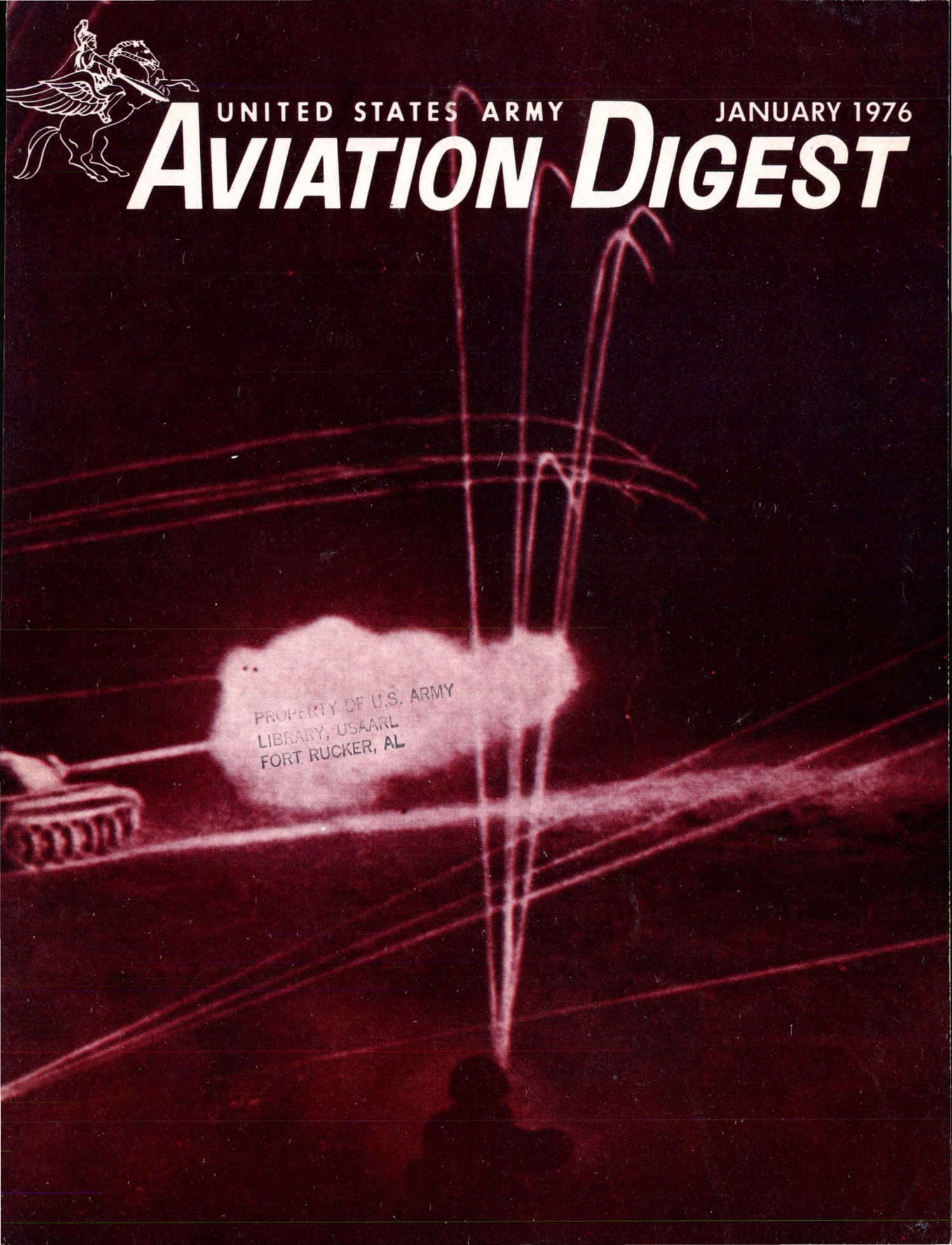
UNITED STATES ARMY

JANUARY 1976

AVIATION DIGEST



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JANUARY 1976 VOLUME 22 NUMBER 1

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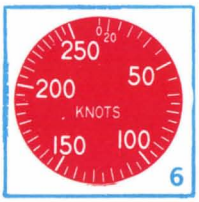

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ABOUT THE COVER

The *DIGEST* thanks the U.S. Army Foreign Science and Technology Center for the cover photograph of a Soviet night combat training exercise. It introduces Mr. McMaster's article, "Soviet Night Operations," beginning on page 2. This issue concludes the *DIGEST's* two-part "After Sunset" series

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

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Thoughts For The New Year

The turning of the year provides an opportune time for reflections upon the year past and the challenges that face us in this our bicentennial year. Like all years, 1975 has been a good, and in some respects a bad year. Perhaps the greatest blessing is that we have had a year of peace and hopefully that trend will continue. Knowing that history is replete with wars and faced with the threat that future wars will occur we can only ask ourselves how much time do we have to prepare for that next war. The year of 1975 has no doubt reflected the greatest universal change in aviation doctrine that has ever been accomplished. Although the Howze Board and subsequent testing of the Air Assault Division fairly described the envisioned threats to Army aviation, terms like nap-of-the-earth, mid-intensity threat, and the like just never became household terms. Today, through the efforts of TRADOC, FORSCOM, USAREUR and other pioneer leaders, I sincerely believe that our newly evolved doctrine for the employment of Army aviation has been accepted. It is certainly important that our aviation units believe and train to survive within this doctrine but equally if not more important, is the fact that the supported ground units understand and demand that all elements of the combined arms team believe in and train under these concepts. I am delighted to report that this is happening. Not just within our active Army structure but in our reserve component units as well. Perhaps one of the highlights of my first six months on the job has been visits to the Idaho and Texas National Guard Aviation units. Their programs for NOE, gunnery, navigation and instrument training have been models of excellence. If all of the reserve components are in as good of shape—we have truly come a long way.

In spite of what appears to be horrendous budget cuts for next year, I think that the aviation programs will do as well as the other major programs. The setback that we feared from the crash of the Boeing Vertol UTTAS now appears to be minimal, and more remarkably, it is going to be rebuilt. Not too bad for having crashed in woods with a rotational velocity of 30-35 rpm. Although obviously unscheduled, the crash certainly speaks well for the design crashworthiness. No serious injuries, nor did the dynamic components such as engines, transmissions or mast separate from the airframe.

The real tragedy of the year has been our increasing trend of what I describe as dumb accidents. Through the date of this writing we have had 44 major accidents which cost us over 5 million dollars but more importantly we have killed 28 of our precious crewmembers. If you don't find that a sobering fact, ask your wife (or husband) what she would be doing for the rest of her life had you been one of these statistics. These accidents were not associated with NOE training or as a matter of fact with any other kind of training. Instead, they were by and large single ship operations that were characterized by absolute lack of command interest, emphasis and supervision. Operating out of cg limits, flying a Cobra into the ground while landing at an unlighted helipad, interpreting a tail rotor drive failure as a transmission failure and applying the wrong emergency procedure, trying to stretch an autorotation to avoid landing in trees, and on and on. These are in my judgment examples of very unprofessional operations. We have done the hard things so well that it is ludicrous to screw these easy operations up so badly.

No question but what this is a bad way to end up a New Year's message to the world's finest aviators but unfortunately we have earned it. Our challenge is to do better and I am confident that we can. We've come a long way this year and '76 should be even better. Happy New Year, Hauoli Makahiki Hou, Ein Gluckliches Neues Jahr, Sae Hae Pok Mani Patusipsio, Feliz Ano Nuevo, Buon Anno.

BRIGADIER GENERAL CHARLES E. CANEDY
Deputy Director of Operations & Army Aviation Officer
Office of the Deputy Chief of Staff for Operations & Plans
Washington, DC

Soviet doctrine calls for continuous, all-weather, day and night combined arms operations. This article presents some of the details in planning night movements. The photo at the right candidly portrays a combined effort as SU-7 aircraft fly cover for T-55 tanks crossing a river. Note the snorkel on the tank, also another snorkel in midstream (arrow) where preceding tank is advancing submerged

A WEALTH OF night vision and sighting equipment, coupled with extensive training and planning, provides the Soviet army with a very credible night fighting capability. As Mikhail V. Frunze has suggested, technological developments will provide the major impetus for future battlefield success. This effectvely means that the momentum must be preserved on the battlefield through all-weather, day and night operations. Soviet writings on the subject are numerous and suggest that their forces will be serious practitioners of continuous operations. These writings also indicate that Soviet night operations will provide an element of surprise in certain tactical situations.

Night operations are conducted by Soviet combat *support* troops as well as combatants. Engineers in particular are skilled in making good use of darkness. This article emphasizes Soviet training and doctrine in regard to both night fighting and attendant combat support and combat service support.

While the Soviet soldier is trained to fight at night, the best and most constant use of darkness is made by reconnaissance patrols, engineer units, geodetic-topographic sections, and other combat service support functions including traffic control teams, which place illumination markers for troop movement at night. At lines of probable contact with the enemy, deployment lines and the avenues of approach are planned by unit commanders upon receipt of their operations orders from higher headquarters.

When studying the ground along the route, the commander plans for stops and rest points in areas providing cover and concealment. Under the relative security of night, a commander also can plan specific routes of attack and rates of advance. His plan typically would include measures against surprise enemy activity, and screening or security measures, as well as the effective changeover from night to daytime operations. A great deal of actual combat may not be expected—there may be more armor than motorized/mechanized—but the operations typically are launched from darkness and carry into the day.

Soviet combat service support operations at night rely on sound planning. Colonel L.V. Shamshurov, writing in the *Military Herald,* on "Engineer Support of Night Attacks" states, *"Control of small units of engineer troops is more difficult at night, as well as [the difficulty of] observing their actions and supervising their work . . . It is expedient to work out special control tables in advance. These should contain the more frequently used commands and instructions for engineer troops, as well as data on friendly and enemy forces."*[1]

Further examination of unclassified Soviet discussions on the integration of engineer support with combat activities provides additional doctrine. For instance, a given combat engineer section of a motorized infantry battalion will reportedly operate 4 to 8 kilometers (km) from the advance unit (similar to a special purpose armored-cav unit), and is specifically tasked with clearing the way for the combat reconnaissance patrol, by use of explosives if appropriate, and the emplacement of light (unspecified) markers: *"In order to conduct engineer reconnaissance, an engineering reconnaissance patrol was set up within the tank bridge building section [this is one of the battalion commander's assets] with the task of organizing a detailed reconnaissance of the march route, determine the technical state of the roads and road structures, find ways of getting around obstacles, find the cover and protective areas of the terrain . . . and designate the most difficult sections of the route by light markers."*[2]

U. S. Army operations officers and staff intelligence officers have been taught to think in terms of weather, enemy and terrain (WET) when making their estimates of the situation. The WET principle is also a matter of doctrine for the Soviet planner. Colonel I. N. Vorob'yev, in his *Combat Operations at Night,* suggests, *"When making an appreciation [estimate] of the situation, it is important to visualize what effect night conditions will have on the nature of the enemy's activities, own subunits [small units] and adjacent units, and also to make an estimation of the terrain and the state of the weather."*[3]

Soviet operations at night are well planned and organized, and certain changes from daylight operations are to be expected in their conduct. March speed and visibility at night have an impact on the configuration of the march formation. For one thing, intervals between vehicles (both wheeled and tracked) will be shortened from about 40 to 50 meters between them to only about 25 meters:[4] This is a matter of better troop control under reduced visibility conditions with a closer formation. The

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ANNUAL AWARD
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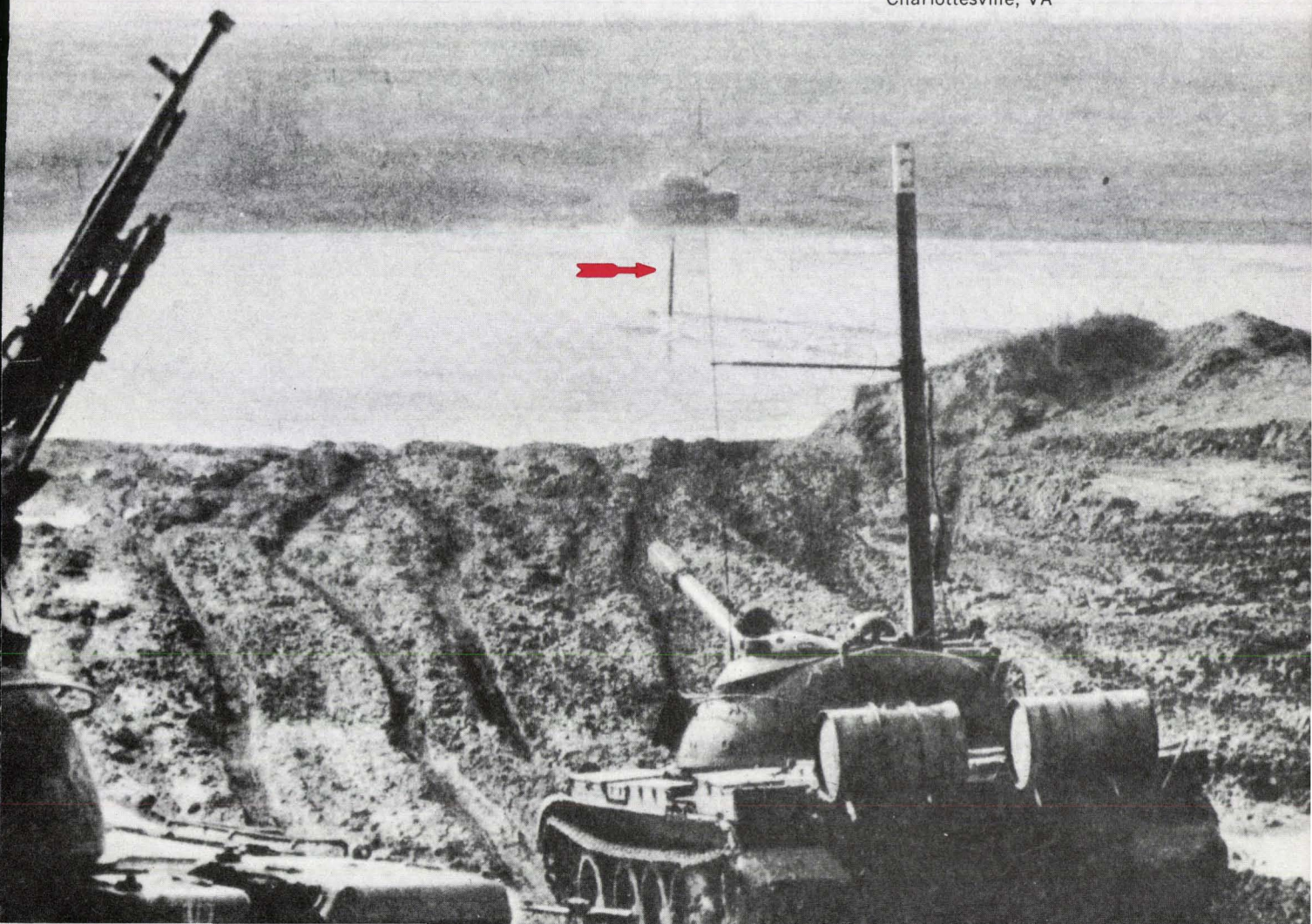
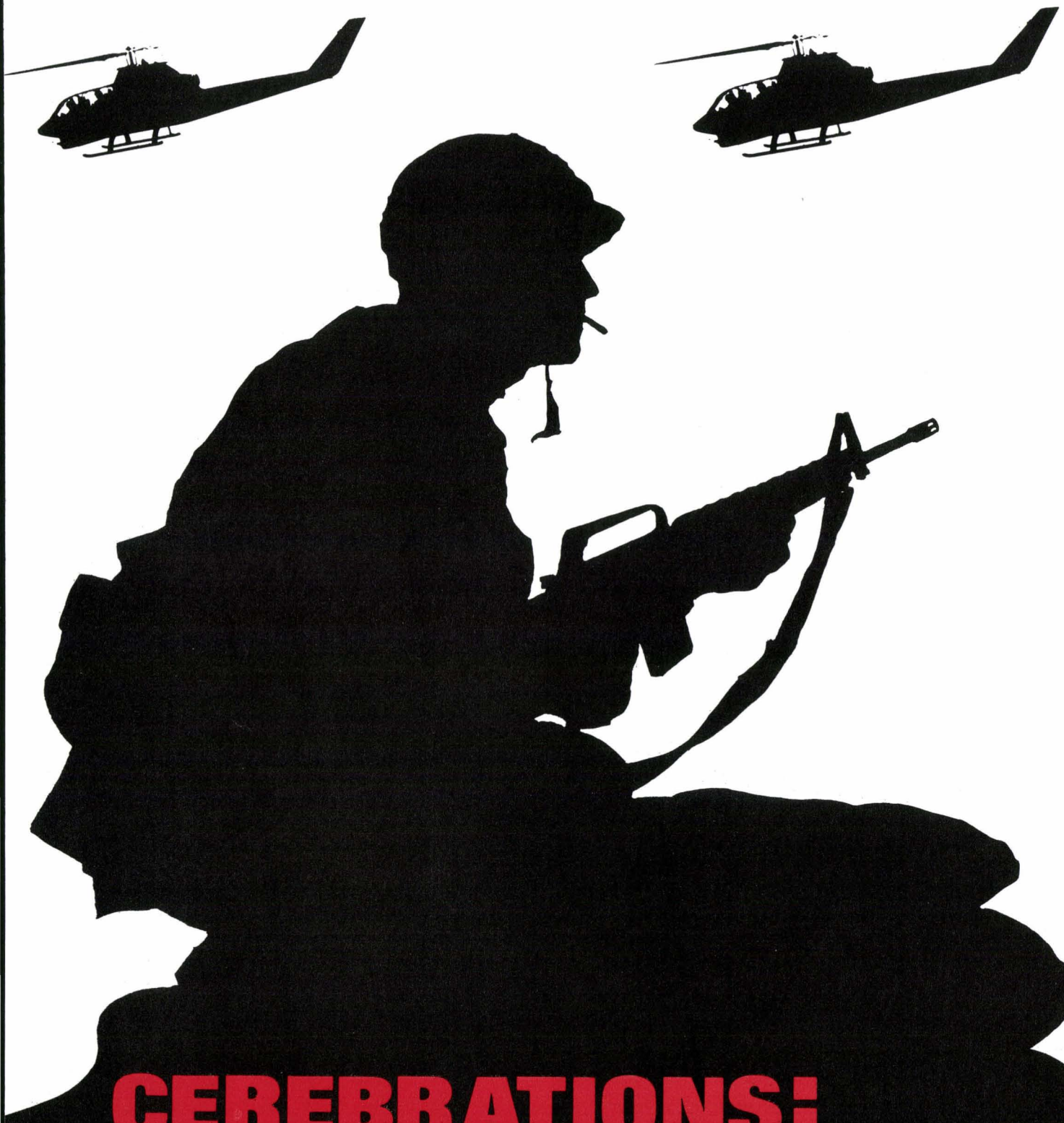
Soviet Night Operations

"Night operations have always been considered to be an important feature in the general course of combat operations; as new areas are conquered in the sphere of technical equipment the role of night operations is bound to grow still greater."

M. V. Frunze
(Selected Works, 1920)

Arthur W. McMaster III
Intelligence Research Specialist
U.S. Army Foreign Science and Technology Center
Charlottesville, VA





CEREBRATIONS:

Night Attack Helicopter Training

This article provides a brief historical overview from Gideon's night attack against the Midianites to Israel's use of night helicopter operations. These historic events lead into the advocacy of increased training for night attack helicopter operations. The focus is on the mid-intensity (high threat) European environment. The thoughts projected encompass current attack helicopter capabilities and the need to train now with available equipment. The proposals cover regulation changes, personnel motivation, use of a crew training concept and a suggested night attack helicopter training schedule

Major William E. Whitworth
Headquarters
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DARKNESS HAS hampered armies throughout history, but at the same time, it has offered the key to success for those who understood its qualities and used them to an advantage.

The earliest recorded use of taking advantage of night combat is graphically described in chapter VII of the Book of Judges. A night attack was launched by the Israelite leader Gideon against an armed camp of the roving Midianites, Zebah and Zalmunna, on the great plain of Esdraelon. Although smaller in number, the well trained, carefully prepared Israelite troops used darkness and the element of surprise to their advantage. The principles of this operation are as valid today as they were in 1249 B.C.

Centuries have passed, the machinery of war has changed, but using the night environment to provide a tactical advantage has continued. George Washington's crossing of the Delaware River under the cover of darkness and the capture of the Hession garrison in Trenton, NJ, on Christmas Eve, 1776, is a familiar example.

More recently, the Israeli defense forces have made successful use of night operations, both ground and air. For example, helicopters using the cover of darkness landed Israeli paratroopers in the rear area of the Eqyptian forces at Abu Ageila on 5 June 1967.

During the combat years in the Republic of Vietnam, both sides utilized night operations. The helicopter gave an advantage in maneuver and firepower but it did not always offset the careful use of darkness by the Viet Cong.

The strategy and tactics of aerial warfare through the years also have been greatly extended by the use of nature's most effective form of camouflage: darkness. Unfortunately, this advantage also is available to the enemy. Thus the need for preparedness is always with us.

There are few operations of war more demanding or, when successful, more rewarding than a night attack. Night operations demand a maximum of preparation, control and coordination. Preparation

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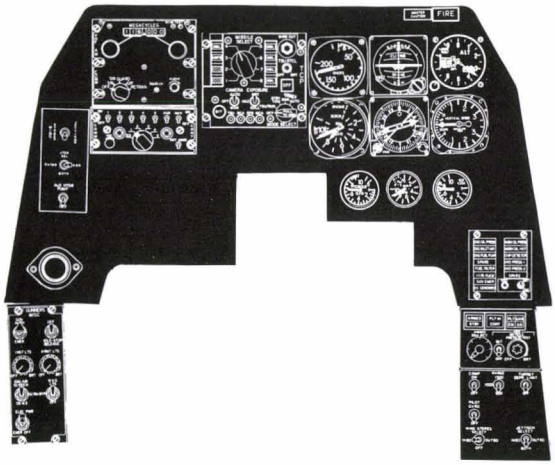
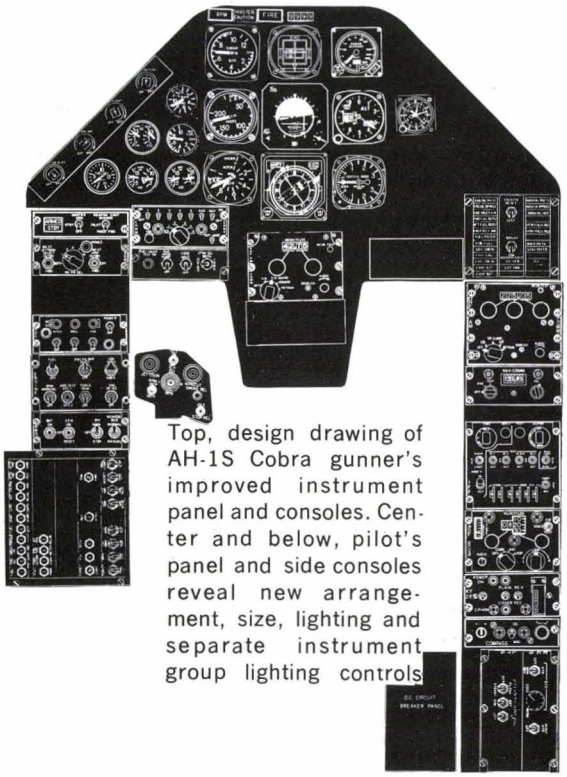




Top, design drawing of AH-1S Cobra gunner's improved instrument panel and consoles. Center and below, pilot's panel and side consoles reveal new arrangement, size, lighting and separate instrument group lighting controls

Cockpit Design for Night NOE

J. H. Emery
Bell Helicopter Company

NAP-OF-THE-EARTH (NOE) flight at night confronts the Army aviator with flight requirements that tax his skills to their limit. His flight techniques, his visual perception and his ability to manage his cockpit and subsystems must be razor sharp.

