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SAFETY MAY 1978

IN THIS ISSUE

LIGHTNING AND AIRCRAFT

Some Electrifying Words On Lightning, Aircraft And You

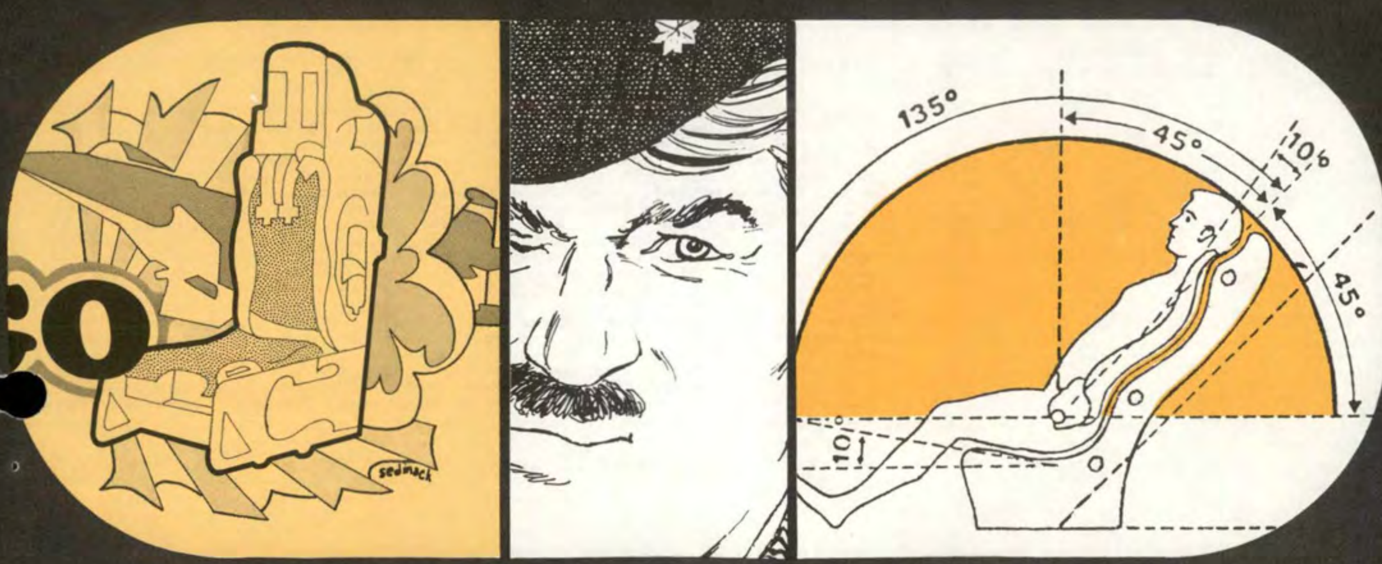
When You Gotta Go . . . Go!

Take The Easiest Way Out Of A Sick Bird

Everybody Knows A Charlie, And We Hope They'll Never Forget

THE DAY CHARLIE DIED

Backache And Helicopter Pilots



UNITED STATES AIR FORCE

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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MAY 1978 AFRP 127-2 VOLUME 35 NUMBER 5

SHARING THE AIR WITH MILITARY JETS

Courtesy General Aviation News
DOT/FAA

Civilian pilots (*as well as military crews*)* will be afforded greater protection in 1978 from an undesirable mixture of traffic with military aircraft, thanks to a new agreement that has recently been worked out between FAA and the Department of Defense.

The general aviation fleet is expected to number 195,000 aircraft by 1981. Most of these aircraft operate below 10,000 feet MSL, where the airspeed limit is 250 knots. However, altitudes below 10,000 feet are also required by the military air services for certain essential training operations which must be conducted at speeds in excess of 250 knots, and this presents a problem.

To be proficient, the military services must train in a wide range of airborne tactics at altitudes frequented by general aviation aircraft flying VFR. The required maneuvers and high speeds of the military planes are such that they may occasionally make the see-and-avoid aspect of VFR flight more difficult without increased vigilance in areas containing such operations. Aircraft intercept, air-to-air combat, ground troop support, low altitude activity, and photo reconnaissance are some of the procedures that must be rehearsed in this segment of the airspace to a point of complete readiness.

Additionally, the full range of military flight training, from student preparation to professional airman status, must be carried out. To some extent this is accomplished within restricted or designated airspace, clearly identified on sectional charts. However, certain types of training missions must be carried out on flights which extend well beyond the range of restricted areas.

