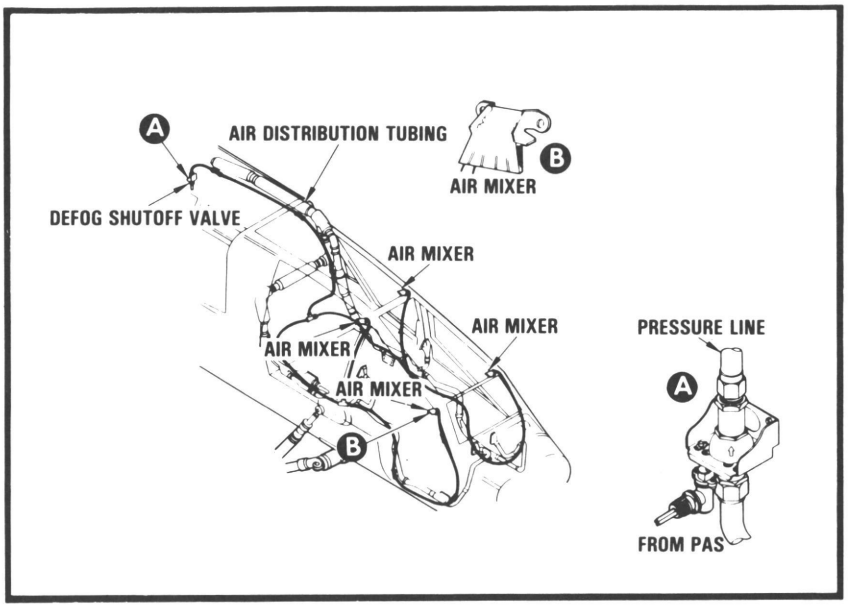


FIGURE 11: Canopy defog system.

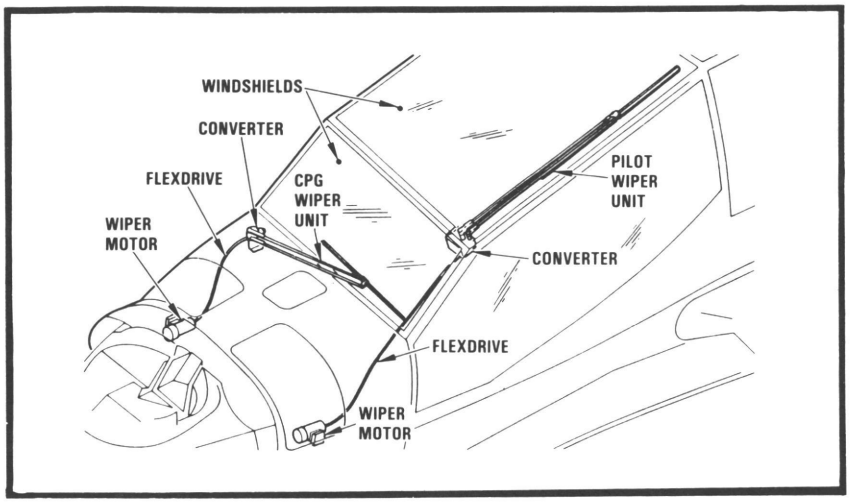


FIGURE 12: Windshield wiper system.

AH-64

A TOTAL SYSTEM FOR BATTLE

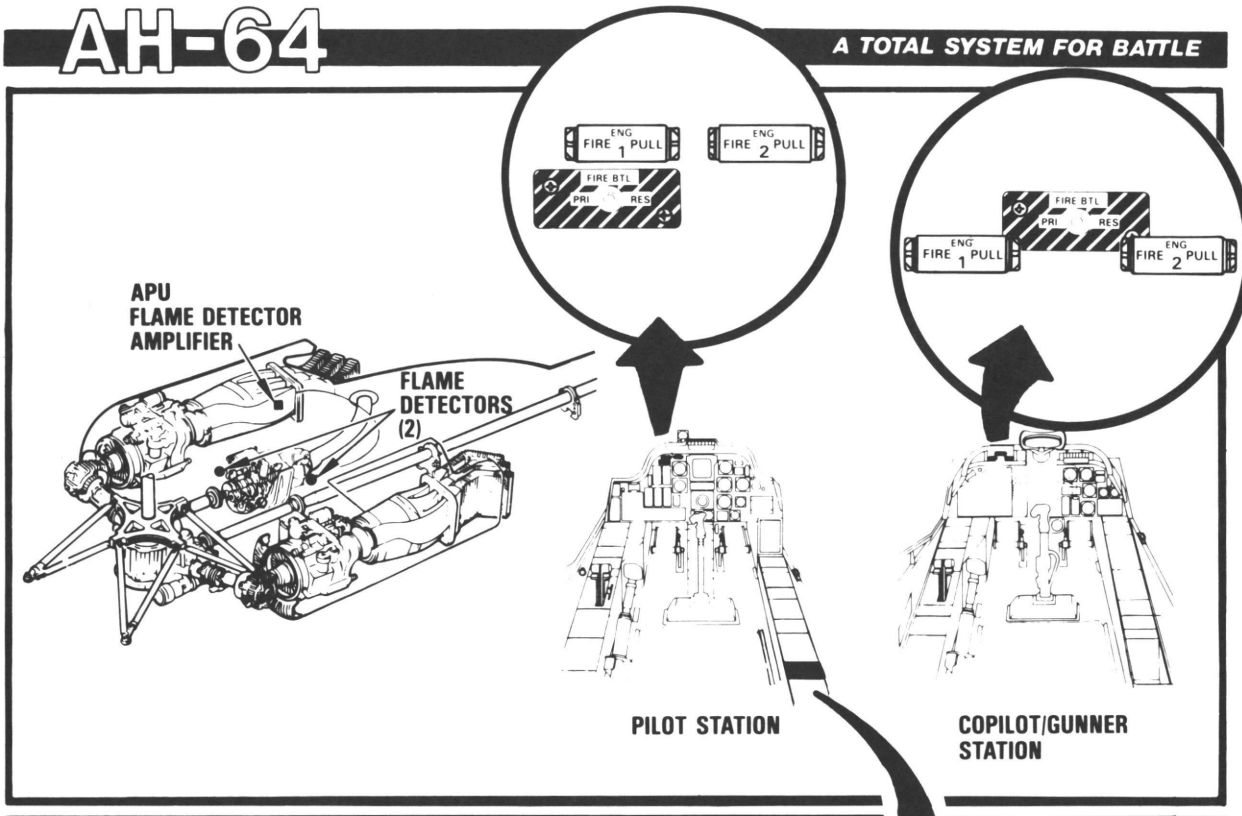


FIGURE 13: Fire detection system.