What is being done to assist him in this new realm of flight operations? For one thing, a new cockpit which meets the pilot's needs has been designed, a cockpit that is dedicated to night NOE and terrain flight. Bell Helicopter's Human Factors Engineering (HFE) group and personnel from several Army agencies have been studying ways to improve the cockpit. The results may be seen in the lusterless black interior of the new Cobra crewstation. This interior, combined with the low-glint, flat-plate canopy, provides the AH-1S Huey Cobra crews with an improved cockpit for night NOE flight.

In the new "after sunset" tactics being developed, the Army aviator will be seeing the world around him, not only through the night vision capabilities of his eyes, but also with the Army's new night vision goggles (NVG). The cockpit design must be compatible with both. The new AH-1S Cobra cockpit redesign emphasized the following areas:

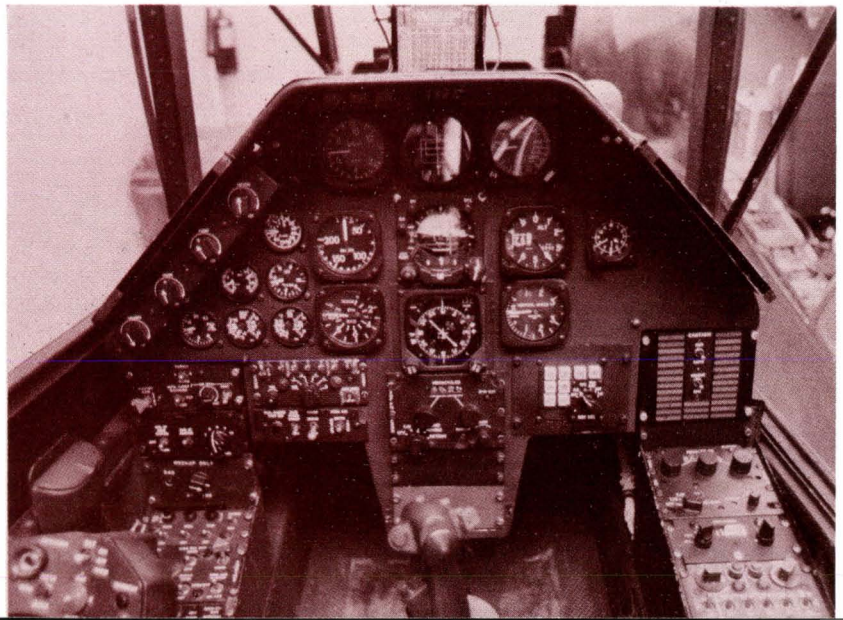
- instrument lighting
- glare and reflection
- panel arrangement
- instrument dial face design

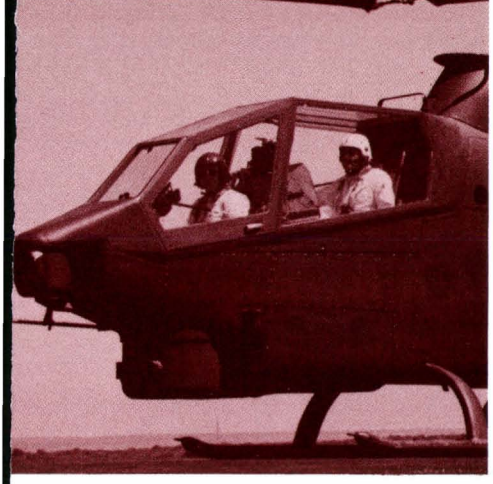
The Lighting: To make the lighting compatible with the eye and the NVG necessitated two major lighting changes. The first was the lighting balance. NOE pilots prefer very low levels of instrument illumination. It is often the case, however, that as the lights are turned to an acceptable low illumination, one or two instrument lights may extinguish. To avoid this, more stringent lighting specifications are required.

The selection of integral lighting techniques and lighting design specifications for the AH-1S is aimed at providing good balance for each display and for the whole panel. The integral lighting provides an even light over the face of the instrument. Problems of previous lighting schemes which caused "hot spots" and varying light levels within a single display are eliminated. Coordination of all lighting results in a total lighting balance within the cockpit.

The second major change concerned the lighting level when using the NVG. It may be remembered as a rule of thumb that, "If you can see the light with the naked eye, it is generally too bright for the NVG." Voltage settings on the lamps used in conventional cockpit lighting range from 1.5 volts to 5 volts. The average setting is 3.25 volts. Studies with the NVG demonstrated that no more than .8 volts could be used without "blooming" and poor visual perception. This required a redesign of the lighting system.

The results of the lighting changes





Bell's production AH-1S Cobra with first operational NOE cockpit. Note low glint, flat-plate canopy

permit the pilot any level of lighting and well-balanced lighting. Pilots of the AH-1S, as they become dark-adapted at night, will find that they will be turning their lights lower and lower.

Glare And Reflections: Every pilot is familiar with the problem of night time reflections in the canopy or windscreen. Some of these come from internal sources, particularly the instrument and console lights reflecting from other cockpits. Others emanate from external sources, such as ground lights. Light reflections seem to bounce around the cockpit. For example, the instrument panel lights in the front seat of a fore-aft seating arrangement may be reflected in three locations—overhead and on each side panel. These reflections impair the pilot's ability to see past them and into the darkened night. A reflection can be almost as bad as the original light source. They must be minimized or eliminated in the NOE night cockpit.

For the AH-1S Cobra, this was accomplished by redesigning the gunner's instrument panel, installing larger glare shields and providing lighting controls that permit the gunner selectively to turn off any lights in his cockpit which he may not be using at the time.

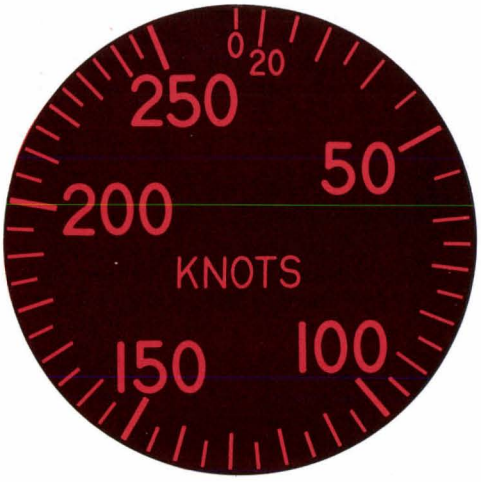
The Panel Arrangement: The new Cobra instrument panel is rearranged into groupings of displays that conform to the operational usage—tactical, flight and engine. Each group has its own lighting control. The pilot, thus, illuminates only those instruments that are required for the particular mission. For example, the tactical group includes the pilot steering indicator, used for the TOW (tube-launched, optically-tracked, wire-guided) missile delivery, the radar altimeter and the torque meter. Placed at the upper extreme edge of the panel, but inside of the glare-shield, the pilot needs a minimum of eye movement to scan from this tactical group to the outside world. For night TOW delivery, only this group would be illuminated.

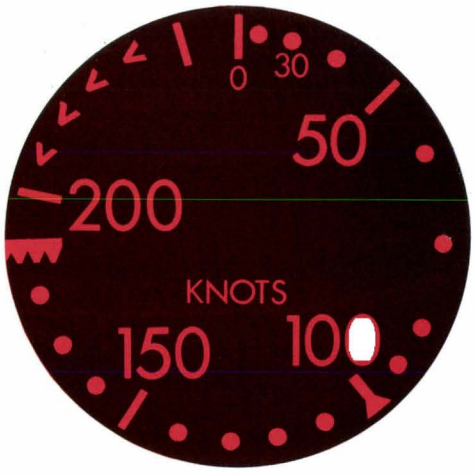
Separate dimming and "on-off" switches are provided for each group. This offers a flexible combination of lighting arrangements to meet the pilot's operational needs. An easy-reach panel, along the upper left slanting edge of the instrument panel, houses four control knobs for dimming and three instrument lighting groups plus the required lights for consoles, radios, etc. The control heads are shape-coded so that they are unlike any other control in the cockpit and can be easily identified in the dark by using the sense of touch.

Consideration has been given to the emergency situation in which all lights are set for use with the NVG (that is, below the visual threshold of the human eye) and suddenly the NVG fail or another emergency arises. For this special case a switch has been located on the cyclic control which brings all lights up to a normal illumination setting. This switch is located where the pilot can use his left hand to remove the goggles and handle the collective control while continuing to fly with his right hand. This will permit him to have immediate instrument information that can be seen without the goggles.

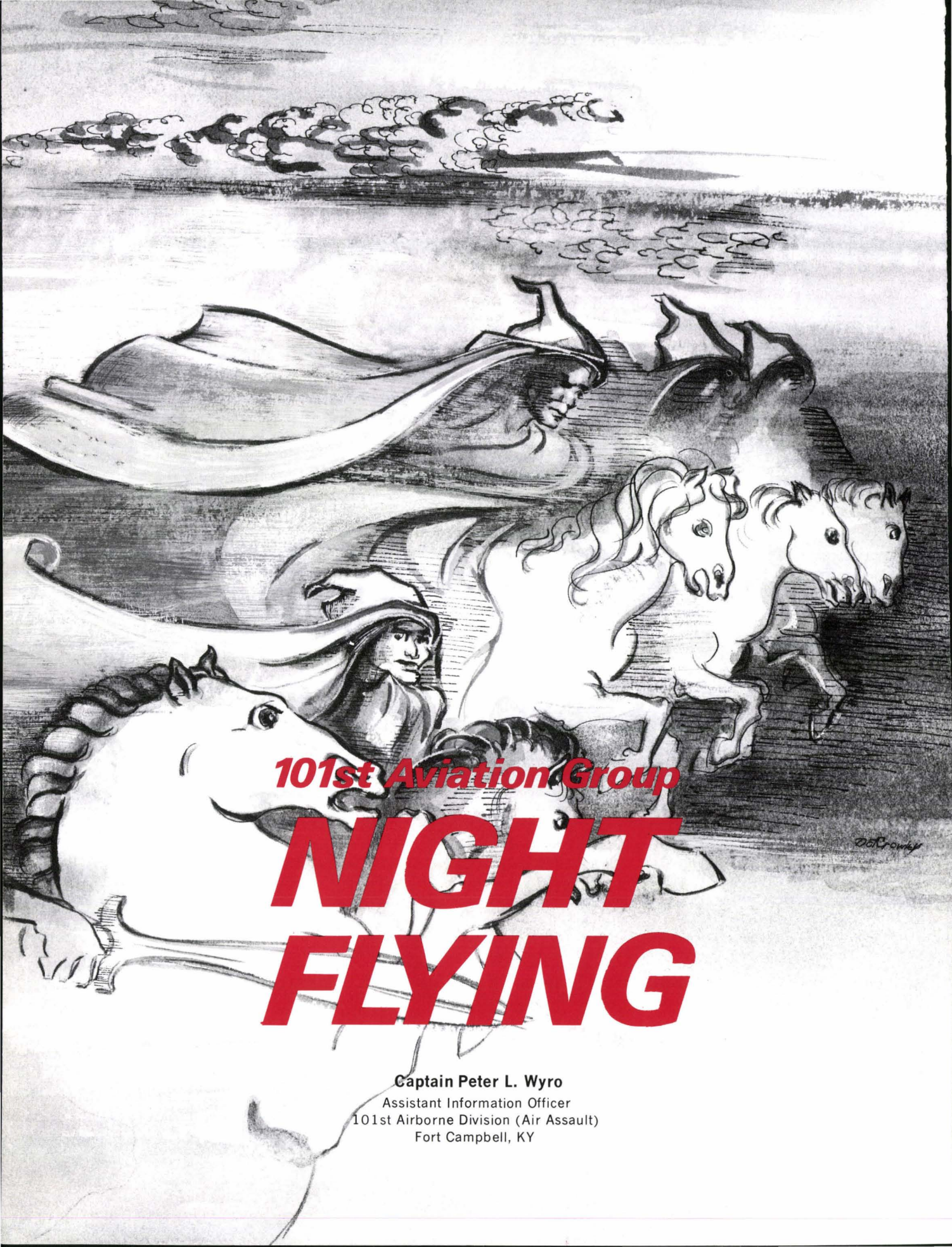
The Instrument Dial Faces: The NVG do not work well with existing dial faces which tend to "bloom" and are often cluttered with too many markings. With the NVG there is also the old problem associated with red-lighted instruments, i.e., color markings cannot be identified. To solve this, Army and Bell HFE personnel have redesigned the instrument dial faces to reduce the clutter and make the instruments easier to read. The operating ranges on the instruments, which usually are identified by color coding, are now identified by shape coding the indices. As examples, where the green line indicates proper operating ranges, the small indices have been changed from lines to dots. Thus, if you are operating "in the dots" that is the same as "in the green." The "red line" marking has been turned into a large mark with a sawtooth shape. Operating ranges beyond the "red line" are identified by a series of "Vs" pointing the direction back to the proper operating range.

The advanced instrument configuration, the improved lighting techniques, the redesigned layout of the cockpit, all combine to permit the AH-1S crew to perform their mission with greater effectiveness. The pilot workload will be decreased while his ability to see will be increased. The result of careful attention to the pilot's needs thus provide for the U.S. Army the first operational night NOE cockpit.





Airspeed indicators under red light. Left, red regions don't show. Right, markings identify ranges—dots/acceptable; sawtooth/red line; Vs/unacceptable, point to desired area



101st Aviation Group

NIGHT FLYING

Captain Peter L. Wyro
Assistant Information Officer
101st Airborne Division (Air Assault)
Fort Campbell, KY

THE ABILITY TO move and fight at night or during periods of reduced visibility has never been a luxury which an effective fighting unit could take or leave at its own discretion.

It has come to be an absolute necessity for the modern battlefield and it holds true for all Army units, including the 101st Airborne Division (Air Assault).

To that end, in mid-1973 planners for the 101st at Fort Campbell, KY, set out to become not only capable of waging combat on the ground at night but also to being able to conduct air assaults, some deep behind enemy lines, as a matter of routine operational capabilities which the 101st would enjoy.

Major Jon R. Mills, now operations officer for the 101st Aviation Group, was an aviation company commander at that time. He has witnessed much of the development which has come with the efforts of the 101st to become proficient in night air assaults.

In August 1973, while Major Mills noticed that many aviation units were flying at night, they were not he says,"really doing tactical night flying."

So Mills' Company D, 158th Aviation Battalion became a frontrunner in the development of techniques and procedures not only to make low level night flying possible, but also to aid in developing the navigational and control techniques which would be an integral part of the training. These techniques have become more or less standard with 101st aviation units today.

Starting at altitudes no higher than 300 feet AGL (above ground level), Company D's aviators initially became familiar with flying small four-ship formations at night. Then as their proficiency improved, they moved to lower altitudes and incorporated larger formations, eventually winding up at flight altitudes around 100 feet and flying night operations in 18-ship configurations.

According to Major Mills, "The pilots thoroughly planned their routes during the training." And he went on to point out that navigation was primarily done by time and distance and heading procedures. But Mills added that often with prominent landmarks illuminated by minimal light, time and distance and terrain techniques for navigation could be used.

To develop the necessary pilot night-flying proficiency, Company D "Ghost Rider" pilots trained as often as three nights each week. But they soon found that pilot proficiency diminshed in ratio to the amount of time spent away from night flying. So night training became the "way it was" and they increased training to four nights each week.

The result was the development of an aviation company which not only was capable of inserting and extracting 101st Infantry troops at night, but also which gave the 101st an added bonus with a standard way of getting it done. The latter was in the form of a SOP (standing operating procedure) which is the guide for most 101st aviation units performing night training.

During tactical night flying, 101st pilots keep a three to five rotor disc diameter between aircraft, with pilot proficiency and weather conditions being their prime considerations. They maintain positions 30 to 45 degrees right or left of the leader or wingman (150 degrees off the nose of the aircraft). These considerations were part of the SOP developed by Company D.

Lighting plays an important role in the control of the formations at night. A series of bright, dim, steady and flashing navigational lights, along with rotating beacons provide the lift pilots with the signals that tell them when to crank, hover, line up, and takeoff, as well as when to prepare for approach, when the ships are in th LZ-PZ (landing zone or pickup zone) and when they have either loaded or offloaded troops.

Instrument lights aboard the aircraft are shut down to minimum settings and cabin lights are turned off for both loading and offloading troops.

The trail aircraft keeps its rotating beacon operating and the command and control aircraft is up with its steady bright rotating beacon on. (This is due to peacetime safety restrictions.)

A 5-second rotating beacon by the lead ship indicates takeoffs and landings.

So with this reliance on the lighting signals, 101st pilots must ensure prepositioning of their lights prior to takeoff, and they must be sure they have all the required lights before the operation.

In addition, the pilot in command has the option to use landing lights if he believes it is necessary, but the landing lights are extinguished when in the PZ or LZ. They are used on the departure and turned off again after clearing obstacles (again, safety restrictions).

Ground lighting depends on the availability of qualified personnel and the tactical situation.

For navigation and control enroute, the aircraft use checkpoints which are readily identifiable at night. For planning, the last checkpoint and the release point (RP) must be in a relatively straight line to be sure that the RP is crossed at the correct heading.

Then, ideally, the line of flight from the RP to the LZ will be straight to ensure proper use of the landing axis and to ensure a proper heading into the LZ.

For training at Fort Campbell the altitude generally is 100 feet with airspeed kept to 80 knots.

Other considerations keep the night serials to five for combat assault by insertion (CABI) and changes in formations at night are kept to a minimum.

The position lights and skids are used for pilot reference and pilots are cautioned during training to keep their eyes moving to avoid fixation.

Emergency procedures for the night-flying 101st pilots recognize detailed IFR (instrument flight rules) breakup plans and procedures for aircraft in the event of radio or complete electrical failure. In the case of the latter, the distressed aircraft drops below the formation positioning his lights to flash, avoids other aircraft and lands as soon as possible.

For radio failure, though, the distressed aircraft loses altitude, falling below the formation, then follows in trail behind the flight.

In all cases other than radio failure, the trail or maintenance aircraft follows the distressed aircraft and reports its condition to the flight lead upon landing.

The 101st's tactical night training becomes a significant undertaking when one considers that these techniques allow 101st pilots and their five-ship serials to conduct CABI over as wide a front as 30 kilometers (km), flying low level to prearranged rendezvous' behind enemy lines where they form into larger formations for the air assault. And, it's all done at night under minimal illumination.

Does it work?

During the 1974 Solid Shield exercises, Company D pilots combined their efforts at night tactical flying with the men of Lieutenant Colonel Stanley Bonta's 2nd Battalion, 503rd Infantry and made numerous night air assaults. One such night air assault resulted in an attack on an 82nd Airborne Battalion command post and the capture of the battalion commander.

Other night operations were equally successful in Solid Shield. They proved that night air assault procedures are effective for troop insertions and extractions and also that "fake" insertions could be used to confuse the 82nd forces about the intent and actual locations for the 101st combat assaults.

From Solid Shield and from exercises at Ft. Campbell, the aviators from the 101st learned that they could infiltrate the forward edges of the battle area (FEBA) in five-ship serials at low level with the probability of only one or two ships out of ten being detected by the opposing forces.

From the aggressor standpoint, within a given sector, the detection of only one or two aircraft at low level would not tend to be a major intelligence item. So, the significance of a night combat assault by infiltration could in all probability be lost until the serials merge toward the base serial, usually in the center sector and at their rally point where they begin their night flight in the larger formation toward the LZs.

By that time the assault is in its final stages and, for the aggressor, the presence of a large opposing force in its rear areas is a reality.

It isn't hard to imagine the rest: The scattered "whopps" of the isolated serials, with pilots in each aircraft in the serial doing their own navigation, form into a large flight complete with attack helicopters flying escort for the lift.

Then, the combined flight hits its final checkpoint and the lead pilot takes his last bearings to be sure he has the flight lined up for the release point.

Approaching the RP the flight lead homes in on a low frequency beacon now operational in the LZ by a team of pathfinders which had been inserted near the LZ earlier. By now they have infiltrated the LZ, set out the beanbag lights, and are completing the terminal guidance for the flight.

The RP is hit. About 3 km from the LZ, the rotating beacon of the lead aircraft flashes on for 5 seconds telling the rest of the flight to land and the flight descends into the LZ.

With cabin lights out, the doors open and the Infantrymen move off the ships to the edge of the landing zone.

Once empty, the pilots signal that their aircraft have completed offloading, and once more flight lead flashes a 5-second beacon for takeoff. Landing lights are flashed on momentarily as the flight lifts off over the trees at the forward edges of the landing zone. With landing lights extinguished, the formation begins its flight back to a secure area on the friendly side of the FEBA, or to a prearranged seclusion site to wait for another mission.

The night air assault is complete and has been made possible by the training and the techniques developed out of the need for the 101st Airborne Division (Air Assault) to be able to carry the flight to the enemy, both day and night.

Planning a Tactical Instrument Flight

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This is the third of seven stories which will appear in the *DIGEST* concerning tactical instruments. See the October 1975 issue, page 17, and December, page 22, for previous articles. Next month watch for "Above The Best, But Below The Threat"

I KNOW THE CONCEPT of tactical instrument flight and am beginning to understand and become convinced of its absolute necessity on the high threat battlefield. But how do I go about planning for a flight into instrument conditions? Is there a checklist of a standing operating procedure (SOP) that I can use or modify to meet my unit's needs?

Strange you should ask such a question. Tactical instrument flight on a high threat battlefield will be required for successful around-the-clock operations. It must be a standard, well-rehearsed technique in which aircrews are highly proficient.

This article proposes and discusses some of the basic considerations, principles and procedures that should be an integral part of planning and conducting tactical instrument flight in a high threat environment. The importance of detailed planning prior to conducting a tactical instrument flight cannot be overemphasized since both successful mission accomplishment and crew survival may depend heavily on the degree of prior planning.

Mission Requirements: One of the most important steps in planning for a tactical instrument flight is to analyze the mission in order to determine all the requirements that are inherent in it. For example, knowing if the mission is a single aircraft flight, a multiple aircraft operation or a multiple sortie mission will significantly affect the planning process. Analyzing the mission as a first step ensures that all subsequent necessary actions are taken and that unnecessary actions are omitted.