To accommodate the national defense requirements, FAA issued a waiver in 1967 to the Department of Defense which allowed DOD to authorize various training activities below 10,000 feet MSL at speeds in excess of 250 knots. DOD at that time developed two types of training routes:

1. TR routes. Used for VFR operations only, 1,500 feet AGL and below. Some 273 of these routes are current. They have been published only on the military DOD FLIP AP 1B chart, which has become known as the "Green Demon" chart.

2. OB (Olive Branch) routes. Flown both VFR and IFR between 6,000 feet MSL and 1,500 feet AGL. About 23 routes have been in use, published only on the "FLIP" charts and in the Airman's Information Manual (Part 4).

Information regarding these military missions was relayed to the nearest flight service station at least 30 minutes prior to departure whenever possible. However, many military missions were unsuited for the TR routes and were conducted on a random basis. Information on these flights was not available from any chart or from flight service stations.

The result has been a mix of civilian and military traffic which has some undesirable aspects. Camouflage paint, used by many military aircraft to avoid detection, makes it difficult for civilian pilots to see them in time. At the same time, high closure speeds, and intense workloads on the military pilots, reduce their ability to see and avoid other aircraft. FAA's Accident Investigation Staff has recorded an average of about 100 military-civilian near midair collisions per year, as well as some fatal collisions. To improve this situation FAA has concluded a new agreement with DOD which authorizes military aircraft to operate in excess of 250 knots below 10,000 feet MSL under following circumstances only:

1. Within restricted areas and military operations areas (MOA).

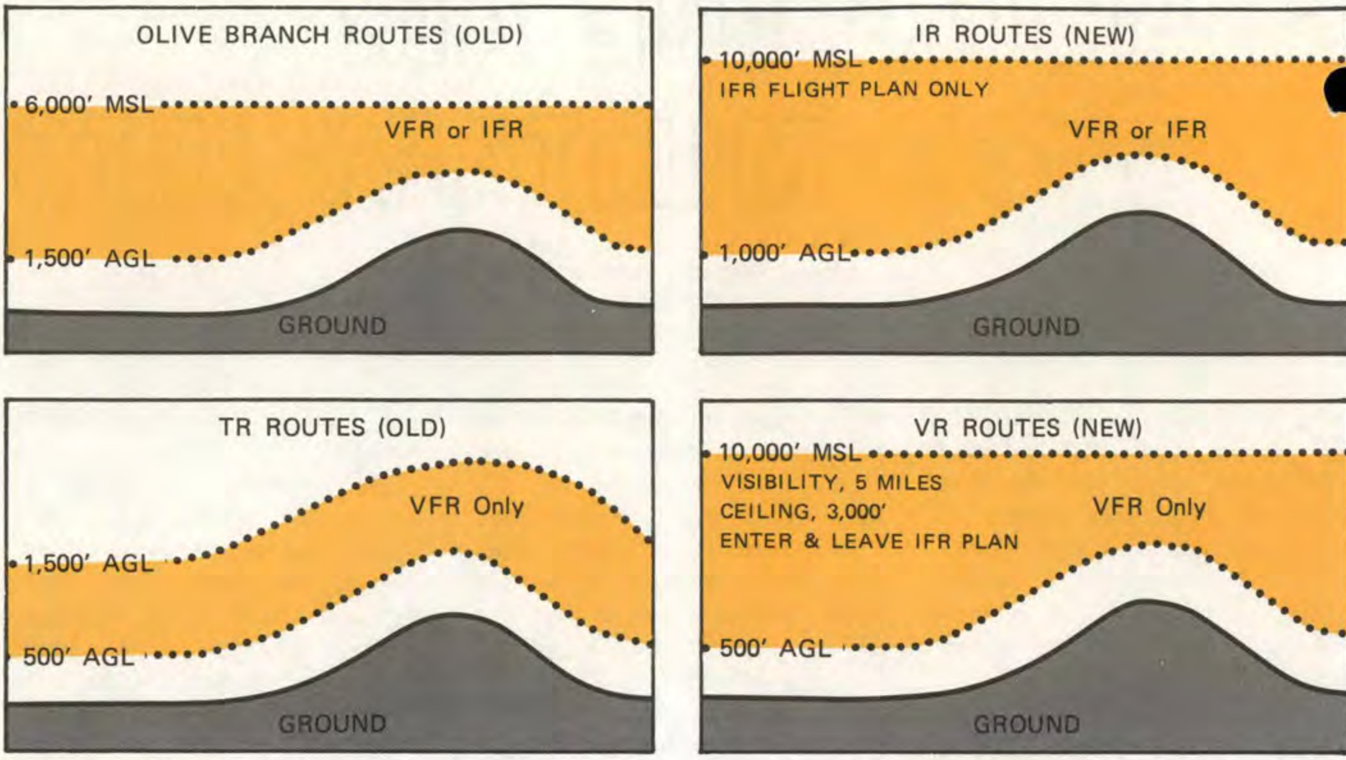
2. Within a large scale exercise or short term mission which the nonparticipating flying public is made aware of.