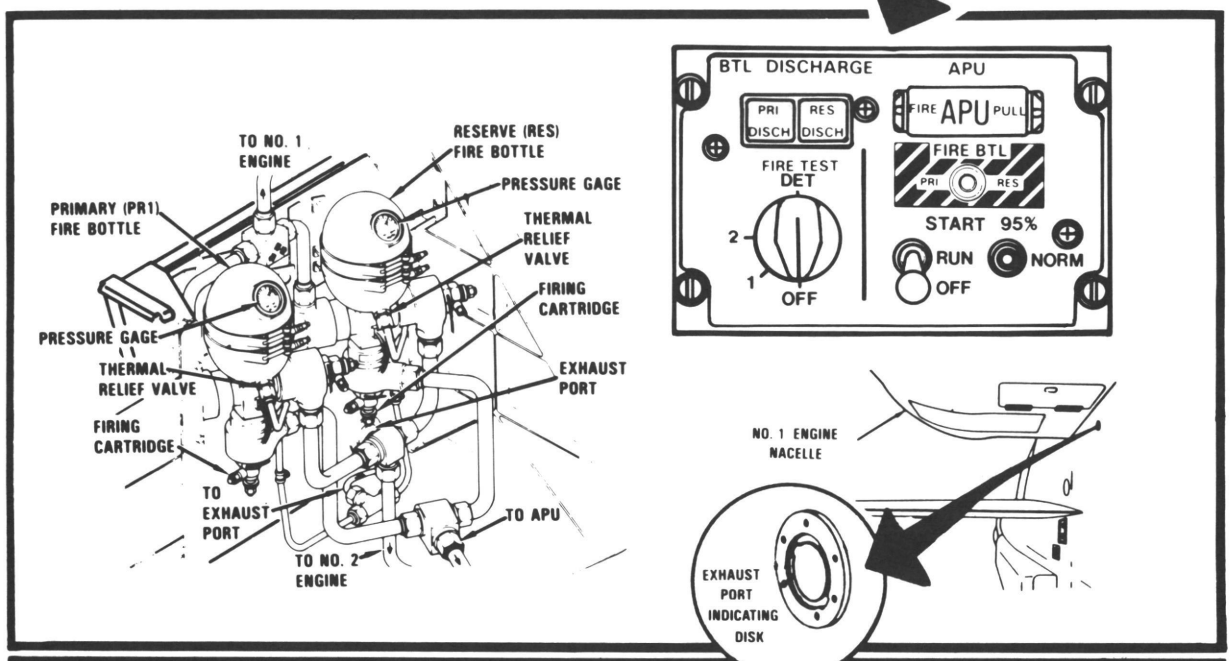


FIGURE 14: Fire extinguishing system.

moisture from the lower and middle canopy panels.

Each wiper assembly consists of a wiper motor, a flex drive, a converter, a wiper arm and blade assembly, and appropriate pilot and CPG control switches.

In the CPG station, the WSHLD WIPER switch is installed on the anti-ice panel and has only two positions—CPG and PILOT.

Under normal conditions, the CPG switch will be in the PILOT position, with all controls coming from the pilot. If desired, placing the switch to CPG will actuate the CPG's wiper to the low speed position. When the switch is returned to the PILOT position, the arm and blade will remain in the last commanded position, as the CPG does not have a PARK control.

The pilot's rotary control switch is located on the anti-ice panel labeled WSHLD WIPER. This switch has OFF, LOW, HIGH and PARK positions. When the CPG switch is in the PILOT position, the pilot's rotary switch also controls the CPG's wiper. When the CPG switch is on CPG, the pilot's rotary control switch will only control the pilot's wiper.

Electrical power to operate the windshield wipers is from the PLT DC BUS 1, supplying 28 Vdc through the WSHLD WIPER circuit breaker to wipers motors' wiring circuits.

When the wipers are turned on, the motors provide rotary motion through flex drives to the converters, where the rotary motion is changed through gearing to provide a sweep motion to the wipers' arms and blades.

The fire detection system (figure 13) is used to sense the presence of flames in ENG 1, ENG 2 or APU area, and alert the pilot and CPG. This system, however, is independent of the fire extinguishing system.

There are two flame detectors for each engine and the APU. Each engine compartment has one flame detector in the lower forward and in the upper aft positions. The detectors are optical sensing devices that generate an electrical signal when the proper frequency of light (infrared) is intercepted.

When a flame is detected, the electrical signal is amplified by one of three amplifiers. These amplifiers convert the signal to a usable voltage level and route that signal through the advisory dimmer control box to the FIRE PULL handle warning lights. Two amplifiers are mounted on the right side of the transmission deck access area and one on the left side. On the right side, the rear amplifier is for the APU. Each FIRE PULL handle has two lights. Both lights in each handle should illuminate. This is to ensure a fire alert is given even if one of the two bulbs burns out. Since the handles are in front of the pilot and CPG, there will not be a C/W panel segment illuminated.

The APU FIRE PULL handle has two lights in the event one bulb burns out. In addition, because of the handle's location behind the pilot's range of vision, a warning panel segment also will illuminate in both crewstations. Only the pilot has control of an APU fire.