Operations/Intelligence Briefing: A complete briefing by the operations officer or his representative is a keystone in the planning process. Information that should be sought includes:

- *Threat Information:* Threat information specifically applicable to the area of operations should be available. This data should include types of weapons; air defense weapons and missiles; effective range of weapons; detection and acquisition ranges; a record of "shot at" reports; and other pertinent threat information that may affect the unit mission. It is important that threat data be kept up-to-date so that the mission can be completed with minimum risk of hostile interference. The threat situation is a primary factor and affects all other mission planning considerations.
- *Friendly Forces:* Location, identification and posture of friendly supporting/supported forces is essential information. Enroute and terminal planning depends heavily on the friendly force situation. Unexpected movements of units or the supported unit can be critical to mission accomplishment.

Frequencies and Call Signs: Ensure that communications-electron-

ics operation instruction (CEOI) information is current and communications with navigational aids can be established and maintained.

Weather Information: As in any form of instrument flight, weather information is critical. Current weather information should be maintained by the unit operations center for the area of operations. It may be necessary to depend heavily on forward ground weather reports by untrained observers. Weather information can be obtained through division artillery elements if more formal weather information sources are not available.

Wind information is extremely important to flight planning. Wind conditions at the point of departure, enroute and at the termination point should be obtained and rechecked immediately prior to departure. For planning purposes, surface winds should be used.

Navigational Aids: Because of the threat in forward areas of the battlefield, it may not be possible to operate NAVAIDs (navigational aids) fulltime. Fulltime operation of nondirectional beacons and surveillance radar NAVAIDs risks enemy acquisition of both the NAVAID and the aircraft as targets—or of having the enemy disrupt the mission by jamming the NAVAID signal. All reasonable means should be used to minimize the time that navigational aids emit a signal.

In rear areas where more sophisticated NAVAIDs can be used along with standard instrument flight rules, efforts should be made to limit the signal transmission time to only those times when needed as an aid. In the fast-moving and increased threat environment nearer the FEBA (forward edge of the battle area), the limited low-power beacons and NAVAIDs should be operated intermittently or only upon request as a standard procedure to lessen the chance of enemy detection. In this austere situation, aviator proficiency and knowledge of the capabilities and characteristics of the NAVAIDs are important.

Currently, ADF (automatic direction finder) equipment is the primary navigational aid on the battlefield. However, frequency modulated (FM) homing can be used as an emergency tactical instrument NAVAID to serve as a backup in the event the onboard ADF equipment malfunctions or the, ground-based nondirectional beacon becomes unreliable or inoperative. In tactical instrument flight, as in visual terrain flying, it is extremely important for the aviator to remain aware of his position as closely as possible at all times in the event he has to resort to emergency backup homing procedures. By knowing his position and using FM homing as an auxiliary NAVAID, the aviator can home:

- To an alternate FM transmitter location in order to encounter VFR (visual flight rules) flight conditions when onboard equipment malfunctions.
- To the original point of departure in order to use an operational or more reliable ground-based NAVAID.

As a general rule, FM homing should be used only as a backup NAVAID to return the aircraft to VFR conditions or to a rear area.

Flight Altitudes: Flight altitudes are dictated by the enemy air defense threat. Most likely, the limits will be less than those specified in AR 95-1, "Army General Provisions and Flight Regulations," and may be as close to the ground as terrain obstacles permit. The overriding concern in tactical instrument flight is to remain below the enemy air defense threat and continue to maintain a safe altitude above terrain obstacles in order to complete the mission. Each mission requiring the use of tactical instrument flight should be individually planned and an appropriate altitude profile planned to remain clear of both the threat and terrain obstacles.

Flight Routes: The current threat, terrain and weather directly affect route selection. In addition, route navigational aid facilities should be mobile and highly responsive. Routinely, they should be capable of rapid displacement on short notice to provide support for a tactical instrument flight. Air traffic management personnel should expect to move their equipment as frequently as every 4 hours, if necessary, to avoid enemy electronic detection and to prevent repeated use of the same airspace. Significant factors that should be considered in establishing tactical instrument flight routes include:

- *Terrain and Threat:* Straight-line flight between takeoff point and destination will probably be precluded in many instances by both the terrain and the enemy air defense threat. In selecting the flight route, the aviator must carefully analyze the threat as it affects potential flight routes. In most instances the threat will be the overriding factor in dictating (or limiting) flight routes.

Consistent with the threat, the aviator makes a thorough map reconnaissance of the possible routes to the destination and return to determine the best route which will provide threat avoidance and terrain obstacle clearance. Efforts should be made to use terrain for masking from the enemy threat whenever possible, especially in the more forward areas of the battlefield.

In tactical instrument flight, terrain obstacles can serve as valuable assets to deny enemy electronic detection just as they are used for concealment and masking during visual terrain flying.

After selecting potential routes based on the enemy threat and terrain obstacle considerations, the aviator should consider the other

factors that affect his choice of a route.

• *Navigational Aids:* The availability and location of navigational aids are significant factors in route selection. Premission planning and briefings, whether in VFR or instrument flight rules (IFR) flight, should include the exact location and availability of aids to navigation and how they can be used to support the tactical instrument flight.

Enroute NAVAIDs farther from the FEBA may be relatively easy to coordinate, locate and use: however, as the NAVAID location is nearer the FEBA, availability as well as flexibility of a NAVAID may well be limited by the intensity of the fighting and the density of other air traffic.

Planning should include provisions for alternate NAVAIDs when available and consideration whether the alternate NAVAID will still contribute to the completion of the mission. Ideally, an alternate termination point or letdown NAVAID should not be used if it will not contribute to mission accomplishment or provide visual flight conditions to the intended destination. Planning should include navigational aids for the return flight, if necessary.

• *Communications:* The enemy will employ highly sophisticated electronic warfare systems. Defeating this capability and protecting aviation assets requires maximum tactical ingenuity and resourcefulness. One of the most effective countermeasures is to keep radio communications to the minimum. This can be accomplished through the use of arm and hand signals, lights and a SOP.

In selecting a route, communications security and a capability for maintaining communications should be prime considerations. Using terrain to mask the aircraft from possible acquisition by the enemy early warning radar also may mask the aircraft from NAVAIDs and from communications with friendly units. Routes should be selected which provide reliable communications whenever feasible.

Approaches: Tactical instrument flight approaches will vary considerably in their sophistication and reliability. Conventional ground-controlled and instrument landing system (ILS) approaches may be used when available. However, because of the dynamics of future battlefields, these sophisticated facilities currently are available only in rear areas. Approaches in forward battle areas will more likely be limited to using area surveillance radar, nondirectional beacons and FM homing.

The altitude to which descent can be made will depend on factors such as crew proficiency, aircraft instrumentation, approach NAVAIDs, terrain and visibility. The ultimate goal of an approach should be to allow the aircraft to descend through restrictive weather conditions to an altitude where conditions exist that will permit mission accomplishment.

Regardless of the kind of approach, the navigational aid at the letdown point should be oriented so that it emits its signal away from the FEBA, thus minimizing enemy detection.

Altimeter Setting: Elevation data obtained from the map will be the primary input for altimeter settings whenever up-to-date barometric pressure information is not available. Even when reliable altimeter settings can be obtained from meteorological sources, the aviator must carefully calculate altimeter indication variations to ensure terrain or obstacle clearance. Altimeter mechanical error, changes in meteorological conditions and irregular vegetation on the terrain can combine to produce a significant difference between the indicated altitude and the actual height above the terrain. Ensuring that the altimeter is set to the terrain elevation (learned from close and intensive map study) can be a valuable aid in holding altimeter error to a minimum.

Fuel Requirements: Map study —coupled with wind information —provides the aviator an early indication of fuel requirements so that he can plan routes and refueling stops as necessary. Time/distance computations to assist in navigation can be accomplished as a result of the map study.

Equipment Requirements: The aviator must make an inventory to ensure that all map sheets and charts or aids to navigation are present for the flight. Weight and balance computations, performance charts and special mission equipment should be checked and secured as part of the planning process. Survival equipment, a necessity for all modes of flight, also should be checked for the mission.

Night Operations: Tactical instrument flight at night should be conducted primarily in the same manner as it is conducted during the day. However, when transitioning from tactical instrument flight to visual flight at the point of letdown, a light source must be present to provide a visual reference point for the aviator. The lighted "T", "Y" or similar reference symbol may be used. If the landing site is located at a location other than the letdown point, a second light source to assist in landing also may be necessary.

Standing operating and planning procedures should be established in individual units to ensure complete and thorough permission tactical instrument flight planning. The procedures and steps outlined and discussed here can be used as a guide or sample and modified to meet specific mission requirements and unit needs. The thoroughness required in the planning process for tactical instrument flight cannot be overstressed!

Soviet Night Operations

Continued from page 3

threat of nuclear weapons would alter this philosophy, as dispersion is then very important.

Figure 1 shows a typical night march formation of a Soviet motorized rifle company.[5] As can be seen in figure 1, night vision devices are found with the flank security patrols and in the columns of the main unit as well. CBR (chemical, biological and radiological) reconnaissance is a vital part of all Soviet security plans (figure 2).

The distances between the lead scout car and the flank guard from the main body are not as great as they would be in daylight, although the flank guard may be up to 5 km distance from the columns. Of course there are other constraints and precautions which must be taken when moving troops at night. Soviet writing in this regard is interesting: *"Camouflage is one of the most important measures in ensuring secrecy in the composition of a night march. It helps towards delivery of a surprise strike against the enemy in the encounter battle (which we might call movement to contact or reconnaissance in force) and makes it possible to achieve victories over him with fewer losses. Bearing in mind the most important give-away signs of columns moving at night and of troops at rest (lights and noise), it is necessary when organizing the march to plan . . . measures for camouflage. Observance of black-out discipline is of very great importance at night since the lights from burning headlights, from the inside lighting in vehicle cabs, and in tanks when the hatches are open . . . lighted matches when personnel are smoking and so on, are visible a long way off in the darkness."*[6]

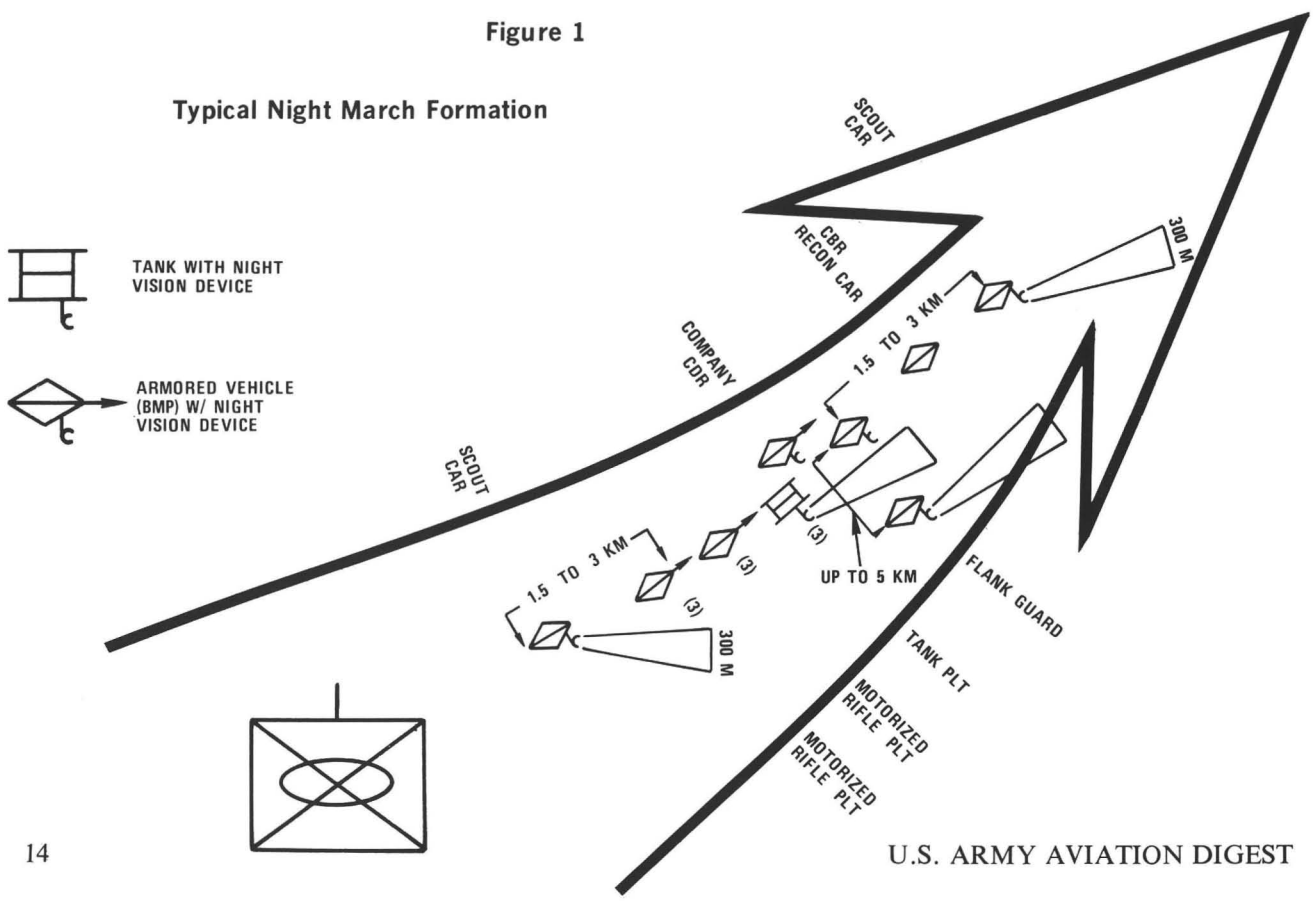
The Soviets are conscious of noises as well as lighting which may jeopardize their night operations. Figures 3 and 4 depict the estimated ranges of lights and noises respectively which may be detected at night.[7 & 8]

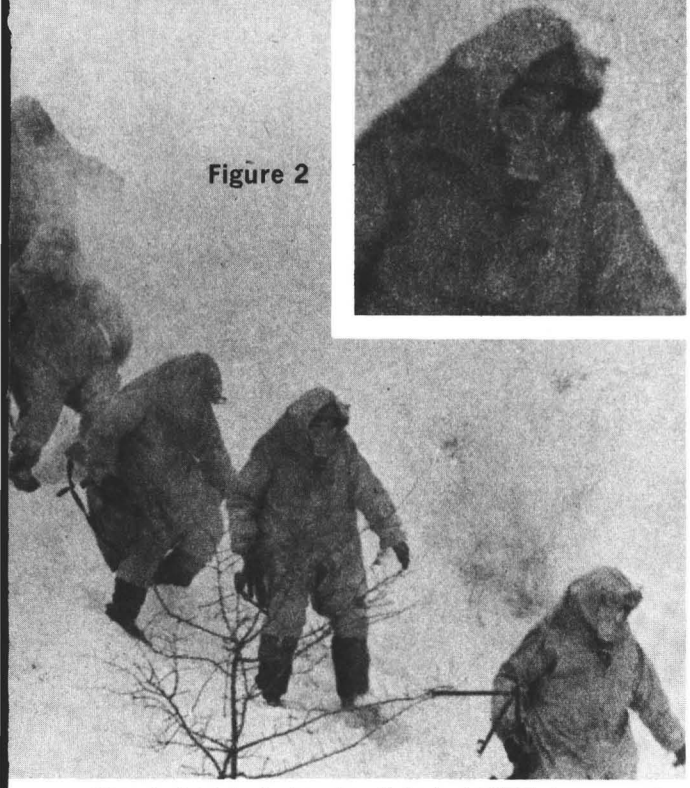
Rest periods also are planned in such a fashion as to attract little or no attention from possible enemy reconnaissance patrols. *"During stops and halts at night, blackout and soundmasking discipline should be strictly observed. The slightest infringement of this requirement may attract the attention of an enemy reconnaissance group and make it possible for him to detect the [small unit] column."*[9]

Regarding exercises and training for actual combat operations at night, an interesting, though unaccred-

Figure 1

Typical Night March Formation





Chemical, biological and radiological (CBR) teams such as this one form a vital part of all Soviet security plans

ited article appeared in the Soviet publication *Military Herald* in June 1973. Again, the keynote is preparation. The author suggests, *"When conducting a tactical exercise, the exercise director should demand of the small-unit leaders a careful organization and comprehensive support plan for night combat, as well as a maximum effective utilization of illumination devices. It is equally important to ensure that troop control is continuous, with no confusion or mixing of combat formations.*

"In order for night training to meet today's increased demands, commanders and staffs should first and foremost correctly plan such training and organize a close watch on training progress . . . As is well known, success in night combat depends in large measure on how small [maneuver] units are prepared for such actions during daylight hours. It is therefore better to begin exercises on night combat tactics while it is still light, giving personnel the opportunity to study the terrain and master those maneuvers which they will be called upon to execute in the dark."[10]

Planning and exercise activity for night operations are important to the Soviet commander, because night operations assure operational continuity. Numerous descriptions of Soviet night fighting have been reviewed; all typically stress extensive planning and detailed operations orders, combined arms operations —including air dropped illuminators—and illumination flares after the battle has begun. The judicious use of night vision equipment also is heavily stressed. This concern probably is expressed with regard to

Figure 3

Range of visibility of different sources of light observed with the naked eye at night

Designation of Source of Light	Detection Range, up to km
Shining headlights of vehicles and tanks	4 to 8
Muzzle flashes of individual guns	4 to 5
Muzzle flashes from small arms	1.5 to 2
Bonfire	6 to 8
Lighted match	1.5
Lighted cigarette	0.5 to 0.8

Such attention to detail is not unusual in Soviet planning, and further emphasizes their serious intent of maximizing the use of darkness on the battlefield.

Figure 4

Sounds [noises] picked up by a man's hearing at night in open ground

Sounds [noises] Produced by Various Enemy Activities	Distance to Which a Man Picks Up the Different Sounds [noises]
Single shot from a rifle	2 to 3 km
Fire from automatic weapons	3 to 4 km
Movement of a tank:	
—over an earth road	1.2 km
—over a surfaced road	3 to 4 km
Movement of a vehicle:	
—over an earth road	500 meters
—over a surfaced road	1 km
Movement of troops in dismounted order:	
—over an earth road	300 meters
—over a surfaced road	600 meters
Loading of small arms	500 meters
Excavating trenches with a shovel in hard, stony ground	1 km
Conversation of several people	100 meters
Snap of a broken branch	80 meters
Steps of a solitary individual	40 meters

use of active infrared (IR) illuminators which can be detected by an opposing force. Low-light-level devices which are entering modern combat inventories would not create this detection problem.

Describing night combat, Soviet Colonel B. Nazarenko, writing in *Military Herald,* states, *"Night gives commanders of small units broader opportunities for display of initiative, resourcefulness, and military cunning than does the day, and permits them to deceive the enemy with respect to their true intentions."*[11] The article is entitled "The Battalion Attacks at Night," and the consistent points made in this paper exercise include extensive preparation

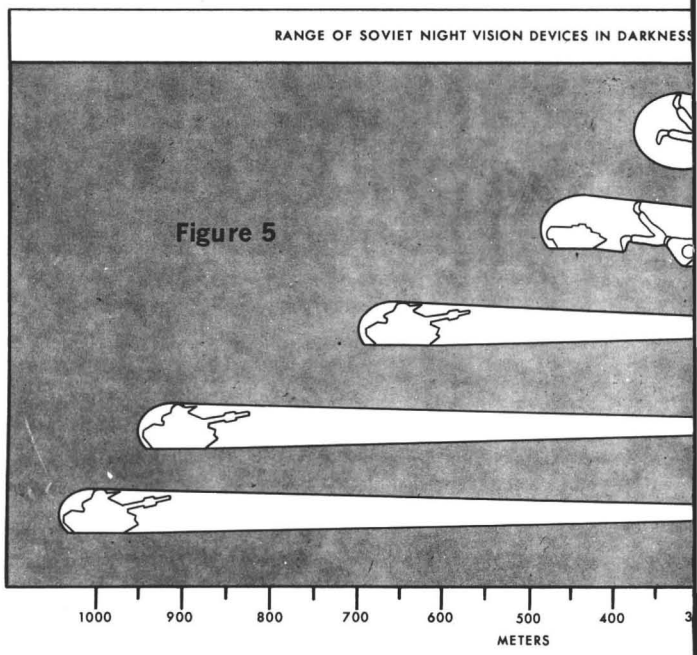
during the day leading to a night attack. The example in the paper was 2000 hours, dusk during the particular time of year.

Artillery fires had softened the objectives, and batteries were placed in direct support of two company-size task forces (armor attached). As to use of the night vision devices, it was stated, *"Instruments for firing and observation at night [would] be used with the launching of the attack, turning them on as necessary for a brief time."*[12]

Conscious of communications security measures, it is stated, *"The radios of the battalion commander's net operated only on receive, and control was accomplished using light signals. While moving out, the commanders of the smaller units [platoons] followed the observation of blackout measures. Night vision instruments were used to keep to the assigned direction while the vehicle drivers oriented on the marker lights and the lights beneath the bodies of the vehicles which were moving ahead."*[13] The operation reportedly made liberal use of illumination shells as the battle ensued.

Colonel Nazarenko stated that upon direction of the battalion commander, *". . . the mortar platoon began to illuminate the assault objectives. The intervals between the bursts of the illumination mortar rounds were about 500 meters. This created the most favorable conditions for the conduct of direct fire by the tanks, guns and antitank guided missiles."*[14] Evidently considered essential in the operations order was the neutralization of the enemy antitank strong points.