3. Along new IFR-only routes to be developed by DOD.

4. Along a reduced number of VFR routes which will be developed by DOD only when required missions cannot be accommodated along IFR routes.

5. The responsible military scheduling unit will inform a key or "tie-in" flight service station, on a daily basis, of all military training flights scheduled for the airspace below 10,000 feet in their area, with

*Italics by *Aerospace Safety*.



The old "Olive Branch" (upper left) and TR (lower left) military training routes at low altitude operate within the airspace designated on the drawing. The new routes, known as IR's (upper right) and VR's (lower right) will penetrate various altitudes below 10,000 feet MSL with varying widths. Military FLIP charts show new and old routes; sectionals will eventually show new routes.

particulars as to time of activity, type of mission, etc. So far as possible, all training will take place along published routes only. The key FSS will relay information to all other stations within 200 miles of the "hot" route segments.

Note: The new program went into effect as of January 1, 1978, but DOD has until May 18 of this year to accomplish full compliance.

The new military training route system, known as MTR, incorporates several significant changes in the route structure:

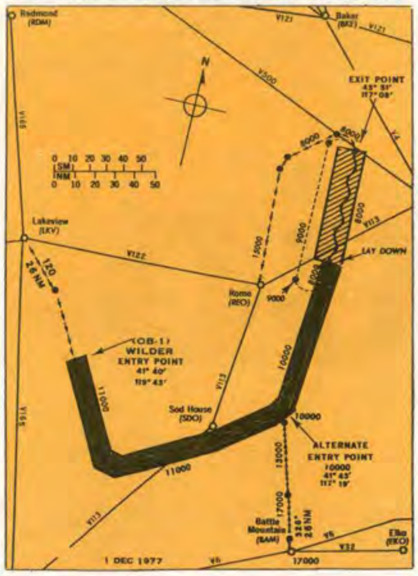
- MTR routes may utilize any portion of the airspace at 10,000 feet MSL and below, but the total number of routes will be reduced to the absolute minimum required for mission requirements.
- All of the "Olive Branch" routes will be phased into the MTR program during 1978, and replaced either by the new IR routes, or when necessary by a new structure of VFR routes (called VRs).
- During this transition period of 1978 both the old VFR routes (TRs) and the new VRs will be in existence. Note carefully: All military training routes will be shown on the FLIP charts, but only the newly established routes, both VRs and IRs, will appear on FAA/NOS charts — as these routes are established, as the appropriate means of depicting them is determined, and as the charts become due for re-issuance.

Unlike the old training routes, the new IR and VR routes will be made up of segments which vary in width and altitude according to their mission requirements. For example, a lengthy straight line approach segment may be only two or three miles wide, while a shorter segment containing a target may be 15 miles wide. Similarly, a route may use only the airspace between 1,000 and 1,500 feet along approach segments, but contain a target segment reaching up as high as 10,000 feet. This is intended to reduce the amount of airspace in which an undesirable mix of civilian and military traffic may occur.

Three basic types of missions will be flown along the new MTR system: Photo Reconnaissance (PR) Road Reconnaissance (RC), and Strategic Navigation (SN). The civilian pilot flying in the area of active routes may be interested in the nature of the mission, but most importantly he will want to know the altitude and width of the route segments in his vicinity, and the "hot" times.

All of this information will be available at the FSS, where the civilian pilot may study FLIP charts, sectionals, AIM, etc., and receive an update briefing (on request) of pertinent low altitude military activity. An MTR activity update

NEVADA/OREGON
WILDER OB-1
EFF:1100Z, 6 OCT 1977
*Hours of Operation – May be 24 hours daily, 7 days per week.