The APU panel has a rotary switch that is used to test the fire detection system. Position 1 tests the upper detector circuits and position 2 tests the lower detector circuits.

The fire extinguishing system (figure 14) is installed to extinguish fires in ENG 1, ENG 2 or the APU area. The extinguishing system consists of two fire extinguisher bottles, six squibs, three check valves, tubing and necessary wiring.

The fire detection system detects a fire and alerts the crew. The extinguishing system is installed to extinguish the fire.

The fire extinguishing system must be actuated manually to extinguish a fire. Only the pilot has access to advisory lights showing which bottle has been discharged.

The fire bottles can be checked for serviceability on preflight on observing both fire bottles for proper pressurization, and that the thermal discharge disk (exhaust port indicating disk) is still in place on the airframe under the No. 1 engine.

When the FIRE PULL handle detector lights illuminate for ENG 1 or ENG 2, either the pilot or CPG can arm the system by pulling the illuminated handle. Pulling the handle will close the appropriate louver actuator shutoff valve, close the engine-to-transmission deck cooling louvers, close the fuel crossfeed and shutoff valve to the appropriate engine, shut down the ENCU and arm the FIRE BTL select switch. Moving this switch to PRI or RES will fire a squib into the selected bottle, routing extinguishing agent into the proper compartment.

A BTL DISCHARGE light will illuminate when either fire bottle is discharged. This is done by wiring a circuit through the squib.

The APU has a FIRE APU C/W panel segment that illuminates (when an APU fire is sensed) on the pilot's and CPG's C/W panels, and the FIRE PULL handle also illuminates. When the pilot pulls the FIRE PULL handle the APU fuel pump shuts off, the APU fuel valve closes and the APU FIRE BTL select switch is armed.

Selecting PRI or RES will fire the fire bottle squib to a direct extinguishing agent into the APU.

The canopy severance system (figure 15) is installed for use if a rollover occurs where rapid egress is necessary and the crewstation doors are jammed closed. There are three jettison handles installed in the system: pilot, CPG and groundcrew.

A shielded mild detonating cord and a flexible core detonating cord are used to interconnect all handles to the explosive cord that is installed around the periphery of each of the four acrylic side panels. Turning and pushing any one of the three handles will detonate the severance system.

When the quick-release safety pin is removed from the system, any handle can be rotated 90 degrees left or right and pushed in to detonate the severance system.

The safety pins normally are removed before flight. After flight, the handle can be re-safetied by checking to ensure that the word SAFE appears above and below the handle, before inserting the pin.

The emergency equipment in the AH-64 consists of a portable fire extinguisher in the right FAB and one standard aviation first aid kit in each crewstation.

The seventh article in the series has addressed capabilities and characteristics of the AH-64A Apache's subsystems of electrical, digital automatic stabilization equipment and utility systems. The next article will address the integrated helmet and display sight system and symbology.

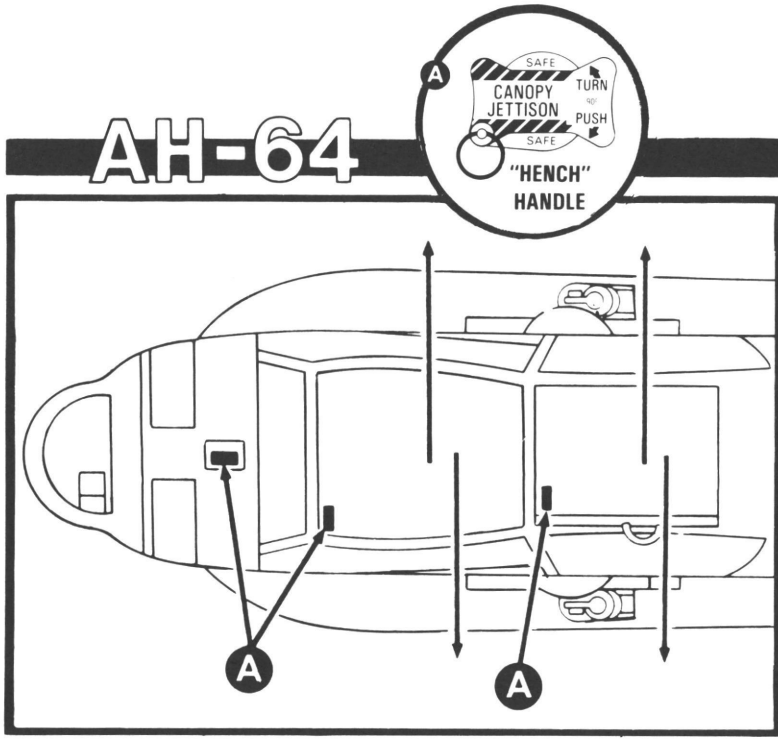


FIGURE 15: Canopy severance system.

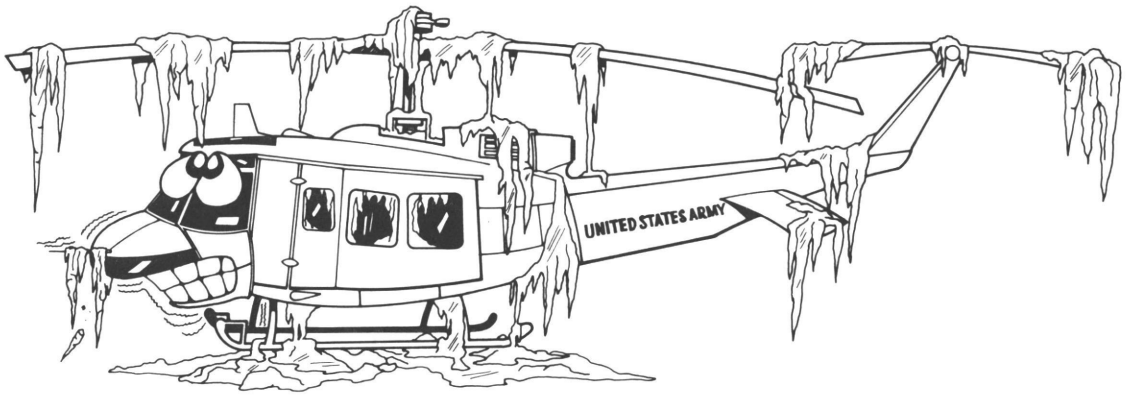
Mr. Ron Brunelle is responsible for the design, development and presentation of the Apache aircrew training courses as well as defining training device requirements, specification, modifications and implementation. He has more than 20 years of experience in aviation including background in both the flight simulators and classroom environment. He is retired from the U.S. Navy.