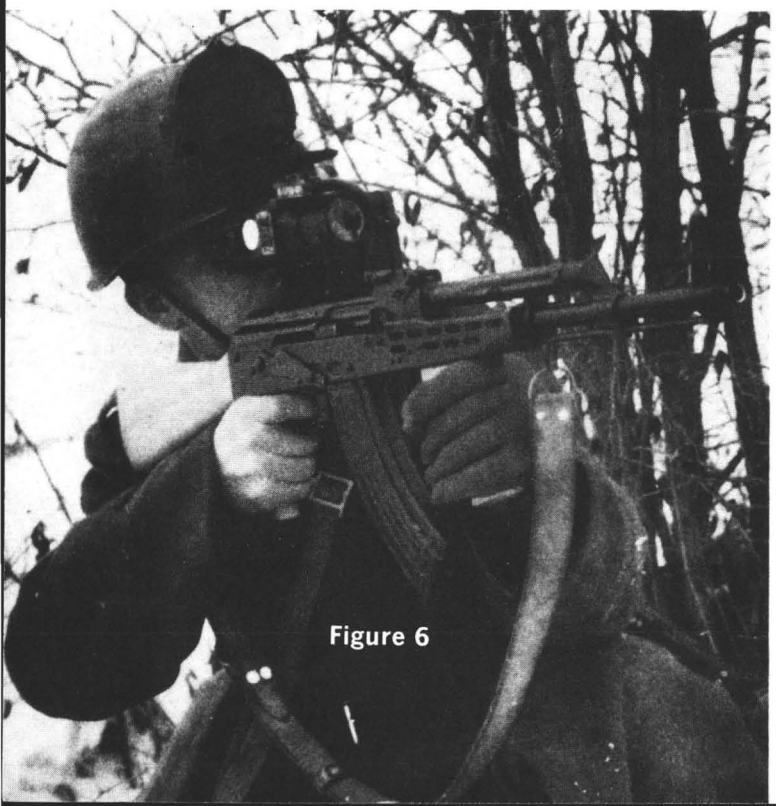
The Soviets have learned well the lessons forced



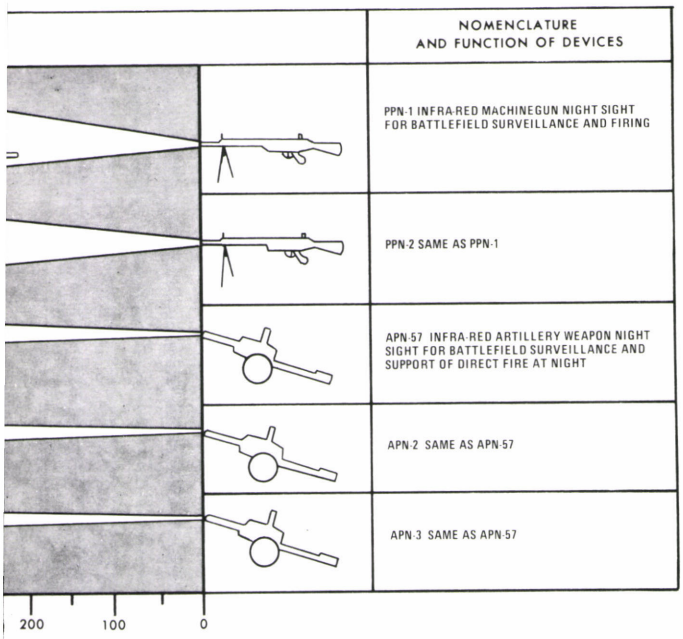
on them from World War II. They believe in the combined arms approach to ground combat, and rely heavily on armor. Their tactical operations, as seen in exercises, both games and real, stress knocking out enemy armor and maximizing their own use of tanks. Colonel Vorob'yev suggests, *"Even in the night battle, tanks remain the driving force of the attackers. They exploit every breach; every unoccupied gap in the enemy defenses to make a forceful dash forward. Using night vision devices or artificial illumination of [the] ground, they conduct [sic] fire on detected targets and muzzle flashes and also against targets indicated by the motorized rifle [platoons]."*[15]

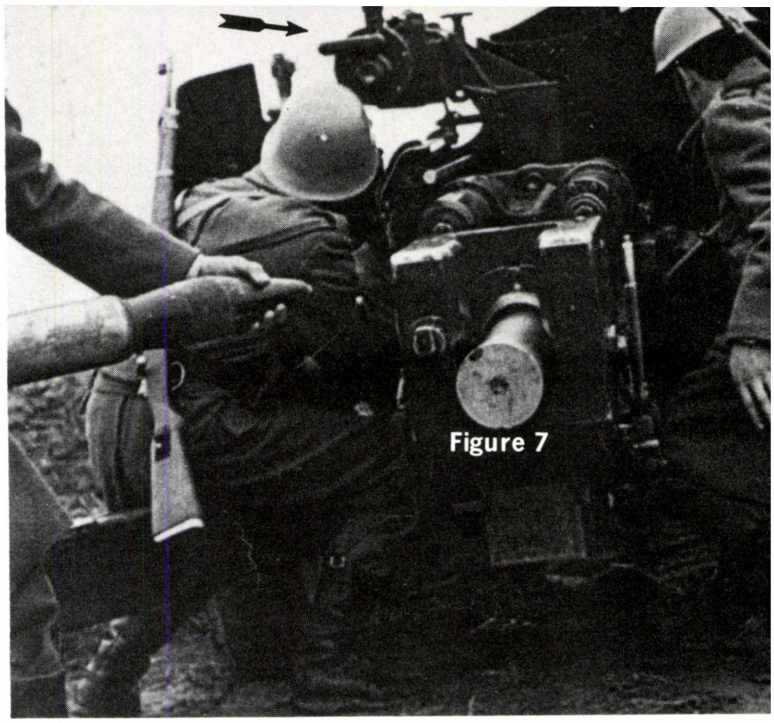
Tactical points made by the Soviet authors are that the tanks would typically lead the combined arms advance, perhaps by a 100 to 150-meter distance. When a natural obstacle, such as a ravine, or a stream or river with a steep bank is encountered, the tanks will fall back and follow the motorized rifle units. *"In this case the tanks support the attacking [platoons] with stationary fire . . . This method makes it possible for tanks to negotiate the obstacle in the most accessible sector, under the cover of artillery and motorized rifle [platoons]. However, at the first opportunity tanks should break out in front again and bring the motorized rifle units behind them."*[16]

As for operation of actual night vision equipment, figure 5 depicts Soviet estimates of certain of their devices. As can be seen, the active IR, infantry-type



Soviet night vision device for general infantry purposes. The IR device is mounted on a Kalashnikov machinegun





The gunsight shown is thought to be a night vision intensifier. It is mounted on a 100 mm T-12 antitank gun

PPN-2, for use on machineguns, has a capability of detecting targets out to about 500 meters. The APN-3 is an artillery support night vision device shown at the bottom of figure 5 with a 1,000-meter range.[17]

The photos in figures 6 and 7 are Soviet night vision devices in use today. Figure 6 shows an active IR night vision device on a Kalashnikov machinegun. It could be the PPN-1 system, or a later, similar model. This is a Soviet night vision device for general infantry purposes.

The gunsight in figure 7 is believed to be a Soviet night vision image intensifier. It is shown on a 100 mm T-12 antitank gun.

In summary, Soviet night fighting is a critical aspect of maintaining the momentum. This is Soviet doctrine, hard and fast. Equally important, Soviet understandings of how battles are won or lost seem to stress the fact that one side must achieve a critical combat advantage over the opposition by masking his concentration of forces. Writings on the criticality of surprise and the value of night operations all support this philosophy. The Soviet commander masks his concentration by making maximum use of night to either prepare for daytime combat, using his engineers or moving artillery positions or by actually fighting at night with the aid of battlefield illumination devices and night vision or sighting systems. Extensive planning and exercise activity indicate that the Soviets are serious practitioners of continuous operations through night combat.

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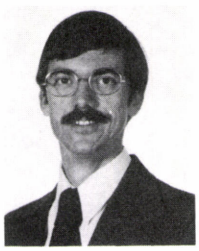

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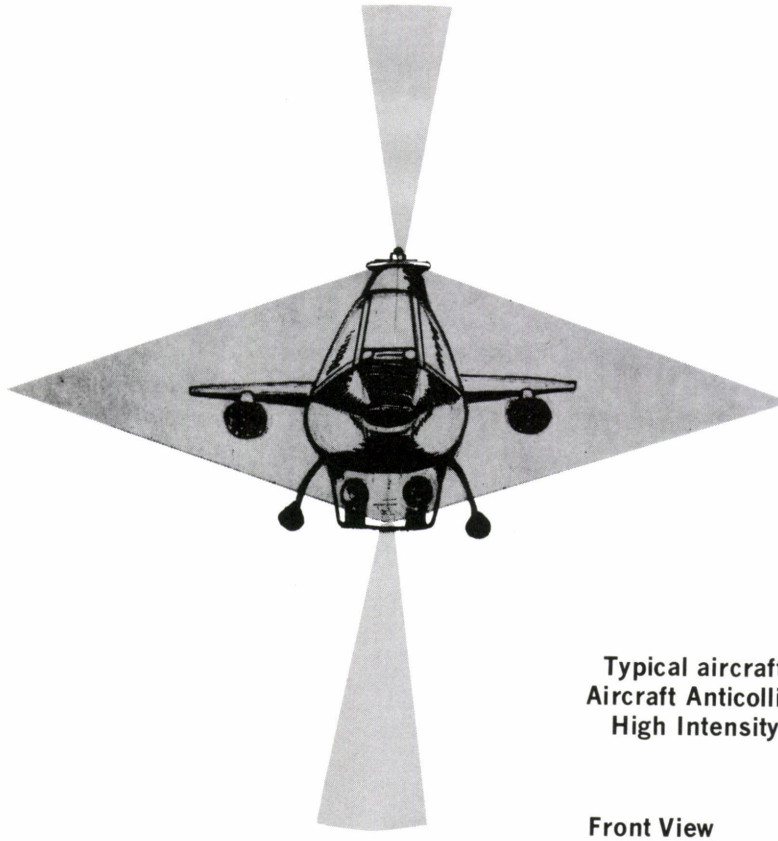


Typical aircraft coverage with the Aircraft Anticollision Beacon System High Intensity Light (AABSHIL)

Front View

ILSAA

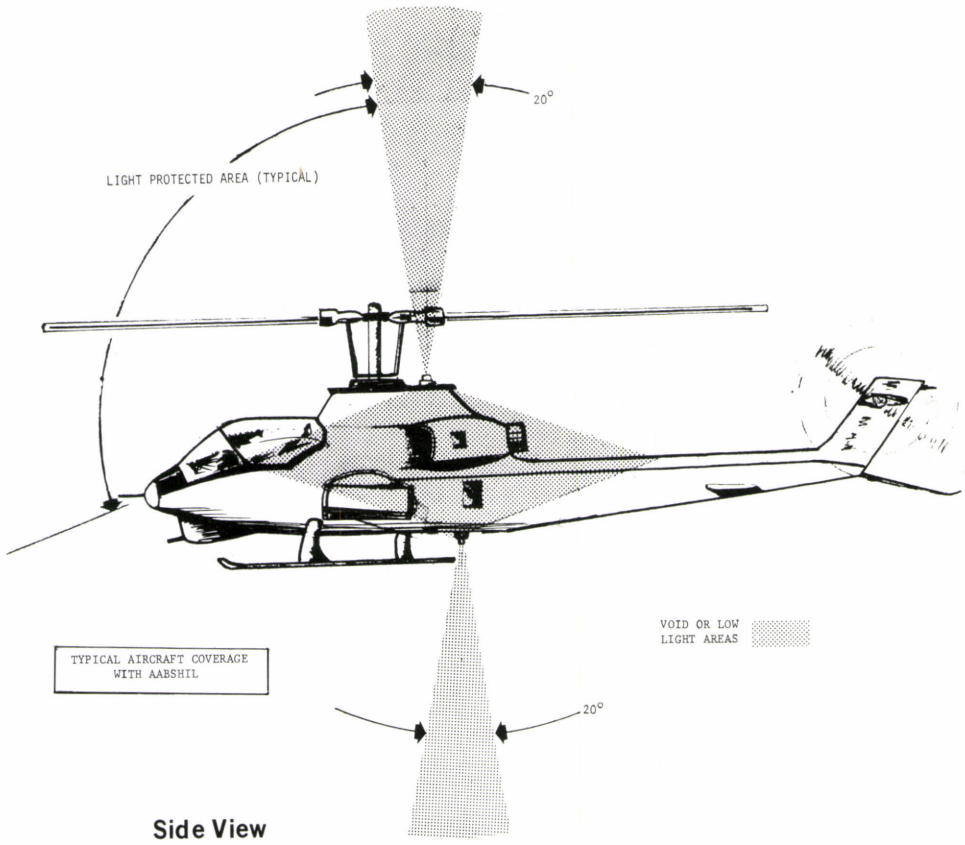
Mr. Silas G. Garrett

U.S. Army Aviation Systems Command
Director for RD&E
St. Louis, MO

SOMEWHERE ENROUTE to providing necessary improvments to Army aircraft, all of the many ideas being presented must be conjunctively analyzed and channeled into a common plan of action.

In addition, the airframe, avionics and tactical innovations we have become aware of are worthless unless our aircraft are so equipped to survive pursuant to mission accomplishments. With Army aircraft vulnerable to enemy action via their lighting and/or inability to tactically perform for the same reason, we have a mandate to effectively improve that lighting.

Early in 1974, a draft proposed required operational capability (PROC) for required improvments in aircraft lighting systems was prepared jointly by the "user"



Side View

Improved Lighting System For Army Aircraft

and developer communities and submitted to the technical community for comment. The requirement calls for an all inclusive effort to provide significant improvements to all tactical Army aircraft lighting and associated equipment.

Since the requirement involves several types of aircraft, and since lighting subsystems are basically different on each aircraft, the task of introducing ILSAA in an efficient, yet cost effective manner, is formidable.

The PROC for ILSAA resulted from many lighting deficiencies on existing Army aircraft. For many years "users" have tolerated undesirable lighting features. Among other things, limited IFR (instrument flight rules) capabilities and recent changes in the tactical doctrine involving use of night vision devices, during night low level formation flight, dictate that these lighting deficiencies be corrected, often as a matter of survivability.

One reason why this proliferation of inadequate lighting exists is that the Army has relied on prime manufacturers to make decisions for the Army and provide systems which they determined to be good for Army aviation. This permitted extensive diversity of opinions and ensuing hardware.

Historically, during past acquisitions of aircraft, there was little or no consideration given to realistic Army aircraft operational environment requirements.

Another source of problems has been the fragmentation of overall efforts of the Army in the aircraft lighting arena. No real concerted application of engineering progress has resulted. We have the multitude of lighting subsystems you now see incorporated on Army aircraft, stemming from this kind of past uncoordinated effort.

As an example of a source of our problems, when asked by the prime manufacturer what we required in the way of lighting subsystems, we had no standards to address and no qualification criteria to express our real requirements. ILSAA is intended to fill those gaps.

Since the ILSAA PROC covers all lighting systems, both *interior* and *exterior*, the problem has been separated into those two categories. As stated, an early effort must be one of establishing basic lighting requirements as standard.

The problems of interior lighting are numerous and complex—to name a few—cockpit spectural glare and reflections, stray lighting, nonuniformity of display lighting, independent illumination controls, incompatibility with night vision devices, sunlight washout, etc. All of these factors serve to contribute to crew and mission inefficiencies as well as potential safety hazards.

In the exterior lighting area, problems exist with regards to inadequate formation lights, landing lights and searchlights. As examples, these last two items have a tendency to produce backscatter and introduce glare back into the cockpit. Recent reports from various field activities indicate the extent and seriousness of these problems.

An additional problem is the external signature which results from emanation of light from existing instrument lighting, providing sufficient signal for detection by modern sophisticated weapons.

Current efforts are directed towards specifically identifying each problem and its relationship to other problems. Near-term solutions, with their associated cost estimates, are being identified where appropriate. As hardware solutions appear, draft letters of agreement (LOAs) or letter requirements are being prepared.

Like all programs, the success of ILSAA will be dependent upon the quality and extent of the effort expended. A joint working nucleus, currently identified as the Army Technical Advisory Committee For Aircraft Lighting, has been established to organize the overall effort and provide continuing technical advice and coordination. This will include formulation of development plans and approaches and monitoring of the integration of tasks and subtasks. This group will include working level representation from each cognizant lab, office or agency.

In view of the stated Army aircraft lighting deficiencies, current state-of-the-art and mission requirements, the objectives of ILSAA are loud and clear. These objectives must include formulation of firm realistic lighting specifications consistent with Army operational requirements and current logistical support concepts. We must improve equipment immediately for interim fixes to allow training and operations with and without night vision devices to maintain a degree of readiness and simultaneously develop new concepts and equipment for future applications.

Currently available technology for aircraft lighting such as electroluminescent (EL) panels, solid-state electronics, fibre-optics and light emitting diodes offer us solutions to many of the existing aircraft lighting problems. However, proper organization and execution of ILSAA are necessary, along with the necessary funding of the proposed improvements, to achieve a completely integrated lighting system which meets the Army's requirements.

Some programs for aircraft lighting improvements have already become fact. For example, the ILSAA effort includes all Army aircraft lighting except the anticollision light system. This system, previously known as the Aircraft Anticollision Beacon System, High Intensity Light (AABSHIL), is the result of a Materiel Need (MN(A)) document, approved in July 1972, and for which the initial contract was awarded at the end of June 1975. This system is designed to provide significant improvements to aircraft conspicuity and thus intended to prevent mid-air collisions involving aircraft. This system provides spherical coverage from topside and bottomside light sources. A minimum of 3,500 candles (white strobe for daylight) in the horizontal plane is required, as compared to approximately 100 candlepower (red incandescent) of the current rotating beacon. A red strobe of 150 to 250 candles is provided for night. The U. S. Air Force, U. S. Navy, U. S. Coast Guard and foreign governments having been involved in the project from inception, plan to use this system as standard. The Army is far ahead of the other services on AABSHIL which has resulted in their plans to use it.

In conclusion, the requirement for this extensive effort exists and is urgent. It should be supported as a high priority project. For more information pertaining to this article, contact U. S. Army Aviation Systems Command, AMSAV-EXR, ATTN: S. G. Garrett, Box 209, St. Louis, MO, 63166 or call AUTOVON 698-3821.

NIGHT HAWK TRAINING TEST

Part II: The Procedures

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THERE WAS A time when students were graduated from the U. S. Army Aviation Center's flight school with a minimum of instruction in night flying techniques. This resulted in excellent all-weather aviators—for daytime operations. But *after sunset* the requirement continues for aircraft and Army aviators to fly combat missions.

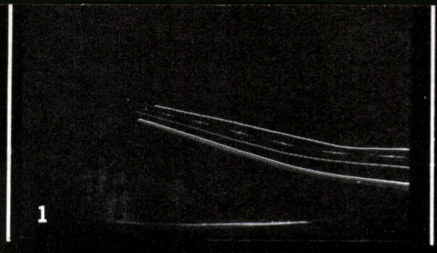
Things have changed now. The increased emphasis on night training throughout the world is bringing forth a wealth of material on night flying techniques. Tests and research teams continue to provide the aviator with the most current methods of safe night flight.

One of the most significant developments in night flight training is Night Hawk, the Aviation Center's test which was discussed last month in CW2 David Heaton's "Night Hawk Training Test, Part I: The Overview." While Dave takes a broad look at the Night Hawk Training Test, this article deals more with details of flight techniques and problems encountered during the test.

Phase I of Night Hawk consisted of a group of Aviation Center SIPs (standardization instructor pilots) whose combined flight hours probably total enough to fly a UH-1 to the moon and back. A series of maneuvers were performed in the UH-1H Huey under multiple aircraft lighting configurations. It started with full lighting (navigation lights steady bright with the use of landing/searchlight). It ended without the use of any aircraft lighting.

Concerning the night tactical aspect, the less lights the better. All basic transition maneuvers, to include external loads and tactical landing zone operations, were performed. By the end of this phase each participant could perform all maneuvers including autorotation with turn without the use of any aircraft lighting to a lane with only one acquisition light on the approach/departure end. The simulated antitorque failure maneuver was eliminated from the syllabus because aviators are limited by physiological characteristics which cannot be overcome. Antitorque maneuvers were performed but when the aircraft began to rotate on the vertical axis, fluid in the pilot's inner ear combined with minimum visional ground references resulted in unusual attitudes of the aircraft and vertigo for the pilot.

Phase II: Now, it was understandable that high-time aviators could perform in extreme dark with minimum lights, *but could an IP (instructor pilot) with a student?* After selection of IPs (see Part I, last month) a stagefield a considerable distance from "civilization" was requested because once



Time exposures of Night Hawk training. 1. Normal takeoff. 2. Approach angle leaves a lot to be desired. 3. Overcontrol on touchdown. 4. Terminating with landing light on. 5. Departure from LZ; while one enters downwind

full night vision is attained, any direct or indirect lighting tends to destroy function of rod cells in the eyes *(AVIATION DIGEST,* July 1975 "Night Vision"; read it). We began using all lights available on the aircraft—then the lights were turned out and stagefield lighting went to a *minimum.*

Let's clarify *minimum* lights. We used five lanes for maneuvers. Lanes 2 and 4 had runway lights set at the lowest setting. Lanes 1, 3 and 5 had only acquisition lights—one light to tell where the concrete began and one where it ended. The only reason for having runway lights on lanes 2 and 4 was to align on final.

Some nights it was extremely difficult to positively identify your intended lane. Each IP received 18 hours of night instruction. No sunset flying was done. Phase I had established a fatigue level of about 1.3 hours as a maximum for a useful training period. Proper diet and sleep were musts. With a good period of sleep, at least 8 hours, an instructor could give each student 1.3 hours of flight instruction under minimum light conditions. After instructing two students the instructor starts making mistakes in control input and altitude recognition. This doesn't sound like a long period, but when you are performing standard and low level autorotations, *mistakes cannot be tolerated.* Without using the landing/searchlight while approaching an unlit lane, an instructor's limits can be exceeded in the blink of an eye.

While in Phase II, we held extensive debriefing periods sometimes lasting until 0300 hours. Also present were technical observers (see Part I) and foreign officers who not only participated during debriefings, but also had the nerve to ride back seats. During debriefings, suggestions were welcome and many ideas and facts were discussed.

After completion of Phase II, the instructors received a checkride for standardization purposes in preparation for Phase III. Autorotation with turn was eliminated from the syllabus because advanced teamwork was required to monitor and control rotor RPM (revolutions per minute). Also, the visual scan pattern required to maintain the proper attitude of the aircraft throughout the turn and align properly on final to a blacked out lane was too demanding.

Things tend to happen fast at night. During nights autorotations, it is extremely difficult to divide your attention from the interior to the exterior environment of the aircraft. At the same time it is necessary to cope with the multiple physiological problems developing. Vertical descents during autorotations could prove disastrous. They give the body the sensation of floating which results in finding yourself lower than imagined, *with a high rate of descent.* The main objective in minimum light maneuvers was—and is—to approach the ground with a rate of descent slow enough that the pilot can react to impaired visual clues in time to affect a safe landing.

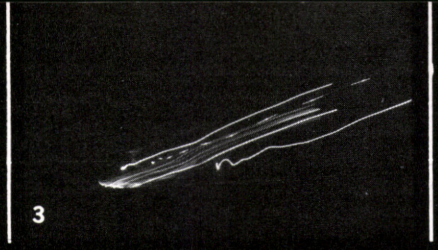
Each IP admitted a certain amount of anxiety was experienced about doing some maneuvers without lights. But after completion of Phase II, *the confidence was there.* Using the proper night vision techniques and strict light discipline, an aviator can judge 100 feet for beginning deceleration for a standard autorotation and, then again judge 10 to 15 feet for initial pitch and cushioning.

Cockpit lighting was altered by field expedient methods. Instrument lights were kept on the dimmest possible setting. Masking tape was used to filter the cockpit warning lights and also to cover the lights on the center pedestal, which cause a dangerous distraction when reflected on the pilot's windscreen. A pilot must be familiar with the location of all switches in a dark cockpit, for example, the low RPM audio, main fuel and hydraulic control. Critical switches are within inche of each other. Enough said!

The pilot's attitude indicator was a definite distraction. Its built-in lighting is too bright! When adjusting the pilot's rheostat to a proper level for the other instruments, the attitude indicator was still too bright. Maybe a filter would have helped.

Other problems were encountered from the pilot's seat (right). The instrument panel limits the scan pattern during some maneuvers such as low level autorotations. We found when operating low level more ground definition could be seen from the left door. This was caused by the difference in color of navigational lights on dim. Red defused lights did not affect night vision as did the green from the right.