Olive Branch routes are all weather low altitude areas where the USAF and Navy conduct navigation/bombing training flights, both VFR and IFR. Pilots should know locations, altitudes and times of use for transiting these areas.

will also be passed along to pilots in response to specific inflight queries. However, the FSS will not routinely provide this information to pilots who call in, unless it is specifically requested. For maximum safety, any pilot who does not have positive information to the contrary should consider all military routes along his flight path to be active.

Suppose, for example, a pilot in flight calls Washington FSS and says:

"This is Bonanza 24688 Juliet, leaving Richmond for Frederick, by way of Fredericksburg and Manassas. Any military activity along my route?"

The FSS reply will read something like this:

"Roger, Bonanza 2468 Juliet, Caution India Romeo eight zero five hot fifteen thirty to sixteen hundred zulu, mission Sierra November. Also caution Victor Romeo eight two zero hot fifteen forty-five to sixteen thirty zulu, mission Romeo Charlie, Richmond altimeter three zero zero two."

The informed pilot will understand from this message that a Strategic Navigation mission will be flown on IR route 805 between 1530 and 1600 hours zulu, and that a Road Reconnaissance mission may be expected along VR route 820 between 1545 and 1630 hours. Locating the training routes on his chart, he will learn that IR 805 segment confronting his flight path includes the airspace between 4,000 and 6,000 feet MSL, and that the nearby segment of VR 820 extends from 500 to 1,500 feet above the ground. The pilot may also note from the chart depiction that both of these routes are relatively narrow, only about three miles in width, in the segments of his concern. For this reason he can be fairly certain that the military planes using these routes will not be maneuvering acrobatically, if he should decide to fly through the route. On the other hand, if he wishes to be especially careful, he knows that choosing any altitude between 1,500 feet AGL and 4,000 feet MSL will keep him clear of military traffic along either route.

This same information may be heard on the live weather scheduled at 15 minutes past the hour on the VOR transcribed weather broadcast or on PATWAS (Pilot Automatic Telephone Weather Answering Service) where available. Information regarding a particular route will also be broadcast 30 minutes prior to and during any activity on the route.

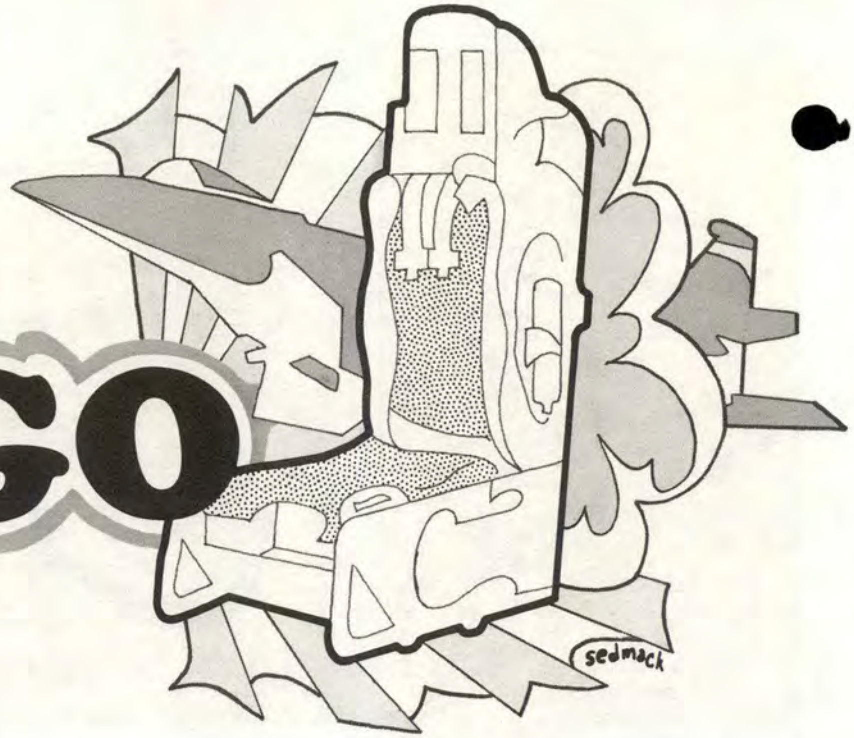
During the 1978 transitional year of MTR, civilian pilots are urged by the FAA to use all necessary sources of information to make certain they are correctly informed about military training flights in their area. Since the total amount of airspace given over to the low altitude training will be reduced in the new system, traffic along published routes is expected to increase. Incidentally, FLIP charts are available for study at most airports in public use. The DOD sends out 13,000 free copies annually to fixed base operators and airport managers.