Mr. Philip A. Mooney has managed the marketing activities for the Apache and Defender helicopters since joining the McDonnell Douglas Helicopter Company in 1984. He has more than 21 years' aviation experience in both rotary and fixed wing aircraft. Mr. Mooney's assignments included tours as a commander, aircraft maintenance officer, instructor pilot and aviation research and development program manager. He is retired from the U.S. Army.

About the Authors

Aviation Operations—

Preparing to Win in the Cold



IS YOUR UNIT prepared to win in the cold? Have you looked at how extreme cold and large amounts of snow will affect your combat operations? The answer to these questions is probably directly related to your particular geographical location. To units in the southeastern United States, cold weather means having to remove ice from your windows a few days a year. In contrast, units in Alaska, Korea and Europe must regularly operate in extreme weather conditions and adjust their procedures accordingly.

Unfortunately, forces in these locations are not sufficient within themselves to defeat a large-scale force and therefore must be augmented by units from many locations. The key point here is that these additional units will not have time to develop standing operating procedures (SOPs) and practice techniques that they will need to save lives and defeat the enemy.

Captain Jerry A. Kidrick
Directorate of Evaluation and Standardization
U.S. Army Aviation Center
Fort Rucker, AL

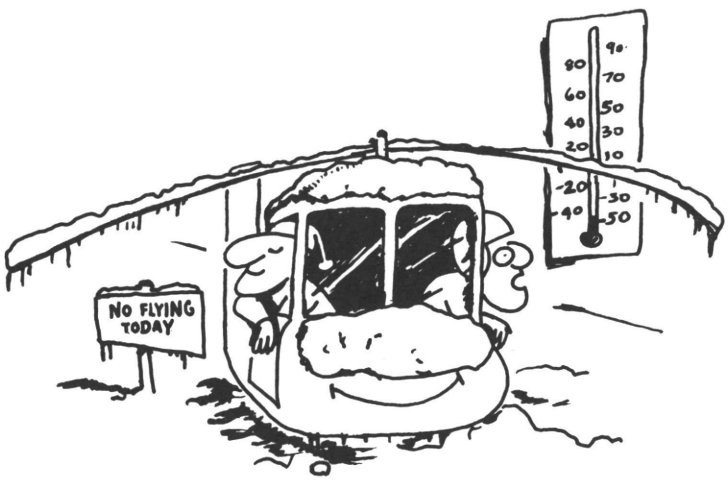
History has shown that combat operations do not cease during times of extreme cold and snow, but often increase. The attacker uses the conditions as a combat multiplier. Units that have prepared and trained for these conditions will be the most effective ones. All aspects of the unit's mission—ground support operations, preflight and actual flight techniques—are affected. Our reliance on sophisticated technology and ground support equipment demands that we take a hard look at how we operate.

Preparing to fight in the cold is best done by experience. Many of the ideas generated and techniques adopted by units in Alaska, for example, are the results of trial and error. Some of these lessons have been learned the hard way—with the loss of lives and limbs, or the destruction of equipment. One of the problems with these lessons learned is that they remain in local SOPs. Often units within the same command, when geographically separated, do not share techniques that they have adopted.

This article is intended to generate some unit self-analyses and highlight possible areas of consideration for any unit that must fight in the cold. My tour in Alaska gave me a feel for the extensive modifications to published procedures that a unit must make in order to operate effectively and safely in the cold. Dealing with adverse weather becomes routine for these units. Their experience should benefit any unit that may operate in

cold climates. Consideration of these items now, and development of an SOP to deal with them, will prove invaluable when deployed to fight in the cold.

Field Manual 1-202, "Environmental Flight," is a good start as a resource for learning to deal with extreme conditions. While not repeating doctrine published in this manual, I will discuss some general and specific procedures and safety considerations. My intent here, again, is to stimulate questions in your unit. How well are we prepared to fight in the cold? What can we do now to better prepare ourselves?



Air Operations

Training. While largely oriented to unit mission and command emphasis, cold weather environment adds another dimension to all major training areas. Some areas that require special attention in these conditions include:

- *Pilot in command (PIC)* selection criteria. This includes closely monitoring actual flight experience in cold and snow. There is no more demanding environment for a new PIC.
- *Crew coordination and selection* are critical. Blowing snow conditions place a heavy load on all crewmembers. The pilot and copilot should complement each other experience wise. A new PIC should be placed with a copilot experienced in snow conditions. Experienced crewchiefs become invaluable during "white-out" landings.
- *Multiaircraft operations* require constant training. Some of the most critical conditions occur during these operations. Experience in this area is invaluable and requires knowledgeable instructors and standardized techniques.
- *Learning how to read arctic conditions* is also a critical skill. Recognizing cloud types, ground snow conditions, icing conditions and indicators of extreme wind or turbulence is a must.
- *Navigation in these conditions is made difficult by the reduction of visual cues.* Use a combination of radio navigation, dead reckoning and pilotage.
- *Night operations both aided and unaided are the most critical conducted in blowing snow conditions.* The loss of depth perception, visual cues and lack of knowledge of the touchdown area combine to create a situation where the pilot does not feel completely in control. *Unaided flight* has been improved by the use of a yellow lens cover over the landing light. This lens cover helps to reduce the reflection of light off of snow crystals back into the pilot's eyes. Night landings are also aided by following the cardinal rule of any snow landing, *use a reference point. Aided night flight* has only been a reality in Alaska since 1983. Early night vision goggles (NVG) in full face form made an already reduced visibility situation worse. The "cut-away" version of the PNVS-5 NVG was a vast improvement, but still drew a lot of skepticism from flight crews. Time and experience help to overcome aircrew fears about their use in blowing snow. With minor modifications, night techniques already in use applied here. The key point is that if your unit is night vision system dependent, as a minimum, one of your training classes should address possible problems of operating in snow and cold weather environments.