Illumination weather briefings can help by giving the percentage of moonlight, visibility and clouds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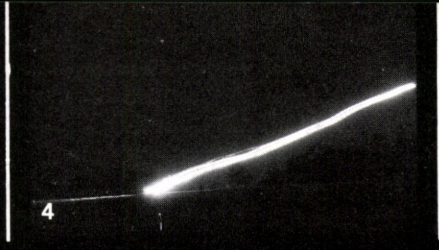
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to include fog predictions. But how dark is dark? Each night has varying degrees of darkness and many degrees were experienced. All phases lasted 4 weeks, covering a complete moon cycle. Sometimes during a traffic pattern the big light [moon] went out due to clouds; some nights it never shined through. Clouds were sometimes an aid depending on their altitude. Cloud layers between 2,000 and 8,000 feet reflect ambient light, making some nights easier to fly in than others. But visible moisture in the air created the number one problem of seeing and interpreting clues correctly. Lower Alabama is famous for hazy humid skys which can develop fog and low skud in minutes. Light rain was encountered only in Phase 1.

Stagefield familiarization was a must for all participants. We all were aware of the location of all hazards, wires, fences, high terrain and BIG OAK TREES—especially the oak off the approach end of lane 1 that appeared so close during low level autorotations. Using one traffic pattern for all lanes proved best instead of split stagefield traffic for different maneuvers.

Phase III: The final phase was the test class. Could student pilots with limited flight experience receive the instruction and develop the techniques safely? Sixteen initial entry rotary wing students were randomly selected from classes 75-17 and 75-18 after they completed instrument training. Each IP was assigned two students. All participants were night vision tested and received about 20 hours of academics on night flying and the physiological limits of man during darkness. In the future, all flight physicals performed prior to flight school will include a night vision test.

Students received 20 hours of day transition work to include external loads. Instructor pilot changes for students were kept to a minimum. The IPs had to be aware of the individual student's flying techniques and habits before the night phase began. Students were highly motivated and ready for the dark Night Hawk Test after completion of transition. We began a series of 4 weeks of night only. Preflight was performed during daylight and briefings were held at sunset. Night vision adaptation periods were cut in half with the use of red goggles and lighting. The goggles proved to be somewhat of a problem. Enroute to the aircraft the second period student led the IP and the other student. The red lenses were terrible to see with and they fogged continually. However, once removed, maximum night vision had been obtained.

Students received 20 hours of night instruction. Maneuvers during the first week were performed with all exterior lights available. From that point on, stagefield lights went to a minimum setting and landing and searchlights were adjusted for emergencies and turned out. But they were always ready if needed. It would have been nice if the copilot's (instructor's) collective had a light switch to immediately illuminate in a case that required immediate action by the IP.

During the third week of the night portion, each aircraft was flown a tactical low level route to landing zones with minimum lighting. Student proficiency with "no lights" approaches was already far superior to that of graduating aviators with more total night. During the last 1.3 hours of Night Hawk, the students received an evaluation ride from a different IP or SIP. All performed satisfactorily. The IP and student held daily critiques on each period of instruction and each maneuver. I wouldn't expect you to believe me if I told you there were no close calls. However, when completed, no mishaps had occurred! That is thanks to *professionalism,* the only way to go in Army aviation.

Keep in mind that Night Hawk was a test, and don't get the impression that the Aviation Center thinks autorotations should be done without landing lights and searchlights. However, methods and findings from this program will make night flight safer and help guarantee an around-the-clock capability. Maneuvers performed in Night Hawk are still under evaluation for insertion into the present student syllabus.

After completion of Phase III the students remained with the same instructors to complete the tactics phase of the Initial Entry Rotary Wing Course. All scheduled night training (12 hours) also was included during tactics.

During the first night-formation period, the students demonstrated such proficiency at night flying techniques that they were making formation approaches to pathfinders located in tactical landing zones with one light equivalent to a cigarette lighter. These classes were graduated from Fort Rucker more proficient at night flying than any before them.

Oh yes, there also was a report of another first: Seems there was a Friday Midnight Flyby. But, don't tell anyone I told you.

IN PAST CONFLICTS, aircrews of attack helicopters found it necessary to expend large volumes of fire to destroy a target. This was due to inaccurate sighting techniques and resulted in most of the projectiles missing targets.

Thus, it has become a common practice to "hose down" the target with a stream of projectiles. Adjustment then is made based on points of impact in relation to the target. This technique plays havoc with staying power by increasing both the ordnance logistical requirements and also the vulnerability of the attack helicopter, i.e., the enemy is alerted by the ineffective fire scattered near his position. Consequently the ultimate goal of every attack helicopter crew must be to hit the target with the first round or burst, and destroy it with a minimum expenditure of ammunition and exposure.

TC 17-17, "Gunnery Training for Attack Helicopters" (see "At Last—Realistic Aerial Gunnery Training," December 1975 *DIGEST*), contains a comprehensive aerial gunnery training program designed to develop the aircrew's gunnery proficiency. However, before this proficiency can be achieved, aircrews must know the delivery techniques that are used to place effective fire on a target. To this end, TC 1-4, "Helicopter Gunnery," has been written. Thus, the two TCs are complementary—they tell us *how to shoot* in two volumes.

Many Army aviators remember FM 1-40, "Helicopter Gunnery," as the only authority for aerial gunnery. But, FM 1-40 has become outdated as new doctrine emerges and weapon systems change. During the Vietnam era, it did provide tactical employment and technical information for armed and attack helicopter weapon systems. Today, weapon systems information is contained in the operator's handbook (dash 10) and TMs (technical manuals) for the appropriate system. Principles of employment for the attack helicopter are presented in publications written by the U. S. Army Aviation Center and the U. S. Army Armor School. Because they address subject material contained in FM 1-40, a new purpose and scope was developed for TC 1-4. As a result, the first how-to-shoot publication for the attack helicopter has been written.

The firing techniques old timers have used for years—but never have been put down in writing and pictures—now are presented in a single volume. TC 1-4 presents both proven ordnance delivery methods and new terrain firing techniques needed to survive in a high threat environment.

The primary thrust of this training circular is to provide information pertinent to the TOW (tube-launched, optically-tracked, wire-guided) missile system. It emphasizes the need for aircrews to employ attack helicopters as effective tank killers. The text provides aircrews with need-to-know information to

TC

Aircrew Gu
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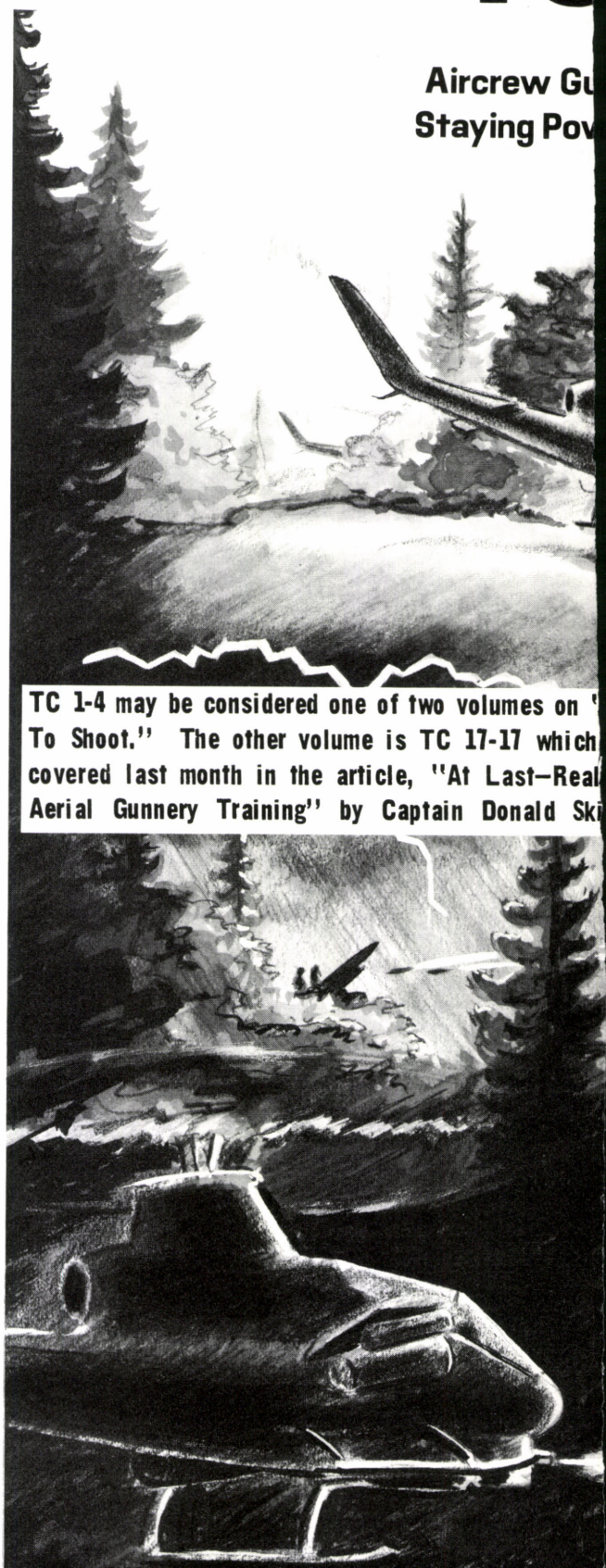


**TC 1-4 may be considered one of two volumes on '
To Shoot." The other volume is TC 17-17 which
covered last month in the article, "At Last—Real
Aerial Gunnery Training" by Captain Donald Ski**

1-4*

ry Accuracy = Survivability

Rush R. Wicker
Education Specialist
Training Developments Department
Deputy for Developments
U.S. Army Aviation Center

***The initial draft of TC 1-4 was distributed to units for field review in November 1975. The Department of the Army publication will be available by June 1976.**

ensure a high probability of kill and survivability against enemy armor. Unlike existing field manuals, TC 1-4 presents employment procedures as though the aircrews actually are engaging an enemy armored vehicle in a real-life situation.

Although the antiarmor role is a main mission of the attack helicopter, it also will be employed to engage personnel and equipment with light defenses. This mission requires that aircrews be proficient in the use of the turret (7.62 mm, 40 mm) and stowed (2.75 inch rocket, 20 mm) weapons. To effectively employ these weapons, aircrews must know how to use gunsights and how to correct for ballistic error.

Although many errors are compensated for in the gunsight, an aircrew member firing the weapon must apply certain corrections for ballistic error. To accurately compensate for specific conditions, a knowledge of aerial ballistics is required. The TC discusses those factors which affect the trajectory of the projectile from the time it is fired until it impacts the target. Specifically, it addresses ballistic factors that affect helicopter gunnery.

The M73 and the reflex gunsight installed on the attack helicopter are accurate sighting devices if properly used. A lack of knowledge in their use results in excessive expenditure of ammunition to hit a target. The procedures for harmonization and establishing combat sight setting are the most critical elements in improving the accuracy of the weapon. Therefore, these elements, plus sight adjustment, are emphasized in TC 1-4.

Since the 1973 Mideast War, terrain flight has been accented. Aircrews must be able to shoot while flying at low altitudes on the battlefield. Numerous nap-of-the-earth firing tests have been conducted within the Army. The data has been accumulated and developed for use by attack helicopter aircrews, and is contained in TC 1-4. An understanding in the use of these delivery techniques will enable aircrews to employ the attack helicopter as an effective aerial weapon and survive in a high threat environment.

Although the primary emphasis is placed on the subjects presented above, the TC also discusses tactical employment consideration, fire coordination, the 2.75 inch improved rocket system and aerial door gunnery training.

The ability of an attack helicopter aircrew to destroy enemy targets—and to win on the high threat battlefield—is a function of realistic training. However, before aircrewmen can engage in this type training they must acquire the basic skill of helicopter gunnery. In other words, they must learn to crawl before walking. Then, as aircrewmen learn basic skills and acquire proficiency through realistic training, they will be able to run. At this point, the attack helicopter can boast the staying power and the punch needed to survive on the high threat battlefield.

Continued from page 5

by the troops involved is the key to success in this environment.

Involvement in a night mission demonstrates how normal tasks become unnatural in the dark. The young aviator or crewman who has grown up with a light switch at his fingertips and a flashlight in his pocket is apprehensive. Similarly, some of our most adept commanders accept the idea that to conduct practice or actual night operations, you just shut off the lights and begin.

Army aviation today is focusing attention, once again, on a mid-intensity (high threat) warfare environment. Survival will require training, planning and aggressive operations.

The attack helicopter is receiving much attention as a highly mobile, quick reaction answer to helping stop the Warsaw Pact armor threat. The doctrine of this enemy stresses 24-hour operations. Recent articles in the *U. S. ARMY AVIATION DIGEST* (September 1974), *MILITARY REVIEW* (July 1974) and the *SOVIET MILITARY REVIEW* (December 1973) clearly document the enemy intent to use darkness to his advantage.

Today's equipment on the attack helicopter is basically rudimentary for night operations. Helicopters in the field do not have night vision devices nor night target acquisition devices as standard equipment. These items are expensive and require lengthy periods of development and acquisition. Electroluminescent station-keeping lights and the AN/PVS-5 night vision goggles are a start but they are not available as standard equipment with which we can fight.

Where we go and how far we get in the future will depend on budgets, people and equipment available. All of these items are critical in the Army today. The answer for the *immediate future* is to use what we have.

During the recent Combat Developments Experimentation Command (CDEC) experiments with the attack helicopter at night (Experiment 43.7, Clear Night Defense) it was found that there is much that can be done with the present equipment and aviators to meet the task of operational preparedness now.

To begin with we must motivate professional attack helicopter personnel and commanders to become involved in night operations. This will require aviation unit commanders to adjust their command supervision and commit themselves to allow increased ingenuity and imagination in unit training programs. All available flights will have to be used to the maximum tactical training advantage. Night environment operations will have to be adjusted upward even if current training regulations don't require it; they also do not prohibit it.

The current field manuals (FMs), training circulars (TCs) and standing operating procedures (SOPs) need to be changed and updated. FM 1-40, "Helicopter Gunnery," should explicitly require night attack helicopter gunnery in

Ground School Subjects	Hours
1. Orientation	2
2. Psychological and Physiological Aspects of Night Helicopter Operations	3
3. Meteorology and Ambient Light Phenomenum	2
4. Mission Planning	2
5. Night Flying Techniques	3
6. Night Low Level Emergency Procedures	1
7. Techniques of Low Level Navigation & Map Reading	9
8. Techniques of Low Level/ NOE Flying	3
9. Multiaircraft Operations	2
10. Firing Position Procedures	1
11. Tactical Considerations of Night Antitank Operations	2
Total Hours	30

Night Flying Program	Hours
1. Low Altitude/ Low Airspeed Proficiency (Daylight)	10
2. Night Refresher/ Proficiency Training	9
3. Reduced Altitude Navigation Training, Stage I	9
4. Firing Position Procedures	4
5. Reduced Altitude Navigation Training, Stage II	24
6. Nap-of-the-Earth Flight Training	15
7. Checkrides	9
Total Hours	80

Figure 1 Master Schedule

NOTE: The ambient light available determines to a great extent what flight training will be conducted. The duration of the course depends on the number of students and aircraft available, the student IP ratio and weather. Generally, each of the major blocks in the flying program will be performed during all three light levels. Checkrides will normally be conducted during low light level to provide the worst case situation. The classes should be offered and the flight instruction performed in the general sequence shown above.

NIGHT NAP-OF-THE-EARTH MASTER TRAINING SCHEDULE

STAGE/SUBJECT PRESENTED	TOTAL HOURS	SEQUENCE OF PRESENTATION WEEK OF TRAINING HOURS/STUDENT/WEEK 1	2	3	4	5	6	7	8	9	10	11	12
Preliminary Training Stage:													
Admin of Psych Test Battery	12	12	-	-	-	-	-	-	-	-	-	-	-
Area Orient Flight, Day—PE	1	1	-	-	-	-	-	-	-	-	-	-	-
(Intro to Onboard Equipment)	(1)	(1)	-	-	-	-	-	-	-	-	-	-	-
Proficiency/Stdzn Flight, Day—PE	2	2	-	-	-	-	-	-	-	-	-	-	-
(Attack Hel Acquisition Sys)	(2)	(2)	-	-	-	-	-	-	-	-	-	-	-
(Scout Hel Acquisition Sys)	(2)	(2)	-	-	-	-	-	-	-	-	-	-	-
Low Alt/Low Airspeed Prac, Day-PE	4	4	-	-	-	-	-	-	-	-	-	-	-
(Expert Design and Scenario)	(4)	(4)	-	-	-	-	-	-	-	-	-	-	-
Exper Instrumentation Instr	3	3	-	-	-	-	-	-	-	-	-	-	-
(Attack Hel Wpns Sys)	(3)	(3)	-	-	-	-	-	-	-	-	-	-	-
(Scout Hel ECW Sys)	(3)	(3)	-	-	-	-	-	-	-	-	-	-	-
Night Proficiency and Orientation:													
*Intro to Night Hel Operations	2	-	2	-	-	-	-	-	-	-	-	-	-
*Psych and Physio Aspects, Hel Night Opns	3	-	3	-	-	-	-	-	-	-	-	-	-
*Met and Ambient Light Phenom	2	-	2	-	-	-	-	-	-	-	-	-	-
Night Area Orientation Flight—PE	1	-	1	-	-	-	-	-	-	-	-	-	-
*Night Flying Techniques	3	-	3	-	-	-	-	-	-	-	-	-	-
Hovering, Takeoffs, Landings—PE	4	-	4	-	-	-	-	-	-	-	-	-	-
*Mission Planning	2	-	2	-	-	-	-	-	-	-	-	-	-
Night Cross Country—PE	4	-	4	-	-	-	-	-	-	-	-	-	-
*Tact Consideration, Night Hel Opns	2	-	2	-	-	-	-	-	-	-	-	-	-
Reduced Alt Opns, 500'—1000' AGL:													
*Night Low Level Emerg Procedures	1	-	-	1	-	-	-	-	-	-	-	-	-
*Tech of Low Level Nav and Map Reading	9	-	-	9	-	-	-	-	-	-	-	-	-
Flight Exercise 3-7—PE	8	-	-	5	3	-	-	-	-	-	-	-	-
(Threat Orgn, Tactics, Wpns Capabilities)	(5)	-	-	(5)	-	-	-	-	-	-	-	-	-
(Friendly Orgn, Tactics, Wpns Capabil)	(4)	-	-	-	(4)	-	-	-	-	-	-	-	-
*Multiaircraft Operations	2	-	-	-	2	-	-	-	-	-	-	-	-
Intro to Multiaircraft Opns—PE	1	-	-	-	1	-	-	-	-	-	-	-	-
Checkride #1—PE	3	-	-	-	3	-	-	-	-	-	-	-	-
Reduced Alt Opns, 250'—500' AGL:													
*Tech of Low Level/NOE Flying	2	-	-	-	-	2	-	-	-	-	-	-	-
Flight Exercise 8-14—PE	24	-	-	-	-	9	9	6	-	-	-	-	-
(Terrain Analysis and Map Interpret)	(24)	-	-	-	-	(9)	(9)	(6)	-	-	-	-	-
Checkride #2—PE	3	-	-	-	-	-	-	3	-	-	-	-	-
Firing Position Procedures:													
*Firing Position Procedures	1	-	-	-	-	-	-	-	1	-	-	-	-
Firing Position Procedures—PE	4	-	-	-	-	-	-	-	4	-	-	-	-
(Detect, Acqn and Handoff—Scout)	(4)	-	-	-	-	-	-	-	(4)	-	-	-	-
(Detect, Acqn and Handoff—Atk)	(4)	-	-	-	-	-	-	-	(4)	-	-	-	-
Reduced Alt Opns—Below 250' AGL:													
Tech of Low Level/NOE Flying	1	-	-	-	-	-	-	-	-	1	-	-	-
Flying Exercise 15-21—PE	15	-	-	-	-	-	-	-	-	6	6	3	-
(Communications Procedures)	(3)	-	-	-	-	-	-	-	-	(3)	-	-	-
(Combined Arms Operations)	(12)	-	-	-	-	-	-	-	-	(3)	(6)	(3)	-
Combined Arms Exercises	16	-	-	-	-	-	-	-	-	-	4	-	12
Checkride #3—PE	3	-	-	-	-	-	-	-	-	-	-	3	-
Repetitive Periods:													
Preflight/Postflight Insps	44	2	4	4	4	4	4	4	4	4	4	4	2
Mission Brief and Preflight Planning	116	6	5	5	11	9	11	11	15	13	14	14	2
Postflight Debriefing	44	2	4	4	4	4	4	4	4	4	4	4	2
Physical Training	36	-	-	4	4	4	4	4	4	4	4	4	-

NOTE: ( ) Indicates Concurrent Training
* Indicates Ground School Subjects

Figure 2

a tactical night nap-of-the-earth (NOE) mode, including multiple aircraft operations. FM 1-100, "Army Aviation Utilization," should classify and address the advantages of night employment of the attack helicopter as an offensive type weapon. The 5-hour night program of instruction in TC 1-15, "Nap-Of-The-Earth Flight Training," is inadequate for training. A course of night helicopter operations, to include the attack helicopter, should be compiled and published as soon as possible. These and other publications must stress the increase in combat capability provided by night operations rather than lengthy discourses on the limitations. Success requires a positive attitude be injected into our programs and directives.

The crew concept is another important source. The Owl Team concept used during CDEC's Experiment 43.7 proved valuable. The group interaction, by mutual or reciprocal action and influence, created superb teamwork. Each team member knew enough of the other members' jobs and personalities to anticipate their actions and react accordingly—thus enabling the crew to operate as a single entity.

The task group concept of the Owl Team provided encouragement, stimulated self-direction and allowed participation at all levels of operations. Each member had a chance to be heard and to contribute to the accomplishment of the experiment. The crew concept provided a psychological boost in an environment filled with anxiety and uncertainty created by operating NOE in the "dead man zone" of the aircraft operating limitations.

It appears that training attack helicopter pilots to operate in the night environment is best done using the crew concept with crews grouped together as tactical teams. The crew, as a part of the crew concept, should consider all crew members, including enlisted personnel assigned to service and maintain the aircraft, so that all become physiologically and psychologically involved.

The POI (program of instruction) of the CDEC Owl Team is a recommended source for planning and developing a unit night tactical training SOP. Figure 1 is the condensed master training schedule developed by the Owl Team during its baseline experiment. The 30 hours of classroom instruction depicted were developed and presented by the Owl Team members themselves. Figure 2 is the complete schedule of training broken down into training periods per week for the 12-week training cycle. It is provided as a suggested place to start in planning unit training for night attack helicopter operations. Note that initial day NOE training was a prerequisite to starting the night training program.

Since Army aviation today is involved in intensive day NOE training, this requirement already will have been met by most crews selected to undergo night operational training. It also has been determined that some aviators will progress more rapidly and may become proficient with less than the 80 hours recommended. This will depend on previous experience, motivation, aircraft qualification and utilization of the best possible night vision techniques.

Training, a concept itself, is important in night operations with the attack helicopter. Training can be defined as the "state of being trained." In real life a crew is never fully trained. Each member of a crew or the complete crew itself may be operationally ready but it would be impossible to say that the crew is ready for every emergency or situation that may arise. Therefore, all aviation personnel, including support personnel, must be constantly in training. This is even more important in the night environment.