Tactical. Air operations in snow do not differ greatly from normal procedures. Some consideration, however, must be given to the environmental differences.

- *Tactical planning* must consider increased aircraft preparation time and the stress factor of flight in unfamiliar and demanding conditions. Mission sequence planning will be altered by the spacing required between landing aircraft in assault operations.
- *Terrain flight masking* will be made more difficult by the signature created by the rotor system over loose snow. Reconnaissance and attack aircraft will be forced to move more often from observation and holding positions, if they can pause at all.
- *Forward arming and refueling point (FARP) operations* can be paralyzed by cold weather. Equipment not prepared for the conditions will not hold up. Units must establish warming areas for personnel and equipment. Fuel contamination by water becomes an increasing problem in this environment. Unit SOPs should address additional monitoring of this resource.

Ground Operations

The preflight phase requires a few simple rules.

- Instant frost bite can result from fuel contacting your skin. Protective equipment is essential for all personnel. The buddy system must be used to monitor the effects of extreme conditions.
- Fuel samples are not taken if the aircraft has been "cold soaked" (several hours outside at 0 degrees centigrade/32 degrees Fahrenheit or below).
- Ensure that skis or skids are not frozen to the ground. Slight antitorque pedal pressure and counterpressure can be used after runup to break free and prevent possible *dynamic rollover.*
- Clear *all* ice from the blades before starting.
- Oil levels will be low before starting so, unless extremely low, check after shutdown.
- During field conditions when a warm shelter is not readily available, a "running" preflight and "daily" are used. To reduce exposure to extreme cold, attention is given to one major area per day while the other areas are given a quick check. Crew continuity and self-discipline are most important in using this method.

Before Starting

- Handle all controls and switches gently.
- Do not change radio frequencies without allowing the radios to warm up.
- Place your flight helmet on your knee to warm up very cold and stiff ear cups. Skull caps are also effective.

After Starting

- The engine oil pressure may go to maximum; thus, allow it to drop before advancing past engine idle.
- Allow the transmission oil temperature to rise to at least 15 degrees C before operation (UH-1 Huey).
- Ensure adequate heater and defrost operation at this time. These can both be mission limiting items of equipment in extreme conditions. Your SOP should set minimum temperature limits at which they must be operational.
- Slowly advance the throttle to avoid spinning on the ice, and ensure that all ground personnel are clear of the aircraft turning radius.

Engine Shutdown

- In UH-1H aircraft with nongreased blade grips, seal leakage is reduced by running the engine at 6,000 revolutions per minute for 1 minute prior to shutdown. (Note: Slow throttle operation prevents spinning.)
- Remove batteries and fire extinguishers at temperatures below – 10 degrees C and store in a warm place. (Not personnel tents.)
- Make extensive use of aircraft covers. Windshield, rotor system and engine covers can save time and prevent ice accumulation in critical areas.
- *Always* refuel the aircraft prior to moving it inside to avoid condensation.

Cold weather flying conditions will be encountered in many parts of the world. Extremes will vary by latitude and season. What is certain, however, is that we will be forced to operate in these conditions. Special skills and techniques must be mastered by units that may fight under these conditions.

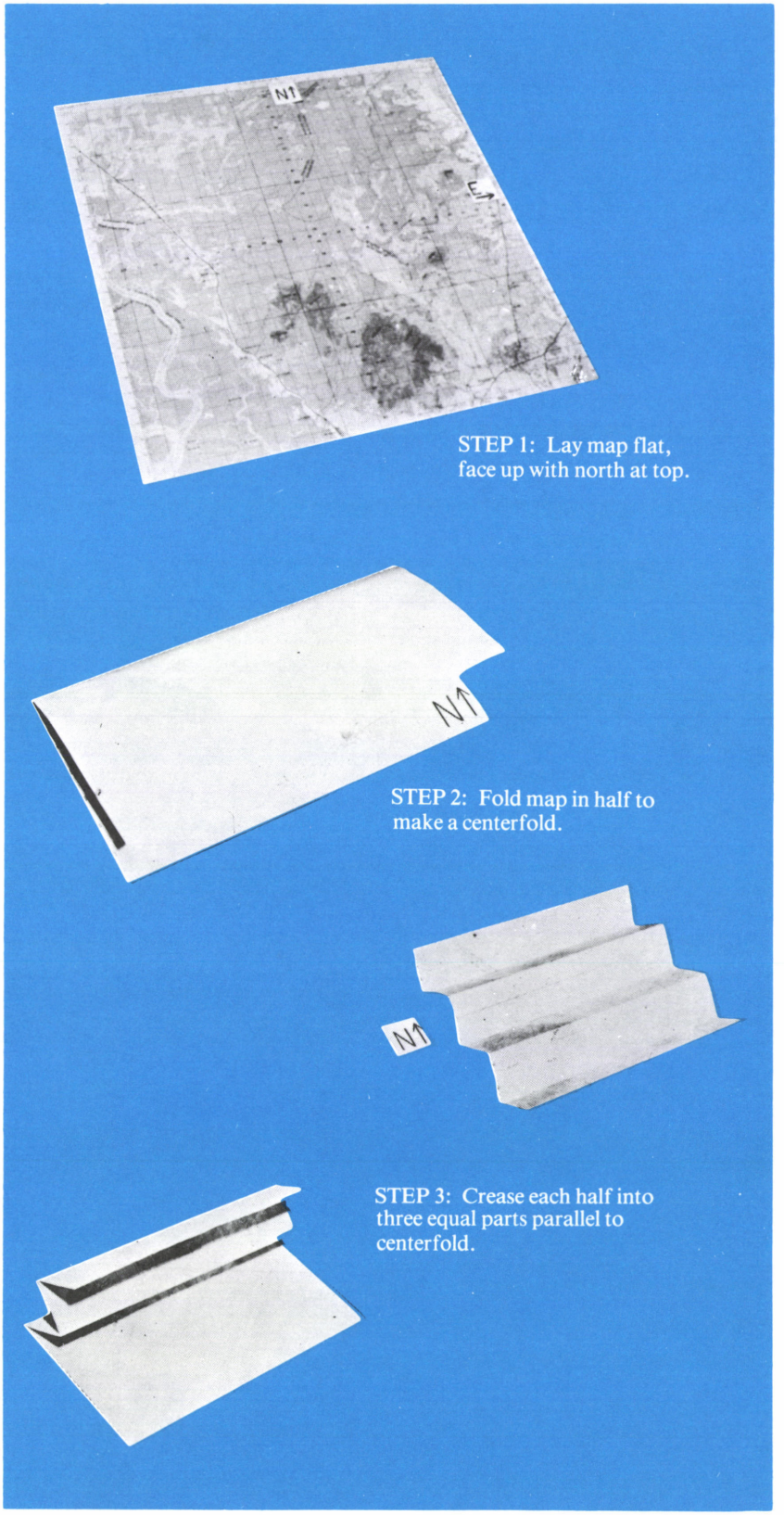
I have briefly attempted to demonstrate the need to examine your unit's mission and develop procedures to cope with the extremes of winter weather. Unit mission, aircraft type and crewmember experience should dictate the development of your operating procedures.

We must work to lessen the impact of being thrown into combat in a hostile weather environment. If the next war is a "come as you are" war, we owe it to ourselves and our soldiers to prepare now to *win in the cold.*

Because of repeated requests for copies of this article, the *Digest* is carrying it again. It originally was published in October 1970.

The Tactical Map and You

CW2 Nile L. Harter Jr.



STEP 1: Lay map flat, face up with north at top.

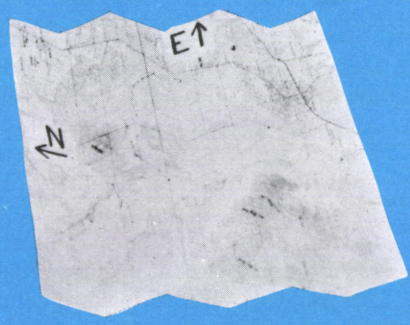
STEP 2: Fold map in half to make a centerfold.

STEP 3: Crease each half into three equal parts parallel to centerfold.

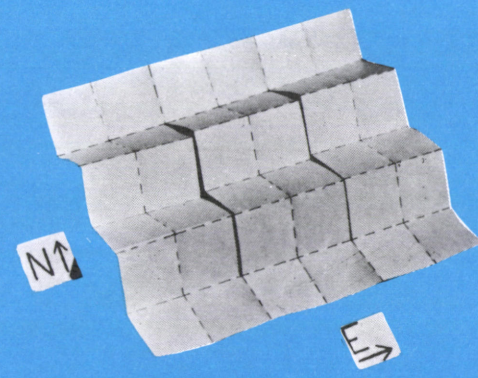
DURING MY LIMITED and somewhat trying career as an Army aviator, I've learned, like many before me, that the best source of information is the "grapevine," better known as the chain of command. Information flows from senior aviator to student pilot and back again in a never-ending stream of knowledge. All aviators encounter and relate many problems daily, some of which are specifically related to a particular aircraft class and type, and others that pertain to aviation particulars that every pilot is likely to experience sometime during his career. Having been recently counseled and enlightened on one of those so-called common problems by a senior aviator, I would like to share my findings with fellow aviators and make my contribution to that valuable grapevine.

Most publications used for instrument flight and radio navigation are not only designed for quick reference but are also physically small and easy to use in the cockpit. Most charts used for instrument flight come prefolded for systematic use in a limited-space compartment. But, what about visual flight publications and more specifically charts used in a tactical or less formal situation that an aviator might encounter while flying missions outside the continential United States?

How about the aviator who must navigate by reference to a tactical or geographical type chart using the pilotage method? He must be, as they say, outside as well as inside the cockpit with his head on a good swivel using an unfolded 33 × 40 inch, 1:50,000 scale tactical chart wadded or stuffed in his lap in an already cluttered cockpit. This article shows you one way of folding a chart for quick and easy reference, small enough for storage in the pocket of your flight suit and efficient enough to provide an excellent tool for visual navigation.

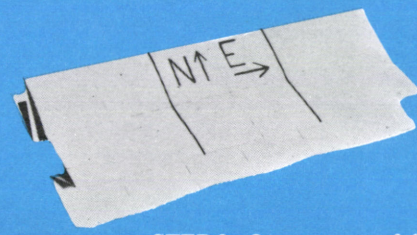


STEP 4: Open map face up with east at top.