Once the initial training has been completed, proficiency cannot be maintained unless the training process continues. Army regulations state that the commander is responsible for all training. To be realistic, each man in the organization is responsible and should become involved. Such involvement, fostered by the crew concept, helps eliminate some of the physical and mental dangers of the night environment.

Last but not least, we must prepare ourselves to use what is currently available to increase our night capability. Waiting for new devices is risky. Lead times for development and production can be, and usually are, lengthy. We must prepare ourselves now, in a peacetime situation, using what we have.

Volunteers should be requested and special training teams set up to visit attack helicopter units to get the ball rolling. Basic training in night NOE operations initially should be conducted at the U. S. Army Aviation Center, Fort Rucker. This training, combined with intensive unit training, would form a nucleus of night attack helicopter qualified personnel for each unit. Command support is required since night training is not cheap, nor easily accomplished.

Until night vision aids are a reality, night flight and tactical night NOE employment must be accomplished with the standard aviator and the standard helicopter. We can't wait for the "golden egg" to hatch. We must train to be ready to meet our NATO (North Atlantic Treaty Organization) and national security commitments now.

An old Chinese proverb states: "The more you sweat in peace, the less you bleed in war." Army aviation must place more "sweat" on night operations, especially the armor defeating attack helicopter, *now!*

USAASO Sez

Automatic Approach Lights

Getting It Correct

LIGHT THE WAY. Time was when airport/approach lighting was left turned on all night for the pilot who might arrive, for position fixing, or for overflight emergency use. The high cost of energy required to maintain this service is known to all. Lights are now turned off at most airports to conserve energy. Call the tower at an attended airport and an operations person will give you the runway or approach lights you want for the time you need them. No real impact is involved, except you need a radio. For unattended airports there is a new problem—and solution. Don't buzz the closed tower with the hope some one wakes up and turns the switches. WAKE UP and observe that FAA (Federal Aviation Administration) is placing radio controlled light systems at many unattended locations as fast as systems become available. Key the radio mike button and light your way. Specific system details and information are published in DOD FLIP and AIM, Part II. These systems are normally activated by VHF radio signals; however, FAA is planning to expand this service for UHF activation at locations identified to them where there is a military need.

USSAASO Sez—Requirements for UHF service should be made known through command channels.

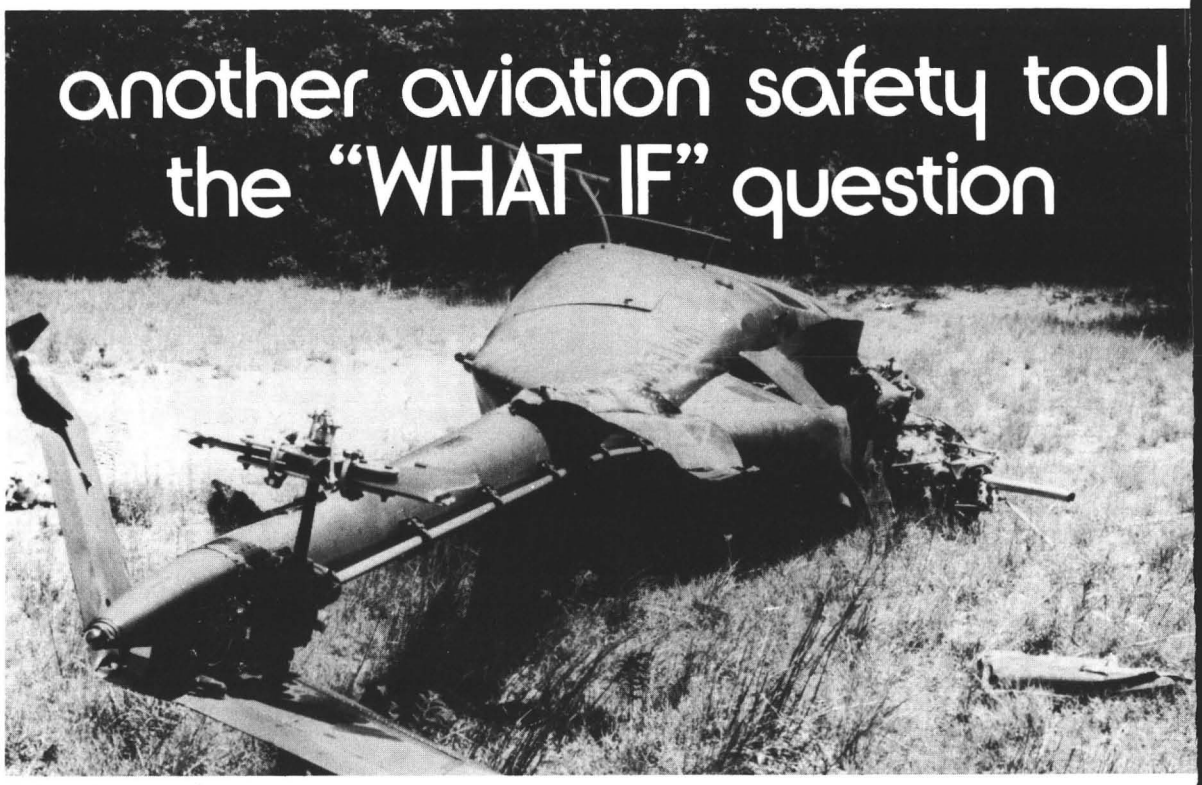
FLIP ERADICATION. Aviators somehow find a way to build a new "Murphy" every now and then. We keep selling the need for everyone to check flight information sources and report errors to us for correction. Now that you all are doing such a good job it may be time to go one step further.

For example, we occasionally get different communication cards from different folks at the same location saying different things about the same problem. Many calls later we find which is correct and initiate a publication change. The phrase "we're all in the same Army" may often be narrowed down to "we're all at the same airfield." The small end of the info funnel at a particular location should probably be the operations officer. If he's doing his thing properly when you report errors in and around your airpatch, he can investigate, validate, and correct if necessary—or even explain why something is the way it is.

In another area—you operation officers should check each issue of FLIP for all data involving your facility. You may be surprised to find that we or the publication house may have changed the meaning or intent of your entry data during the editing process. In a recent case, the GPI and TCN for a precision radar system was listed wrong for several cycles before it was discovered. However, at the local level, official support documents and flight check records were not cross referenced and the error corrected.

Even though we have gotten super professional in recent years, what with standardization boards, ATC agencies, flight safety elements, etc., we must remember the airfield commander is responsible for all that goes on, in, around and over that airpatch. His central agent for correct information and verification is usually the operations officer or other designee whom everyone knows. For pilot procedural related errors, check with your standardization people.

another aviation safety tool the "WHAT IF" question



Colonel E. P. Lukert Jr.

USAAAVS

A West Point graduate and a Master Army Aviator, COL Lukert is Director, Military Capabilities Studies—Mid East and Africa, Department of Military Planning and Strategy, U. S. Army War College, Carlisle Barracks, PA

CW3 MIKE CLARK was feeling much better now that the initial shock of the accident had worn off. In fact, having had his commander, Major Thomas, congratulate him for putting the bird down in that small hole without any injuries almost made him feel okay. However, those broken skids and splintered blades meant his first accident would be a major one. Just a little more luck and he would have been receiving a Broken Wing Award instead of facing an accident board. Well, the accident board should be no problem. There's no question that it was complete engine failure. After all, they can't hold a guy responsible for that, can they?

Unfortunately, Mr. Clark was in for a rude shock when the accident board's report was finished. It wasn't the engine failure or the tree stump in the touchdown area which made him look like a clod. It was the long list of other items which made him look nonprofessional—things which Clark *knew* were totally unrelated to the accident:

- Improper flight plan—passenger list incomplete.

- Crewmember wearing fatigues, not Nomex.
- Logging IP time when not actually giving instruction.
- Failure to brief passengers on emergency procedures.
- Failure to use the checklist for preflight.

On and on went the list! *And that's what this article is all about.*

Just about any thorough accident investigation will uncover a similar list of errors, violations or omissions which may not have a direct relationship to the accident under investigation, but in themselves are potential causes for other accidents or disasters. In trying to establish an effective aviation safety program for the 101st Aviation Group, which was reforming at Fort Campbell, KY, in 1972, I wanted to take advantage of such findings before the accident rather than after the fact. In an attempt to obtain this information, I instituted a "What if that flight had ended in an accident?" procedure.

In its simplest form, this procedure consisted of selecting, at random, a tail number of an aircraft in flight for the "what if?" treatment. As soon as the selected aircraft landed, the safety officer would hold the crew and aircraft until he activated the crash alarm system (test mode). We usually assumed that the skids had failed upon shutdown or some other simple accident so that some facts could be reported through the crash alarm system. We then followed normal procedures in appointing an accident board and let them go to work.

When the "what if?" accident report was finished, we had a lot of useful information for our aviation safety program. First, we knew where our problems were throughout the entire accident reporting chain. Everything from defects in accident notification to the difficulty in finding a flight surgeon. As for the flight investigated, we not only had a list of crew errors, but also indications of faulty regulations and flight procedures established by the command.

The use of this information is obvious. Correct command deficiencies first. Next, use crew errors as a discussion topic at the next unit safety meeting. Have the involved crew conduct the discussion. Peer pressure and professional pride will reduce subsequent crew errors overnight. It also helps mold crew attitudes for aviation safety and professionalism.

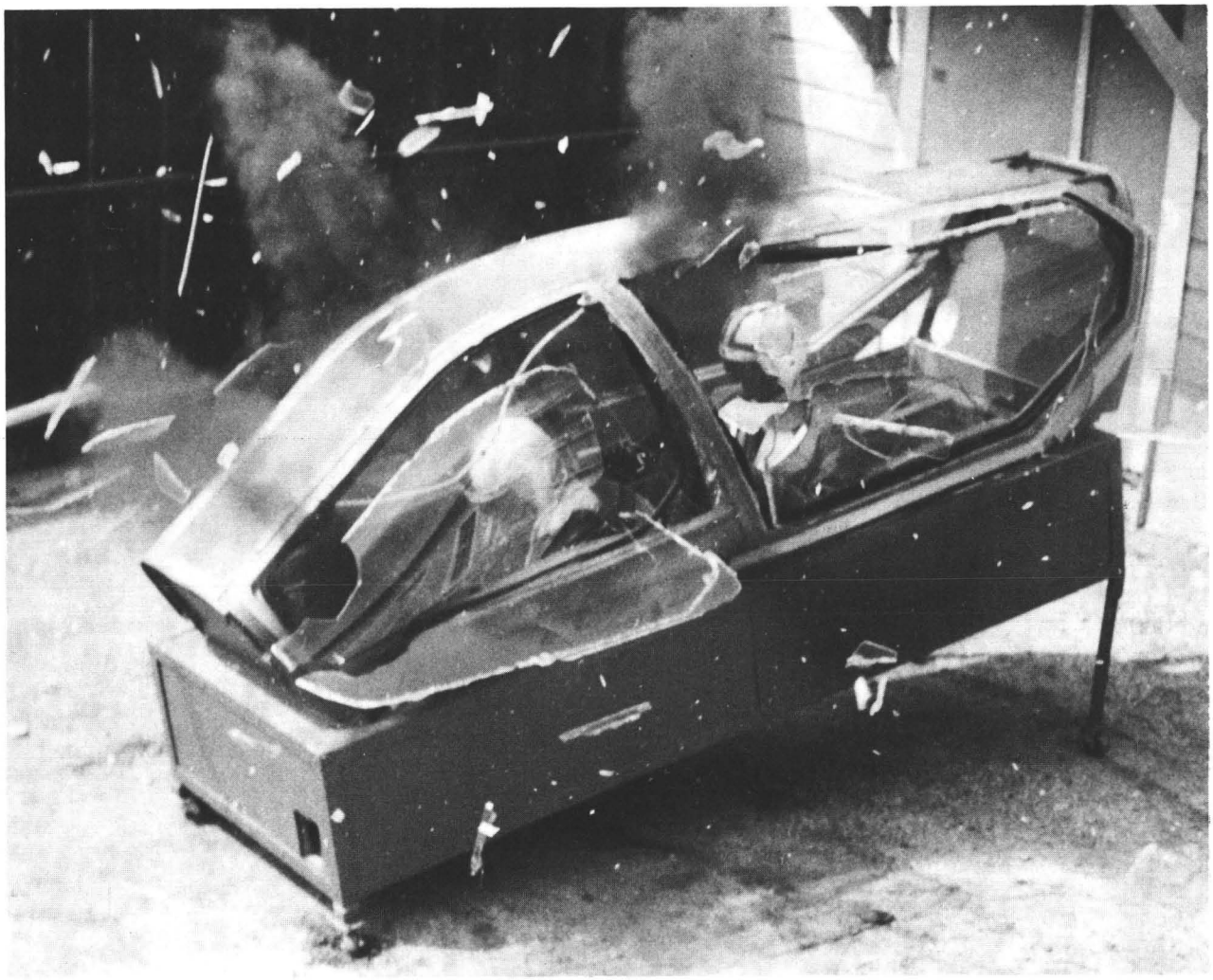
Obviously, there are some disadvantages for such a program. It takes time and effort. Used too often, it loses its effectiveness. In addition, I cannot prove it prevents accidents; but I believe it did contribute to a full year of accident-free flying for the 101st Aviation Group in FY 73.

Fortunately, you don't have to be an aviation unit commander or safety officer to benefit from the "what if?" method. Take your last flight—imagine it terminated in an accident. Now be your own hard-nosed, nit-picking accident board. What was your true attitude toward that flight? Put it down on paper. Next, make a list of your errors, omissions and things you could have done better—BE HONEST! Would you want that list published with your obituary? If not, you can take your own corrective action. Just recognizing your own deficiencies and taking your own action to correct them is far more effective than any command sponsored safety program. It's your ticket for safe flying and the route toward true professionalism.

What if? Try it. You won't like it, but it may save some lives, including yours.

It takes a heap of convincing before pilots place confidence in anything unknown or unproven. First it was the parachute, then the ejection seat. This time it's the canopy removal system in the AH-1 Cobra . . .

A MATTER OF CONFIDENCE



Arnold R. Lambert
Publications and Graphics Division
U. S. Army Agency for Aviation Safety USAAAVS

HOW DO YOU suppose Christopher Columbus signed on enough crewmen when the local sailors heard his plan? It wasn't his destination that bothered them; it was the shortcut he was planning.

After all, everyone knew that if you sailed out too far you would drop off the edge of the earth. Columbus must have been very convincing to gain the confidence of enough men to journey into unknown waters.

Most men are, by nature, very cautious about the unknown or unproven. It takes a heap of convincing before they will place full confidence in anyone or anything.

Escape systems in aircraft have not always been welcomed with open arms by aviators. During World War I, military pilots had very little confidence in parachutes, but today, astronauts returning from the moon place their confidence in them for a safe splashdown. Confidence in the parachute had to be earned.

The ejection seat drew the same reaction from aviators. It was designed, tested, redesigned, retested, modified and tested again, and today it has been proven a valuable escape system and aviators place full confidence in it.

Now we have an egress system that must win the confidence of aviators. This time it's the canopy removal system (CRS) in the AH-1 Cobra.

In most emergencies, the Cobra can be autorotated and landed safely. However, combat experience has shown that an effective emergency egress system is needed once the helicopter is on the ground. Many autorotation landings are made to undesirable terrain and the aircraft is often damaged. The helicopter usually comes to rest on its side or inverted. Door-opening mechanisms are sometimes inoperable and, even though the crew is able to get the aircraft down, they can't get out of the cockpit.

The Cobra CRS was designed to ensure that the crew can exit the aircraft in any postcrash attitude. The system requires no electrical impulse, uses no mechanical devices and removes the helicopter transparency panels by explosive fracturing.

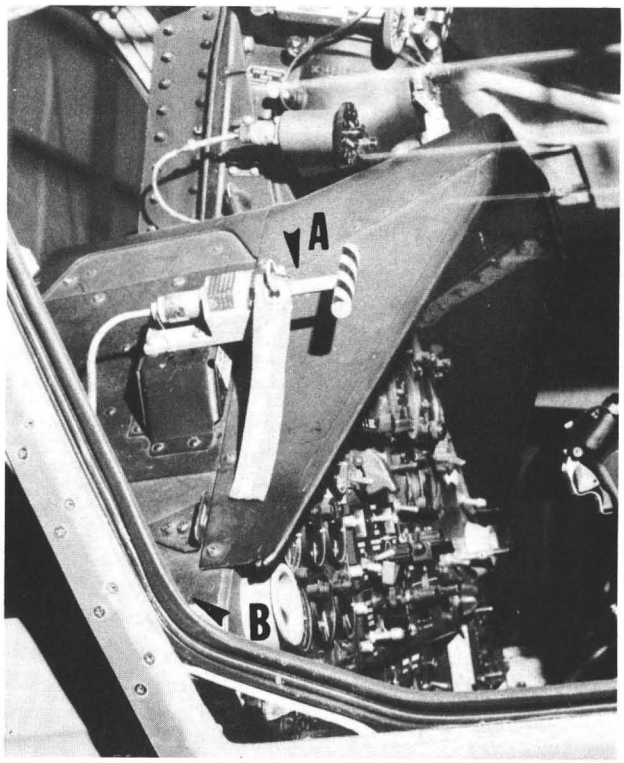
The CRS is self-contained and consists of three basic components: the primary arming-firing (A/F) handle, the energy transfer system and the window cutting assemblies.

A/F devices are located at both crew stations and either crewmember can activate the egress system. Each manually operated A/F device requires multiple motion and is designed to prevent inadvertent firing. An energy transfer system transfers the impulse from the A/F handles to the initiation points on the window cutting assemblies. This is done through an interconnected series of explosive transfer lines. These lines initiate an explosive linear cutting assembly which is attached to each window panel and fractures the acrylic at the frame line. Each cutting assembly is a redundant loop that ensures removal of the panel. The systems, regardless of crash attitude, give the crewmen an opening for rapid egress from the aircraft.

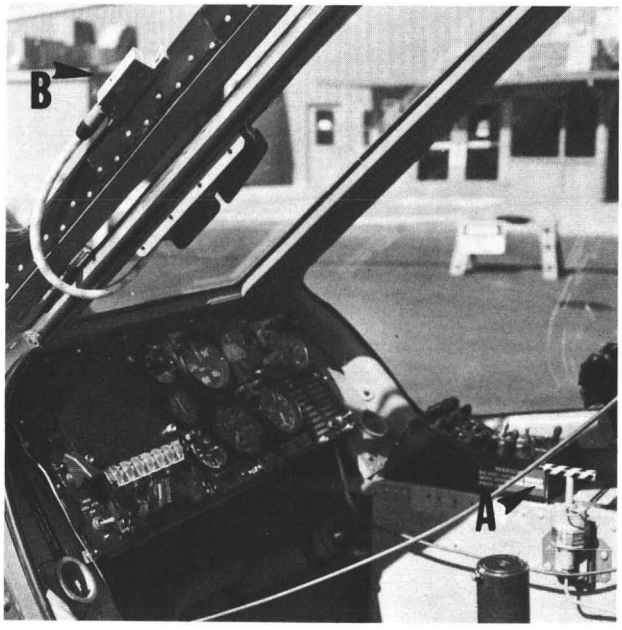
The CRS used in the AH-1 is a variation of systems which have been developed and are operational for Air Force fighter aircraft. These systems have proven to be totally safe and have provided aircraft crews with a reliable means of rapid egress in emergencies. Extensive tests have been conducted to show that during activation the system presents no hazard to the crew. Laboratory tests have shown that the system is insensitive to electromagnetic and thermal radiation and it will not inadvertently initiate from these sources. If the system is exposed to a fire it will not detonate nor will it sustain fire, and it cannot be ignited by impact from high caliber projectiles or lightning strikes. Additionally, an AH-1 pilot door and frame complete with installed window cutting asembly (WCA) was placed on absorbent cellulose packaging material saturated with JP-4 jet fuel. Activation of the system and the cutting action of the window panels did not ignite the JP-4 fuel.

The WCA is designed to prevent injury to the crew from backblast during the cutting action. To demonstrate that the system performs as it was designed to, a complete canopy removal system was installed on a helicopter and test fired. The firing was accomplished while test engineers were seated inside the cockpit. Both the pilot's and gunner's doors and windows were separated from the aircraft and the crewmen (test engineers) suffered no ill effects as a result of the noise or debris generated during the functioning of the system.

Operation. A recent change in the operating in-



ABOVE—"A" shows the pilot's arming/firing handle with the safety pin installed. "B" shows part of a window cutting assembly installed. BELOW—"A" shows the arming/firing handle in front seat. "B" shows one of the system's manifolds with a flexible line attached.



structions for the CRS requires that the safety pin in both A/F mechanisms be removed before flight and reinstalled before departing the helicopter. With this change only two distinct and different motions are required to activate the CRS. The A/F handle must be turned 90 degrees counterclockwise (to arm the system) and then pulled to fire. (*NOTE: If the A/F handle has been turned to the ARM position, it may be returned to its original position and the safety pin reinstalled.*)

The system is designed to direct the explosive force outward. The force of the cutting action can throw pieces of broken plastic about 20 feet, so care must be exercised when activating the CRS.

In-flight emergencies. If in-flight activation of the CRS is required, it should be done while in level flight or in a slight climb (see dash 10). The airspeed should be reduced to 20 knots. Each crewmember must know what the other is going to do and when the CRS will be activated. If the aircraft is being ditched over water, the crew must coordinate their actions so the CRS activation coincides with entry into the water.

Preflight inspection. The CRS must be inspected and maintained regularly if it is to function properly. A visual inspection of the components during daily and preflight checks is all that is required.

Here are some of the things that should be checked during preflight: Be sure safety pins are in place. Be sure transfer lines are perpendicular to their point of connection with the A/F mechanisms and manifolds. Check lines and manifolds for scratches, nicks, loose connections or evidence that lines have been used for handholds or support.

The protective casing of the WCA should not be cracked at any point. Check bends and areas around rivets for cracks. The linear explosive substance (LES) is gray and about the diameter of a pencil lead. Check the LES for breaks. A slightly discolored section in the LES usually indicates damage or a break. Be sure LES is held against the plexiglass around entire perimeter of each section. Report any damage to maintenance.

The CRS is engineered to work. It is ready to work and it will work. Learn its operation and should the need arise, don't hesitate. Trust it and reach for that handle.

If you have any questions or information concerning improper handling, installation, maintenance or operation of the CRS, contact the Directorate for Maintenance, AMSAV-FEU, USAAVSCOM, St. Louis, MO 63166.

Captain Robert H. Lewis Jr.
Mississippi Army National Guard

USAAAVS

THE DIFFERENCE

THE VIETNAM conflict is over. We have returned to the peacetime mission of the Army—readiness. Along with this stand down has come an awareness that our resources are not unlimited. The name of the game today is resource conservation.

All aircraft accidents can be traced back through a sequence of events which set the stage for the last act, the accident itself. We're not having many new accidents; we're having old ones over again because we're not developing remedies.