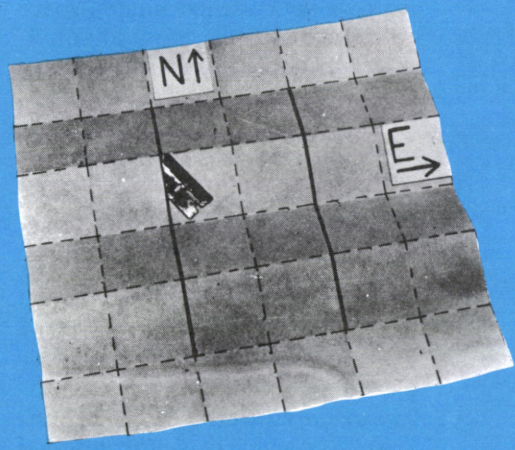


STEP 7: Disregarding cuts, using folds previously made, fold into parallel east and west sections.

STEP 5: Fold in half turning top edge down to meet bottom edge and then repeat step 3.

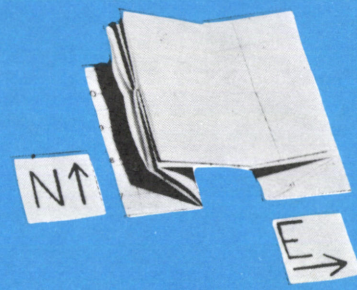


STEP 8: Open to centerfold, lay flat.

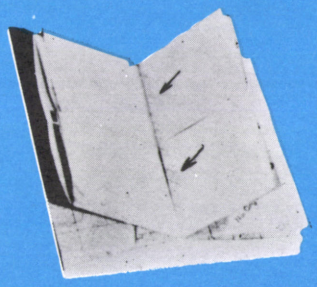


STEP 6: Open map, lay flat, north at top and with sharp blade neatly cut along heavy lines (dotted lines represent folds made).

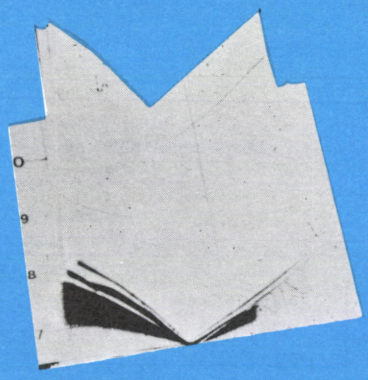
STEP 9: Disregard cuts, using folds previously made, fold into parallel north and south sections.



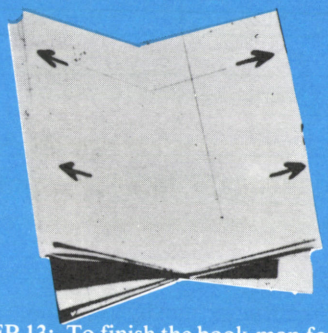
STEP 10: Open to centerfold, lay flat.

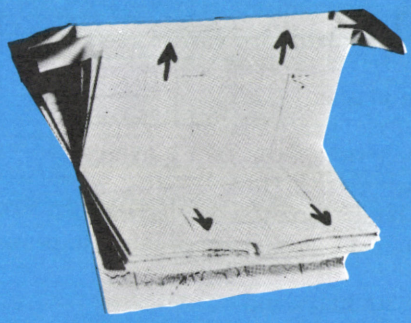


STEP 11: Turn map over as it is now folded and using a single strip of tape form a binder.



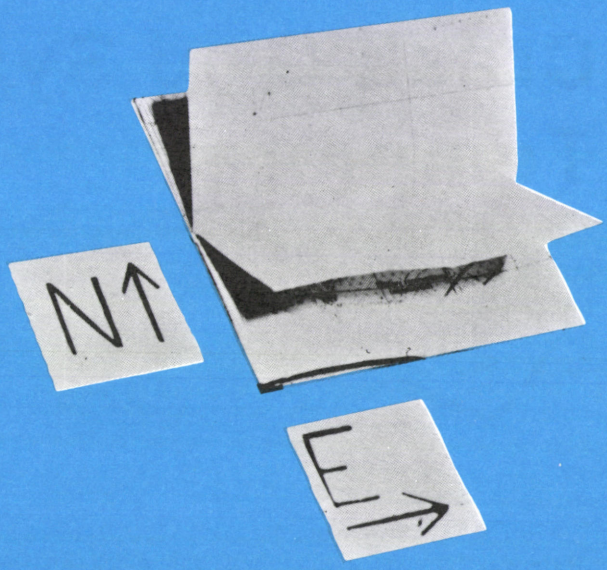
STEP 12: Turn map over and use taped folds as a binder. You should now have a three-section, two page book-map.





STEP 13: To finish the book-map for use, tape or glue the eight places where the edges you have cut come together (two places at each arrow).

STEP 14: If the map has been properly folded, cut and taped, you will find that there are not only three usable sections from east to west but each of these sections can be folded north or south as desired. There are three usable sections folding north and south within each usable section folding east and west.



STEP 15: Now your book-map is ready for use; however, the addition of cardboard covers and gluing down of loose corners will prolong service and add to the durability. With little practice one will be able to navigate with ease to any given point on the map by simply folding or turning sections north, south, east and west. Good luck.

Crash Grid System Templates

Mr. Thomas J. Callahan Jr.
U.S. Army Air Traffic Control Activity
Aeronautical Services Office
Cameron Station, Alexandria, VA

AIR CRASH Search and Rescue (ACSAR) maps are on the way; however, at this time we cannot tell you when they will be available at your airfield. Availability depends on the production capacity of the individual Army topographic units. A product that can help bridge the gap is the crash grid system template.

Currently in use by Army National Guard (ARNG) aviation units, this template is based on a crash grid developed by CW4 Norm Stewart, aviation safety officer/instructor pilot, Army Aviation Support Facility #1, New Jersey ARNG. After modification, the template was reproduced and distributed by National Guard Bureau Multimedia Branch, Ft. Rucker, AL.

The template is a piece of flexible clear plastic, 1/32-inch thick, measuring 7 inches by 9 1/2 inches. The actual grid, about 5 3/4 inches wide and 7 1/2 inches long, is divided into 48 squares as shown on the facing page. The template will fit into the standard 3-ring binder aircraft logbook and also into the logbook used in Army ground vehicles.

The template is designed to be used with maps and charts of varying scales. Figure 1 gives the approximate coverage for several fractional scale maps.

FRACTIONAL SCALE	NAUTICAL MILES PER INCH	APPROXIMATE COVERAGE NAUTICAL MILES
1:24,000	.329	1.9 × 2.5
1:25,000	.343	2.0 × 2.6
1:50,000	.686	3.9 × 5.1
1:62,500	.857	4.9 × 6.4
1:63,360	.869	5.0 × 6.5
1:100,000	1.371	7.9 × 10.3
1:250,000	3.429	19.7 × 25.7
1:500,000	6.857	39.4 × 51.4

FIGURE 1: Fractional scale data for use with crash grid template.

To use the template during ACSAR operations, you must have the same map or chart as other users. Orient the template to grid north on your map by using the arrow on the grid. Place the dot at the center of the template grid over a common known point on the map. This can be an airfield on the smaller scale charts, a road intersection on

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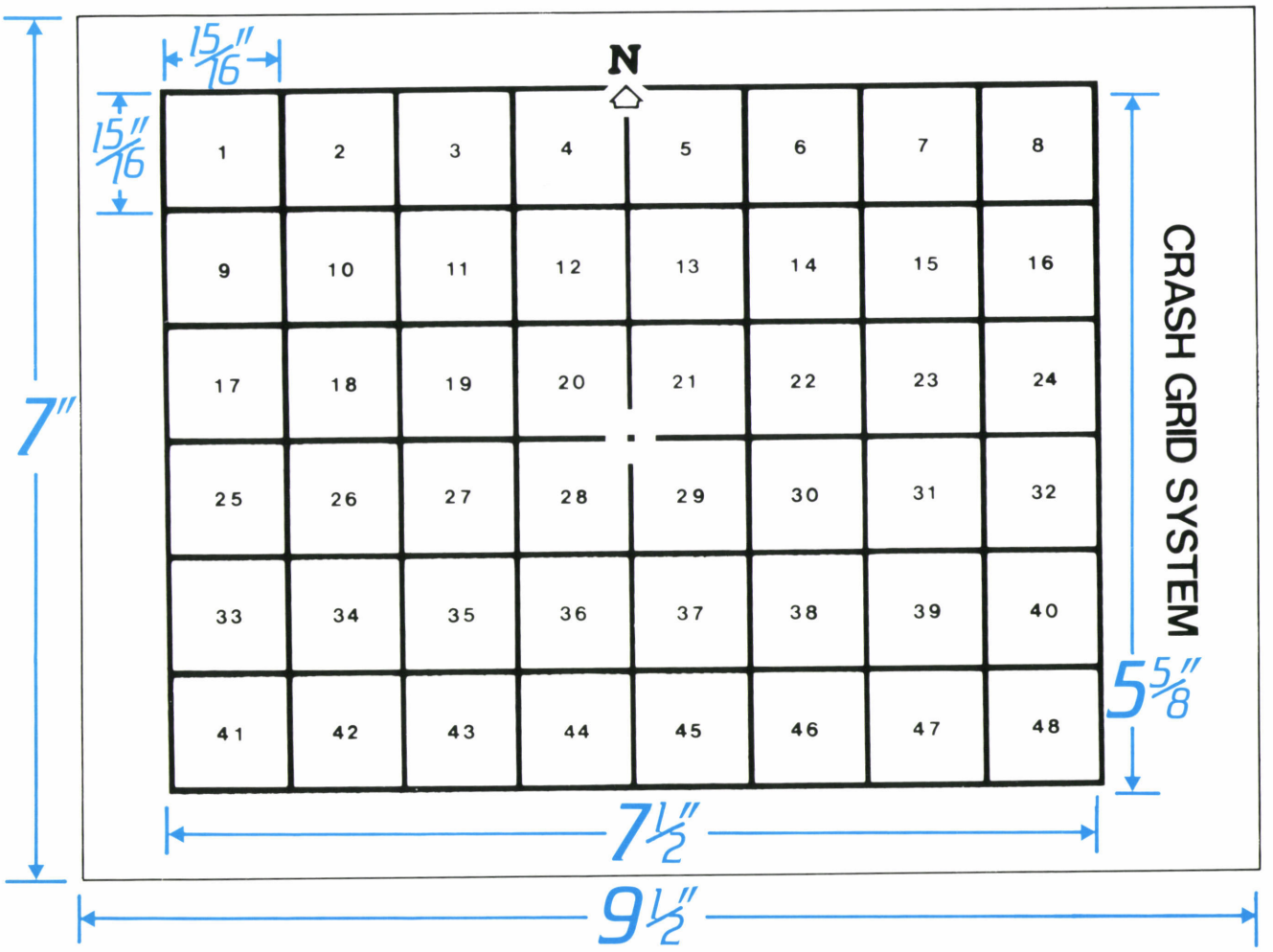

FIGURE 2: Crash grid system template (65 percent of actual size).

larger scale maps or any other point readily identifiable. You may also use the actual map coordinates of the known point. For ACSAR you might be assigned search sectors identified by the grid numbers on the template. Once the downed aircraft site is located, its position can be transmitted to the other rescue participants by identifying the appropriate template grid number (see figure 2).

In addition to using the template for ACSAR, it also may assist you in flight planning and flight following at tactical sites. Once again, center the grid on a known point and assign your area of operations based on the numbered template grids.

We recommend using a grid system of this type for search and rescue when a standard ACSAR map is not available. The templates can be made on any copying machine that is capable of reproducing on plastic transparency. However, the transparency will not be as sturdy as one made from a thicker plastic. For additional information or assistance contact Mr. Callahan, AUTOVON 284-7773 or Commercial 202-274-7773.

Readers are encouraged to address matters concerning air traffic control to: Director, U.S. Army Aeronautical Services Office, Cameron Station, Alexandria, VA 22304-5050.

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