Conservation of our resources depends on breaking this sequence of events. Theoretically, if any one event is removed from the chain of events, the accident shouldn't happen. This is where the aviation safety officer (ASO) comes in. It is his responsibility to identify and remove hazards and control the sequence of events. The ASO's true job is prevention.

USAAAVS provides the ASO with a tool of great value, the accident prevention survey. The "Guide to Aviation Resources Management for Aircraft Mishap Prevention" is rather a fancy name for a checklist for saving lives and preventing injuries. If used properly, this tool is a means of resource conservation, a major means of accident prevention both on the flight line and in the maintenance shop.

The "Guide" provides the ASO with an in-depth means of removing hazards from the working environment through a detailed survey of flight facilities.

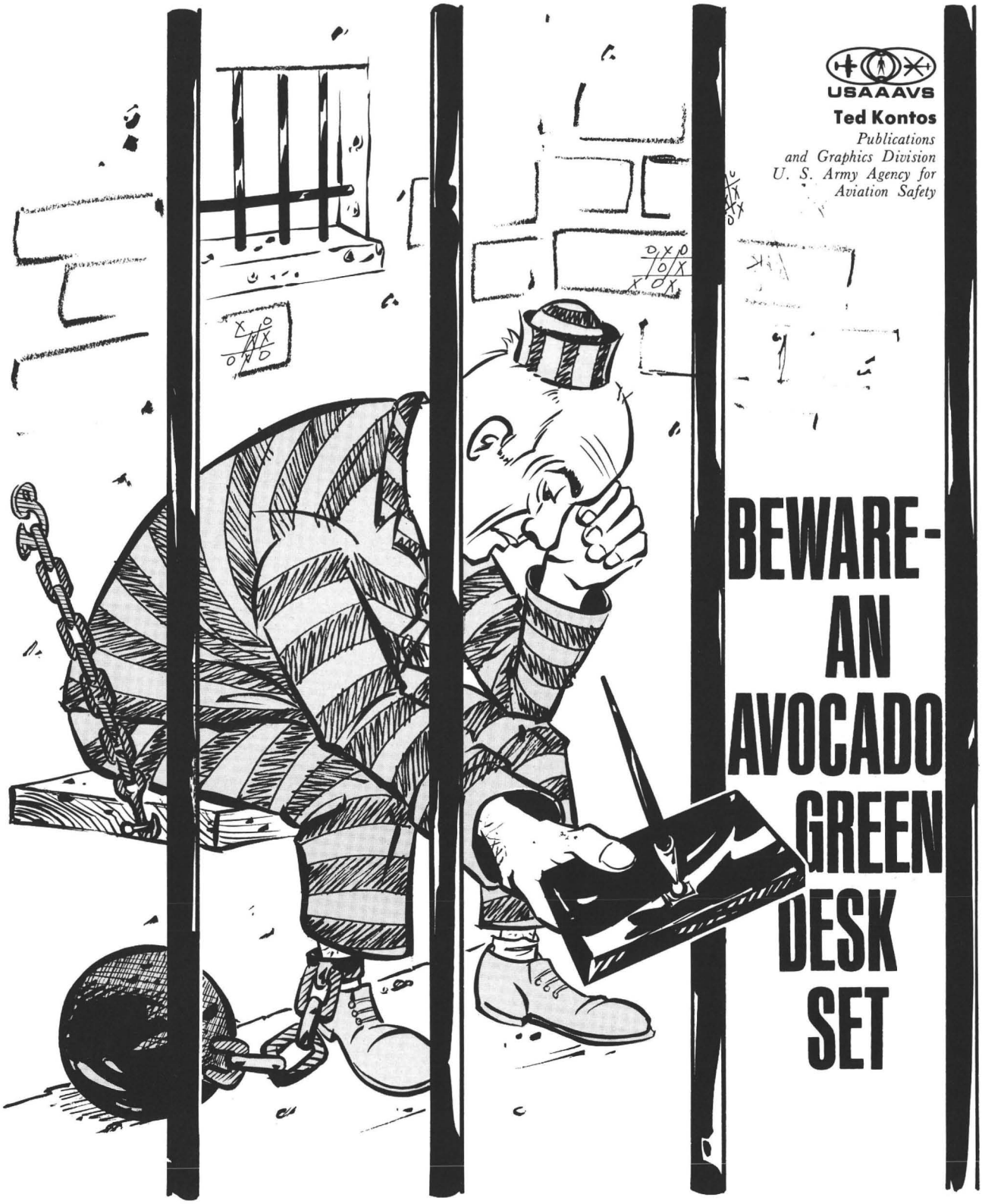
This survey is required on a semiannual basis by FORSCOM Supplement 1 to AR 95-5, and recommended semiannually by USAAAVS. This means that at least twice a year the ASO and his select team must spend several days inspecting the unit. Once this is completed, deficiencies are reported to the commander for correction. This in itself can cool everyone's enthusiasm toward the desired end result—a reduction of accidents by removal of hazards. The survey may never get off the ground when the ASO looks at all those references. True, the checklist is lengthy and detailed, but two simple solutions evolve.

One solution is for the ASO to take two or three items a day, from different sections, study the reference material for those items and then make his inspection, getting around to each item at least twice a year.

A second solution may well be the most difficult and time consuming initially, but of possibly even greater benefit in the long run. This is the reduction of the entire checklist into ten separate surveys, one for each month with the entire survey being used twice a year.

With this process, those items needing continuous and almost daily supervision and inspection can be listed on each survey rather than just once on the semiannual survey. This provides you with a continuous check on such things as: parachute repack schedule, use of the dash 20 during maintenance, proper refueling procedures, grounding aircraft in the hangar, proper calibration of torque wrenches, blocked fire lanes, use of protective clothing in the shop area and many, many more. Some of these items are checked only on a semiannual survey and never looked at again until another semiannual is due.

This weekly, or day-to-day, survey will also reap a benefit in reducing the loss of man-hours for correction since it can be accomplished during times of reduced activity within the unit. One of the biggest jobs the ASO has is the identification and elimination of hazards. The "Guide" provides him a means to achieve this end. It may well make the difference between preventing an accident and investigating one.


USAAAVS
Ted Kontos
Publications
and Graphics Division
U. S. Army Agency for
Aviation Safety
BEWARE-
AN
AVOCADO
GREEN
DESK
SET

AN ENGLISH INSTRUCTOR recently tasked his students to draft a letter of complaint to a fictitious firm concerning some item of purchase. The idea was for each student to identify his order, state the problem, make any needed explanations, then close the letter on a cordial note. One student who, perhaps, had imbibed a wee bit too much (or for whatever his reason) wrote the following:

Sneers
1313 Lostluck Avenue
Someplace, U. S. A.
Gentlemen:

The desk set (invoice 15062A) my wife recently ordered arrived intact. However, upon removing the packaged set from the shipping container, we noted it was sealed in cellophane, and therefore, did not open it to check the contents. Consequently, we failed to notice you had inadvertently shipped us an avocado green set instead of the wine colored one we ordered.

Normally, this would have posed no problem. However, this desk set was intended as a birthday present for my wife's mother who suffers from a somewhat peculiar malady that causes her to react adversely and uncontrollably to certain hues of the color spectrum. Avocado green happens to be one of them. Unaware of your error in shipment, we gift wrapped the package in anticipation of the gala event.

Everyone at the party was having a joyous time, especially after the second or third round of drinks, until it came time to sing "Happy Birthday" and have ice cream and cake. Well, we all managed to finish singing at approximately the same time and "Mama," as I affectionately call her, managed to blow out the candles without losing her teeth. But that was about all that went right. Unfortunately, our gift was the first one she picked, and I can still see the look on her face as she opened it. Her cheeks turned pale, her eyeballs caged, then suddenly, like switching off the lights, she zapped out—right into the punch bowl—head first.

Looking back, I admit the situation really wasn't very funny; and I admit if I hadn't been sneaking a few drinks on the side, I wouldn't have found it quite so amusing. I also admit if they hadn't pulled the old gal out, she might very well have drowned. But, at the time, seeing her with that peculiar expression, through the pink punch, with ice cubes, cherries and orange slices floating by, and all those bubbles rising to the top . . . well, I just thought if they'd hold off long enough, I could snap a picture or two with the camera I brought along for the occasion. You know, I figured it would be something we could all look back on and laugh at in the years to come. That was when my wife attacked me.

The verbal barrage she hurled at me wasn't painful at all; but the silver tray across my skull was. While I was busy fending off my wife, "Mama" came to life. It is utterly amazing how vicious a usually sweet, little old 98-pound lady can become. Without hesitation, and spurred on by the wild cheers of the guests, she rushed in to reinforce her daughter who was doing all right on her own and didn't need to be reinforced.

What happened next was pure accident. I swear it. And that is exactly how the policeman wrote it in his report after he managed to push my wife aside and pull "Mama" off my chest. All I did was to throw my arm up to ward off what appeared to be a well directed karate chop to my neck when my knuckles accidentally caught my wife across her nose. Right away I knew something was wrong. Her nose appeared to have slanted over to one side towards her cheek, giving her a rather odd expression, you know—as if she were pointed in one direction and headed in another. Anyway, to make a long story short, the plastic surgeon assures me her nose will look better than ever when he removes the bandages, and will be worth every penny of his $4,500 fee.

Fortunately, money is not a problem. During our 20 years of marriage, I have managed to accumulate a substantial amount of savings, stocks and bonds, and other securities, all of which the judge awarded my wife when he finalized our divorce. He also gave her the house, cars, camper, boat and custody of our children. I got the avocado green desk set.

But while it had an adverse effect on my mother-in-law, the color isn't really that bad. In fact, it enhances the decor of my jail cell nicely, lending a note of cheer to the otherwise drab battleship-gray walls and floor.

Please believe me, I am not a common criminal and have never been in jail before. It's just that the more I studied the judge's protruding teeth as he mouthed away all my belongings to my former wife—except, of course, the avocado green desk set—the greater was the urge to poke my fist into his fat face. I guess I am the impulsive type. Anyway, when I could no longer resist the temptation, I laid one on him. I know I shouldn't have done it, and I really felt sorry afterwards. However, in time, I think he will not only forgive me but also thank me. I am certain when the orthodontist straightens the teeth I jarred loose and replaces the broken ones, he will look much better than he did with all

those horrible buck teeth. Who knows, he may even drop the lawsuit he has initiated against me. Right now, however, I suppose I should concern myself with finding another job.

I don't hold a grudge against Vanderbolt, Robespiere and Morguatroit Associates for discharging me. After all, a highly respected firm such as theirs cannot afford to retain a senior vice president whose reputation has been somewhat tarnished. But I must admit, it will be difficult having to start at the bottom again. Fortunately, there is a bright side. Without the responsibilities of a house, cars, camper, boat and family, my needs are much less than before.

One good thing has come out of all this. I discovered I have a chronic back ailment I never knew I had. But after pacing back and forth across the concrete floor of my cell and sleeping on the irregularly-surfaced mattress provided me, my back trouble showed up. I can hardly sit or lie down, and when I do, any effort to change my position brings on excruciating pain. I am so glad I found out I have this trouble.

Please don't think me a chronic griper. I am writing this letter only because I felt you might want to casually ask your shipping clerk to be a bit more careful when processing orders. Obviously, even a slight error, insignificant as it may seem, can sometimes cause a customer some degree of inconvenience, however small, as occured in my case.

Personally, I like your avocado green desk set very much, and I thank you for your promptness in shipping it to use in time for the birthday party.

Yours very truly,

Don Haddit

Well, it's doubtful this student's letter satisfied the requirements the instructor had in mind; but it does embrace a point or two worth noting, and does have its parallel in Army aviation.

How many times has a "slight error" on the part of a mechanic caused "some degree of inconvenience" to the pilot? How many times has failure on the part of a technical inspector (TI) to verify the contents "packaged" by the mechanic caused a similar problem? And what about the pilot himself? How many times has he been "inconvenienced" because he didn't bother to check the "product" handed him? Every week we find examples in FLIGHTFAX. The following are typical:

- A CH-47 developed airframe vibration as a result of restricted fore and aft movement of the synch shaft splined adapter at the combining transmission. The adapter spline had not been lubricated.
- The No. 2 hydraulic system of an AH-1 failed on landing. The cause was an improperly torqued fitting at the lateral servo.
- Fluid was seen coming from the battery vent of a UH-1. Inspection revealed the voltage regulator was set too high.
- The pilot of an OH-58 felt the tail rotor pedals binding during takeoff. An avionics cannon plug for an uninstalled radio was found wedged between the center console and the tail rotor push-pull tubes.
- The pilot of a U-8 noted a drop in No. 2 engine rpm of approximately 800. Maintenance personnel had failed to safety the propeller link assembly during the previous maintenance inspection.
- A U-21 pilot noted fuel siphoning from the right nacelle tank following takeoff. Inspection of the filler neck revealed the lip was bent, preventing proper sealing. A similar problem on another aircraft occurred because the cap had not been properly installed. As a matter of fact, during a recent 13-month period, U-21 fuel and oil problems included seven improperly installed fuel caps, one loose filler cap, three bent cap wells and four improperly installed oil caps.
- An OH-58 ground accident occurred recently after the engine was started with the throttle left open. The engine accelerated rapidly and the pilot could not abort the start because N_1 was binding in the open position. During maintenance, the N_1 bolt was tightened excessively and no movement between the torque tube and the bellcrank was possible. Neither the mechanic, TI, nor the pilot ensured freedom of throttle movement during their respective checks.

In contrast to these examples, a test pilot did check his aircraft before flight and not only saved himself some embarrassment but also earned a WELL DONE. The aircraft, an OH-58, had been readied for flight following replacement of the main rotor hub grip seals. The work had been inspected and signed off by the TI. During his preflight inspection, the pilot noted the blades had been installed backwards.

Granted, because of our fallibility, any one of us can inadvertently make an error. That's why we have a set of checks and balances. But when we fail to follow stipulated procedures, we invalidate our checks and balances and lose our protection. This brings up the first point: Regardless who makes the error, it is usually the pilot who pays the penalty. The second point, then, becomes quite clear: Following by-the-book procedures in all areas of aviation offers the best protection possible. It's simple to do, extremely effective and the best possible way to ensure we don't get stuck with an avocado green desk set.

From AEROSPACE SAFETY

O-RING KNOW HOW

USAAAVS

Captain Jon New
Directorate of Aerospace Safety

A PROBLEM EXISTS very close to home in reference to O-rings—or are they gaskets or seals or packings? This nomenclature omelet really gets scrambled when you consider that what may be an O-ring in one application can suddenly become a packing or even a gasket in another. Different manufacturers frequently assign many names to a basic part just because its uses are varied.

Here's one working solution: Rely on part-number identity to obtain the correct materials! If you have that number down in black and white, whatever that widget's called (an O-ring or even a "toroidal elastic pressure retarder") doesn't matter much. Granted, it may take a little longer to chase down a part number because of nonstandard names or keywords, but the insurance is worth it.

There are definitions and descriptions of these things, and perhaps we ought to take a crack at them. One goes along these lines: An O-ring's "function is to confine, and prevent passage of, liquids

and gases under pressure between the parts of a joint." Another easier one: An O-ring "very simply is a means of closing off a passageway to prevent a loss or escape of fluid." One of our favorites: "O-rings are usually black and circular, and all look alike. You can tell what they do just by looking at them."

What an O-Ring Does

Before we go into what they do, let's examine how O-rings function. The basic principle is shown

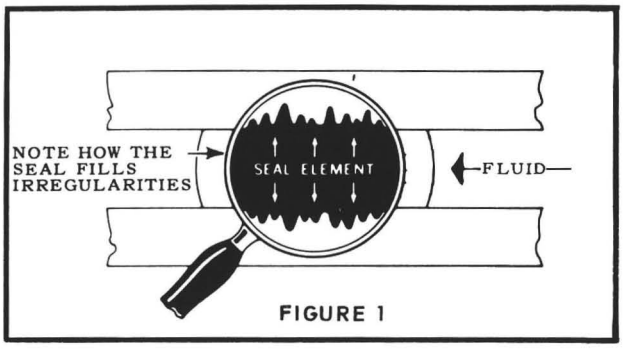


FIGURE 1

in figure 1. The O-ring element compresses under load, literally filling the super-fine passages in the mating metal surfaces, and blocks off the fluid flow. Therefore, the ability of the O-ring to "fill" the surface irregularities and its capability to maintain the "filling" are measures of an O-ring's true effectiveness. The ultimate performance of an O-ring depends on certain characteristics. Stay with us—we're about

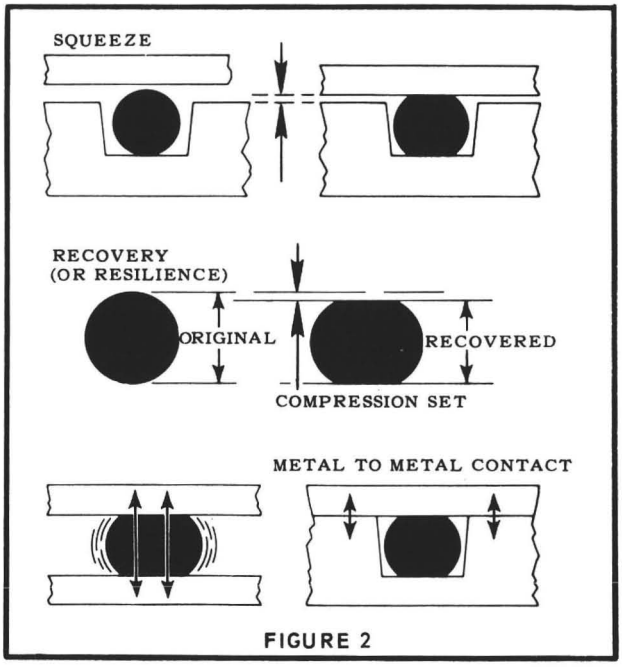


FIGURE 2

to define and depict them for you, as painlessly as possible!

Squeeze

Squeeze (figure 2) is the O-ring's initial ability to

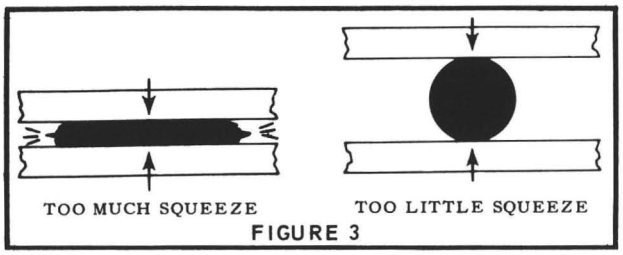


FIGURE 3

be distorted and still block off a passageway. And it isn't necessary to crush the seal to make it work. The effective, usable range is from 12 to 35 percent (figure 3). If you have too little, the joint will leak immediately after installation and particularly at lower temperatures. Too much, and the O-ring will either be destroyed outright, or it'll cold flow to take an early set. Too little or too much, your O-ring becomes totally ineffective.

Recoverability

Recoverability (also "resilience"—figure 2) refers to the O-ring's ability to act as a surging spring over long periods. The amount by which an O-ring fails to recover after deformation is called "compression set."

Metal-to-Metal Contact

Metal-to-metal contact (figure 2) is vital to ensure the correct amount of squeeze and to prevent destruction of the O-ring. In a well-designed seal, the torquing or bolting loads are transmitted through the metal, not through the O-ring.

Statamic* Installations

*No, we're not stuttering. Read on . . . There are a couple of other terms with which you're probably familiar. These refer to the type of application. "Static" means that no movement is involved; all mating surfaces to be sealed are stationary. "Dynamic" applications occur when there is movement of one or both mating surfaces. The three basic fluids sealed by O-rings in aircraft are fuel, synthetic lubricating oil and hydraulic fluid. Each requires a different ring, and we'll get to their selection shortly. Each, however, involves static and dynamic ("Statamic," see?) installations. The static seal is usually the simpler. Dynamic types are subdivided into a mess of others; reciprocating, oscillating, rotary and seat.

And now we can talk briefly about backup rings. A backup ring is a handy little device that works to "prevent extrusion of the O-ring" (figure 4). When system pressure exceeds 1500 psi, the backup ring is used. In static face seals, backup rings may not be needed.

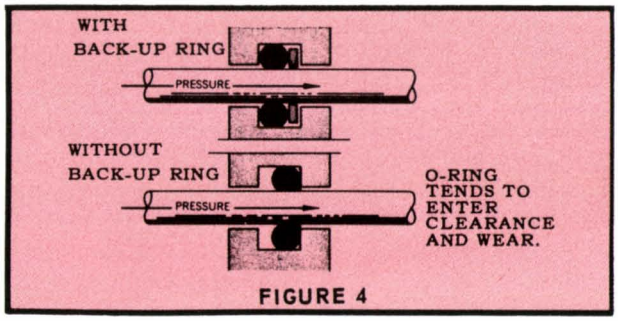


FIGURE 4

Three Factors That Cause O-Ring Problems

Look what happens: There's a fillion (that's a finite but large number!) of these things on an aircraft; but many are exposed to extremes of temperature and pressure; others work under constantly vibrating conditions. Add all that together, and you're bound to have problems with O-rings, even under the best of conditions.

There are three factors that cause most O-ring problems:

1. *Size.* O-rings must fit correctly or their function is ineffective or totally destroyed.

2. *Compatibility.* They've got to be made of a material compatible with their aircraft environment. A good rule of thumb is that O-rings designed for one fluid are generally not good for another.

3. *Installation.* Improper handling of O-rings at assembly can make much grief. We'll discuss how it should be done later.

Helpful Hints

The answers to two of those problems have, for the most part, been simply wrapped up—in paper! Manufacturers are now wrapping O-rings in individual packages of this "kraft" paper. These packages are imprinted with data that includes part number, seal compound, manufacturer's name and special instructions if necessary.

O-ring size cannot be determined by color code. Exact replacements can only be determined by part number. (That's getting to be a familiar tune.) Don't try to match by feel an O-ring removed from an assembly. Sure, it goes against your grain to rely on numbers rather than refer to the actual sample you're holding. Sure, we all hate to pay income tax —but it has to be done!

There's one other thing: Don't open that package until you're ready to install the O-ring. The wrong ring might get in; the right ring might get out and be damaged or misplaced.

Techniques for Removing Old Rings

Here's where we separate the men from the boys; removing an O-ring is a highly critical operation. In fact, a poor installation often begins when an old seal is removed. Here are some points to bear in mind.

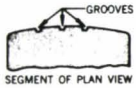
Removal

- O-ring removal involves working with parts that have close tolerance surface finishes. In critical surface finish areas, scratches, abrasions, dents and surface deformities cause faulty seals, resulting in functional failure of components.
- Don't use hardened-steel, pointed or sharp-edged tools (knives, screwdrivers, church keys) for removal or installation of O-rings or backup rings. Soft-metal tools such as brass or aluminum are okay, and tools of phenolic rod, plastic or wood can be formed into useful aids to help ring removal and installation.
- Tool surfaces must be well rounded, polished and free of burrs. Check your tools often, especially those surfaces that come in contact with ring grooves and critical polished areas.
- When O-rings and backup rings are removed from pistons and cylinders, every effort should be made to avoid contact with critical surfaces of parts.

Inspection

O-rings in service undergo slight swelling and softening, and may be invisibly worn. Increased damage can occur on reinstallation; therefore, new rings only should be used. Inspection of old, damaged rings can indicate failure from wear, extrusion, excessive permanent set, torsional strain or excessive rolling in the groove (figure 5 and table 1). Exces-

TABLE 1

FAILURE	GENERAL CONDITION	EXAMPLE
Progressive cutting by corner of piston groove.	Pulsating pressure on O-Rings.	
Progressive cutting as in static packing plus abrasive wear.	Pulsating pressure on O-Ring.	
Knibbling extrusion. Rupture of material, large pieces torn off.	Fatigue from shock loads, high temperature, local seizure, pulsating pressure, etc.	
Rotation of part or all of circumference of packing in groove. (sometimes called "spiral failure")	Complete explanation not found. Occurrence not predictable. Possibly sudden increase in friction on working face.	FOUND TO OCCUR CHIEFLY WHEN PACKING WAS MOVING IN SAME DIRECTION AS PRESSURE
Axial grooves worn in working surface.	Imperfections in cylinder surface. Particles of dirt, metal, or rubber.	 SEGMENT OF PLAN VIEW
Axial grooves as above.	Rapid passage of oil across working face.	See above sketch
Packing totally extrudes through clearance space.	Large radial clearance. Soft packing.	

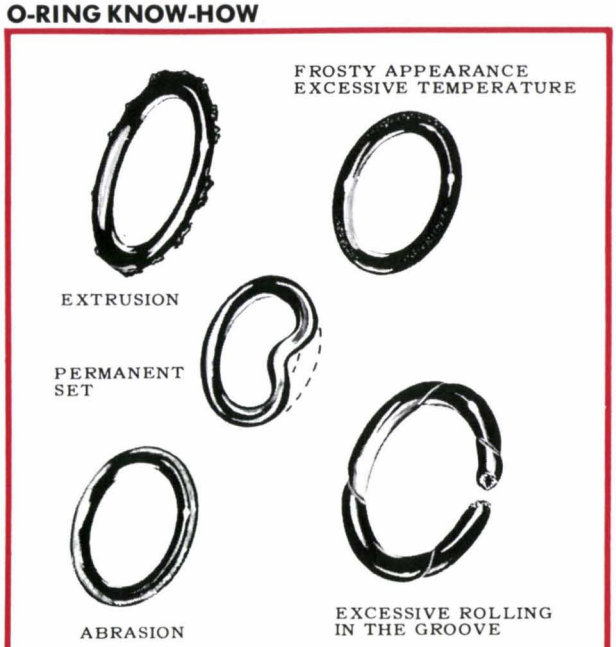


FIGURE 5

sive extrusion can indicate the wrong type of ring was used originally or that backup rings were not installed.

Irregular wear may indicate a rough spot in the cylinder, or an eccentricity. The ring can also fail from a defect that should have been found by a careful preinstallation inspection. O-rings that lack proper resilience may have been subjected to over-temperatures. Because rings are not designed for high temperatures, they should be replaced, regardless of their appearance, when it is known they have been subjected to unusual heat. Overheated rings are hardened, crack with flexing, take a set and lack resilience.

After you've inspected the old ring, cut it in two places, and throw it away.

So, now you've got the old ring out, and you're ready to install the new one—oops, hold it! There are a few things to check first.

Inspect Surfaces, Rings

Metal surfaces must be free of dust, dirt and gunk before assembly. Stoddard solvent (a kerosene base with a rust inhibiting film) cleans parts and leaves a good surface for lubricating grease to adhere to. But look out! These cleaning fluids can cause some O-rings to swell up like a toad and cause trouble. So, be sure the metal cleaning fluid will not harm the O-ring is any of it is left on the surface.

Assume you've selected the proper replacement O-ring—and it is the proper ring; you just checked the part number!—so now the job is to examine the ring itself for imperfections, dirt or lint.

Open the package. If you find any faulty rings, throw them out after you've cut them (and, if they're from bulk storage, check the rest of the batch). New rings that are too tight when installed should be discarded, not returned to storage because they may have been slightly damaged during installation. After installation, an O-ring should seat snugly but freely in its groove.

Here are a couple of other hints: Be sure the smooth surface of the ring isn't scratched by fingernails, tools or fitting threads. Don't pinch the ring between the boss and fitting. Watch for sharp edges on groove shoulder or fitting. Thread burrs are often removed by running a nut onto the thread.

Before any installation, lubricate the ring and bearing surfaces with a light coat of grease; but lubricate sparingly.

Leak-causing distortion can result if the O-ring is stretched too much. Lubrication now only helps eliminate this, but also lets the rings seat naturally in grooves without twists or wrinkles. But remember to use a lubricant that is compatible with the O-ring material and the system fluid!

In a hydraulic system, flow-wash the bearing surface with hydraulic fluid, and wipe the parts if necessary, only with a lint-free cloth.

If you're working with an oxygen system, don't permit oil or grease around the O-ring. Oxygen is a very dangerous gas; get it in the presence of oil or grease, and it goes—but good!

Installation Techniques

During installation on, say, a piston, you'll have to stretch the ring. Stretch it as little as possible, and try to stretch uniformly. Once it's installed, be

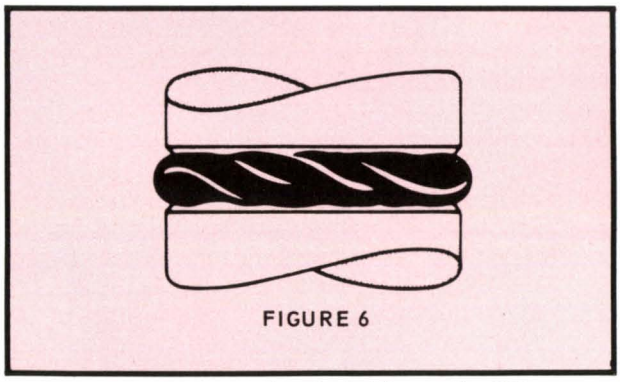
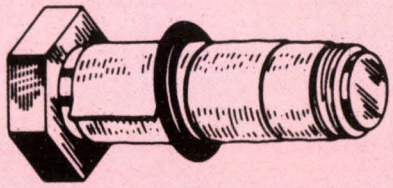


FIGURE 6

sure to remove any twists in it (figure 6). When you push the piston into the cylinder, push straight in and not with a turning motion. Turning motion tends to bunch and cut the O-ring, eventually causing leakage.

For some installations, the ring has to be slipped over sharp edges, such as screw threads. Cover edges with thin plastic tape or aluminum foil, lu-



TAPE PROTECTS O-RING DURING INSTALLATION

FIGURE 7

bricate ring and work it into position (figure 7.) Or construct a thin thimble of plastic, push it onto threads and work ring into position over thimble.

Other installations are more involved, such as placing a ring in a positioning-type AN universal fitting

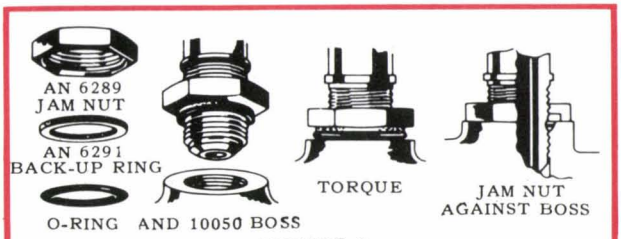


FIGURE 8

(figure 8). In this case, an AN-6291 backup ring is lightly coated with lubricating grease and then worked into the counterbore of the jam nut (AN-6289). The O-ring is stretched and rolled over the fitting threads, and onto the smooth threadless surface designed for the backup and O-rings. Next the jam nut is pushed firmly against the lower threaded section of the fitting.

The fitting is installed in the boss (AND-10050) until the O-ring contacts the boss and increases the torque. The jam nut is held stationary in this position while 1½ turns are applied to the fitting. The fitting then may be turned into the boss not more than one additional turn to position it. Final step is to hold fitting, and torque jam nut in accordance with applicable figure or drawing.

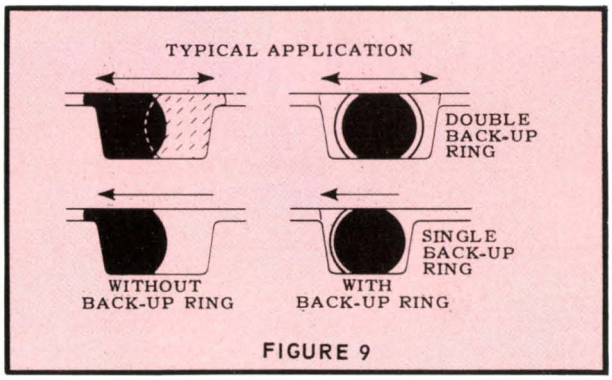


FIGURE 9

A similar procedure is used for nonpositioning type fittings, except that the jam nut and backup ring may be omitted.

Backup rings provide a firm surface against which the O-rings can press to avoid being extruded, under high pressures, into the clearance between the surfaces being sealed. Any movement between the surfaces with the ring so extruded would result in a high wear rate, leading to eventual ring failure.

A backup ring must be installed on each side of the O-ring if the pressure is in alternate directions (figure 9). Where a single backup ring is used, it is installed on the downstream side of the O-ring.

Other Problem Areas Include Contamination

We've learned a lot about O-ring contamination over the years. As a result, there has been a continued improvement in the way the rings are handled, shipped and stored. And your job is easier. But there are some things you should be aware of as a matter of course. Let's review briefly.

Dust and Dirt

By now, these should really make you jump. If your rings are individually packaged, you have no worries. But if they are from bulk, and you have the slightest suspicion that the rings have been exposed to dust, discard them. Dust is a very tough abrasive, worse because it's frequently unseen or unnoticed.

Atmospheric Chemicals

Ozone, oxygen and moisture will, over the long haul, act on O-rings. Today, most manufacturers add chemicals that slow down or eliminate the effects; again, individual packaging also helps.

Heat and Light

If you're beginning to get the idea that O-rings are as delicate as your maiden aunt, forget it. We only suggest you treat 'em as though they were. Excessive heat is a problem, however. If the stockroom guy has been storing your rings on the top shelf, near the corrugated-iron roof, remove the rings, throw them away and store that stock man up there—preferably all summer! Additionally, sunlight and fluorescent light have a tendency to age the O-rings prematurely, so they should be protected from these.

Remember

- Select the proper O-ring on the basis of part number identity.
- Keep all parts clean.
- Use compatible fluids and rings.
- Use individually wrapped rings.
- Don't use hardened-steel tools for removal or installation.
- Make it your business that new rings are not contaminated and are properly protected.

briefs that teach

the exception proves the rule

After replacement of four rotor blades on a CH-47A, the crew chief began a runup for blade tracking. He was assisted by a 3-man maintenance crew. After completing the forward blade track they began to track the aft rotor blades. One of the men, using the strobex light device from a position on the right side engine work platform, could not get an indication from the reflectors. He related this to the crew chief and another man who were in the cockpit.

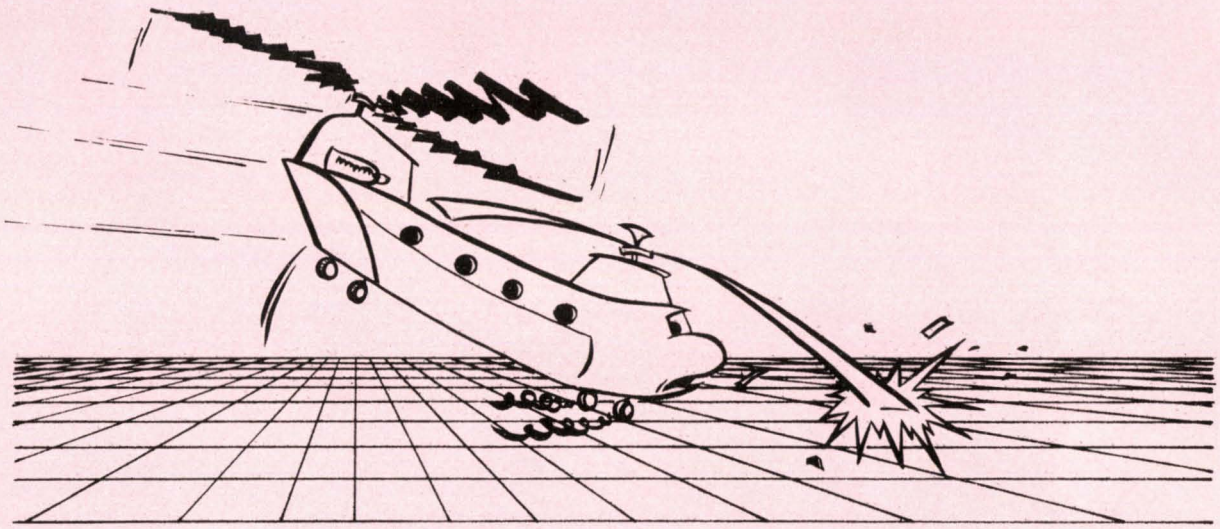
The maintenance man left the cockpit area and moved rearward, to attempt to obtain the track. The man on the work platform stepped down from his position. When he did, he felt the aircraft become light, slightly lift and then settle to the ground again. He noticed that the right rear wheel was off the ground and said so over the intercom. The aircraft continued to rise to an estimated 10 feet.

The man moved backwards and lay prone on the ground. The rear of the aircraft rose 20 to 30 feet, with the nose scooting forward. At this time the forward rotor blades struck the ground and an explosion was heard. The crew chief was still in the cockpit. A second explosion was heard as the aft pylon separated from the fuselage and the forward and larger part of the aircraft was engulfed in flames.

Minor injuries were sustained by personnel involved in the accident. The aircraft was a total loss. Eight other aircraft had minor damages from debris and/or fire.

Supervisory error was a factor in this mishap. **A nonaviator was assigned duties that were beyond the scope of his training and expertise.** These duties required him to perform complex starting and operating procedures that were normally performed by two aviator personnel.

Higher headquarters had granted the unit an exception to AR 95-1, par. 5-14c, to allow aircraft ground operations to be conducted by nonaviator personnel. This exception was granted without regard to the caution listed in par. 3-7, TM 55-1500-328-25, that requires a full crew as defined in par. 11-6, TM 55-1520-209-10, for ground operations in cargo helicopters when engines and rotors are in operation.



PEARL'S

Personal Equipment & Rescue/Survival Lowdown

Wearing of Undergarments

What is your recommendation on the wearing of undergarments? I know they should be cotton but elastic waistbands seem to be standard for Army and civilian types. I have been advising that the waistband of the underdrawers be positioned under the trouser waistband and belt.

USAAAVS recommends that the standard Army issue underwear be worn by all aviation personnel as a part of the protective flight clothing system. Other underwear may be worn, but at no time should undergarments made of non-fire-retardant synthetic materials be worn.

The undergarment elastic waistband has not been reported to USAAAVS as a cause factor of injuries in aviation mishaps. Our mishap data file indicates individual aircrewmembers have received severe thermal injuries during postcrash fires while wearing nylon/orlon type synthetic undergarments. The thermal injuries have been attributed to heat transfer through the Nomex flight clothing and the low melting point of the nylon undergarments. This agency has one mishap on record where the aviator was wearing nylon/orlon batted thermal underwear. The Nomex uniform provided protection from the fire, but the individual received fatal burns due to the melting of the underwear. Your advice regarding positioning of the undergarment waistband under the trouser waistband and belt appears to be reasonable and logical. The additional layers are barriers to transfer of heat.

Resupply of SRU-21/P Survival Vest

My unit has allocated funds for the next period to be used for resupplying our SRU-21 survival vests, i.e., fire starters and pen flares. What publication lists NSNs, cost, etc.?

National stock numbers and cost and supply information for the survival vest may be found in Supply Bulletin 700-20. The individual components of the SRU-21/P survival vest also appeared on the back cover of the November 1974 AVIATION DIGEST.

Sunglass Lenses and Marker Distress Light Batteries

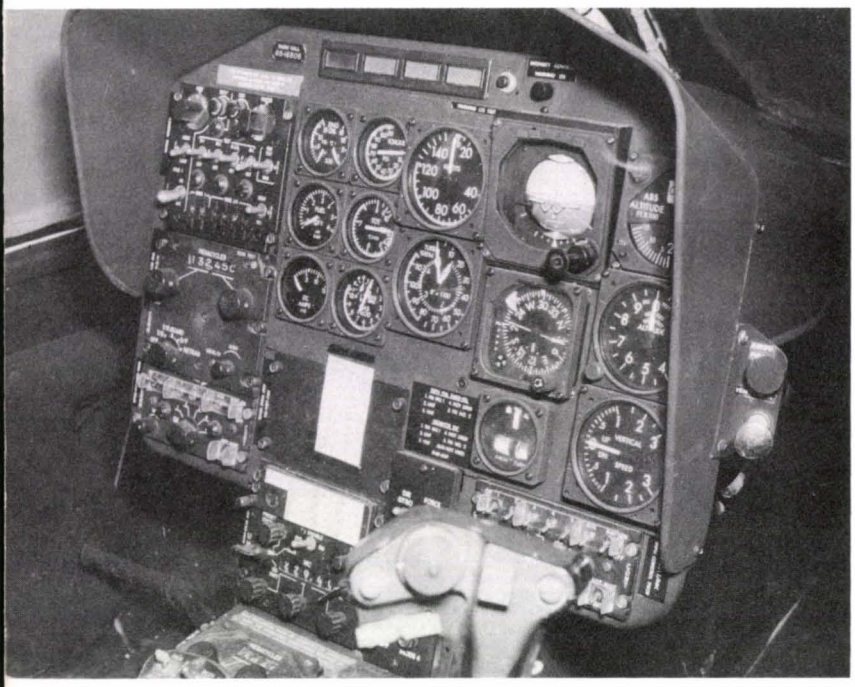
I would like to know the NSN for the following items: lenses for spectacle type sunglasses, NSN 8465-00-753-6261; and batteries for marker distress light, SDU 5/E, NSN 6230-00-938-1778.

Preshaped lenses for spectacle type sunglasses, NSN 8465-00-753-6261, are not available in the supply system. Round, unshaped lenses are available, but only to Army optical laboratories. It is recommended that you consider using the Army Suggestion Program to pursue the matter of replacement lenses for the sunglasses, using DA Form 1045.

The NSN for the marker distress light, SDU 5/E, NSN 6230-00-938-1778, is 6135-00-073-8939. This stock number is found in Supply Catalogue 8465-90-CL-P02. The supply catalogue is referred to in paragraph 2-18c, page 2-87, TM 55-1680-317-23 & P, dated 8 August 1975, "Organizational and DS Manual Including Repair Parts and Special Tools List for Army Aircraft Survival Kits."

MK-13 Mod "O" Smoke Flare

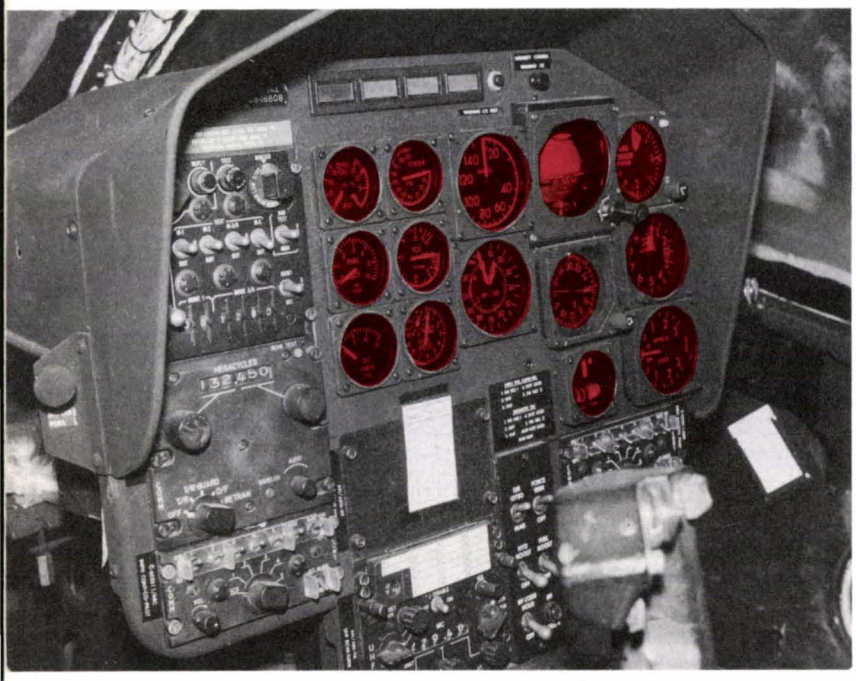
We have learned that several flares have exploded upon ignition and one man has suffered severe burns as a result. Armaments Command (ARMCOM), Rock Island, IL, has been contacted about this problem. All units that have been issued flares under lot numbers 20-HK0367 and 31-HK0367, dated March 1967, should use extreme caution when igniting these flares. One unit has sent a malfunction report to ARMCOM. ARMCOM will analyze all such reports and take necessary action to correct the problem. For further information, contact Mr. A.B.C. Davis, Aviation Life Support Systems Manager, USAAVSCOM, P.O. Box 209, St. Louis, MO 63166, AUTOVON 698-3241/3291.



RED OR WHITE?

Which is most effective for helicopter instrument lighting? The Army has been experimenting with both colors on the OH-58. Currently two OH-58s are at the U.S. Army Aviation Center, Ft. Rucker, for further evaluation

Photos by SP/5 Roy H. Crosley



TOP—Instrument panel with white lighting

BOTTOM—Instrument panel with red lighting

RIGHT—Both helicopters are equipped with a back panel which allows instrument panel lights to be turned off

THOMAS JEFFERSON

Make Aviation Safety The SPIRIT OF '76

"DELAY IS PREFERABLE TO ERROR"

IN KEEPING WITH the patriotic theme of our nation's bicentennial celebration, our new 6-month Safety '76 promotion features a series of quotations of military leaders and statesmen of the Revolutionary period. These quotations, made 200 years ago, are appropriate for many of today's aviation problems.

Although Thomas Jefferson probably never envisioned our contemporary world of air transportation, his statement, "Delay is preferable to error," can be applied to every member of the Army aviation team—no matter what job is being done.

• Does the commander consider environmental factors before he assigns the mission? Weather, density altitude and terrain are potential accident cause factors when ignored.

• Does the operations officer select the best flight route in accordance with the assigned mission? Trees, wires, poles and towers pose the greatest threat to safety during nap-of-the-earth and low-level flying.

• Does the mechanic account for all tools before he releases the aircraft for flight? A toolbox inventory requires only a few minutes and is one of the best preventers of FOD.

• Does the POL handler check for contaminants before he refuels the aircraft? Water and dirt in hose nozzles, plus dirty fuel filters, are known causes of engine failure.

• Does the crew perform a thorough preflight inspection? Mishaps frequently occur because preflight inspections have become so routine and hurriedly performed that obvious discrepancies are overlooked.

The fundamental reasoning of Thomas Jefferson and others like him served to form the nucleus of a nation which has grown to be the greatest ever. If *delay was preferable to error* in the founding of America, don't you think the end result was worth the wait?

JOSEPH W. CLARK
Directorate for Plans, Operations and Education
U. S. Army Agency for Aviation Safety