The first FLIP charts containing new MTR routes were published on December 29, 1977. Publication of military routes in FAA civilian charts will be undertaken during the course of 1978, and pilots will be notified of their availability through *General Aviation News* and other publications.

Sharing the airspace intelligently is a matter of self-preservation. The sky above us will remain free only as long as we are willing to bear the burden of defending it.

NOTE: A free advisory circular, AC 210-5 contains further information on military flying activities. For a copy write to DOT, Publications Section, TAD 443.1, Washington, DC 20590. ★

When you gotta go — GO



RUDOLPH C. DELGADO
Directorate of Aerospace Safety

Year	Ejections	Survived Number	Survived Percent
1976	64	50	78
1977	70	54	77
1978-1	17	13	76

Fig. 1

FATALITIES BY CAUSE CATEGORY

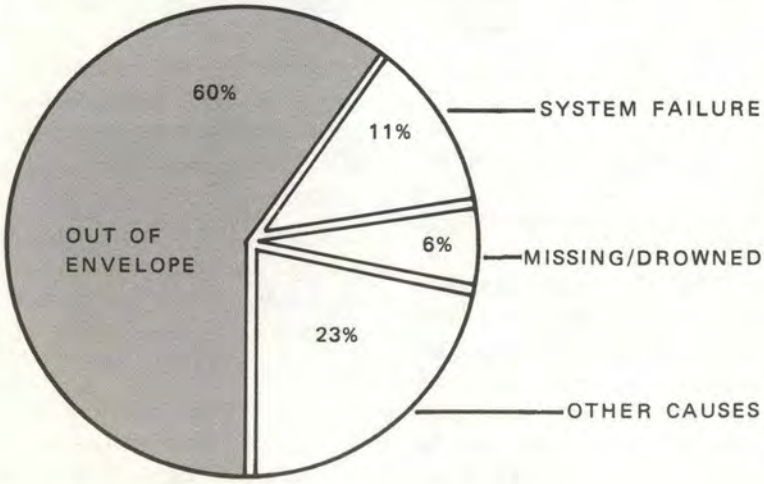


Fig. 2

The USAF ejection survival rate, a subject that should be near and dear to the hearts of crewmen who fly ejection-seat-equipped aircraft has been uncomfortably low lately.

In previous years this rate has hovered around 82 percent, but, as shown in Figure 1, in 1976 it went down to 78 percent, and in 1977 it dropped to 77 percent. The undesirable trend continued through the first quarter of calendar year 1978, with a 76-percent rate.

Historically, out-of-envelope ejections have accounted for over half of the total ejection fatalities. The remaining fatality causes are usually divided between material failure, missing/drowned, and "other." Figure 2 shows a breakdown of these based on a 10-year period of ejection experience. The material failure and missing/drowned categories are already being addressed by the responsible agencies. The "other" category is a catchall for the random problems which, individually, do not occur in sufficient numbers to warrant full-scale modifications.

Based on the foregoing, then, it appears that the out-of-envelope category is the one that offers the biggest potential for improvement. This is far easier said than done. In fact, this problem is the most difficult one in the emergency escape area, as attested to by the fact that it has plagued us since we started using ejection seats, and we have been unable to satisfactorily conquer it to date.

A few years back a big effort was made to improve and modernize existing escape systems to enlarge their escape envelopes. After this was done, no appreciable improvement in the overall ejection survival rate was noted.

Lately the emphasis has been on improved aircrew life support training in an effort to increase aircrew awareness of their escape system's capabilities and its safe escape envelope. This is a step in the right direction. But the real key to the whole thing is the individual crewman. It starts and ends with him. He has to want this knowledge about his escape system, and then he also has to be prepared to use it without hesitation to save his life when the aircraft is no longer flyable. It should not matter whether it be because it is breaking up or is out of control.

Nobody claims that this is an easy decision to make, and it certainly isn't. It becomes even more difficult when the crewman knows it may be his fault his aircraft is in trouble. Figure 3 shows very emphatically that operator factor mishaps have a very high percentage of out-of-envelope ejection fatalities, whereas logistic factor mishaps have a comparitively low number. The point here is that the pilot who finds himself in trouble due to his own mistake will usually try to overcome his problem longer than one whose problem is not of his own making. In far too many cases the former dies because he tried just a little too long, whereas the latter usually lives to tell about it.

ACES II ejection seat, a high technology system, will be used in F-15, F-16 and A-10 aircraft.

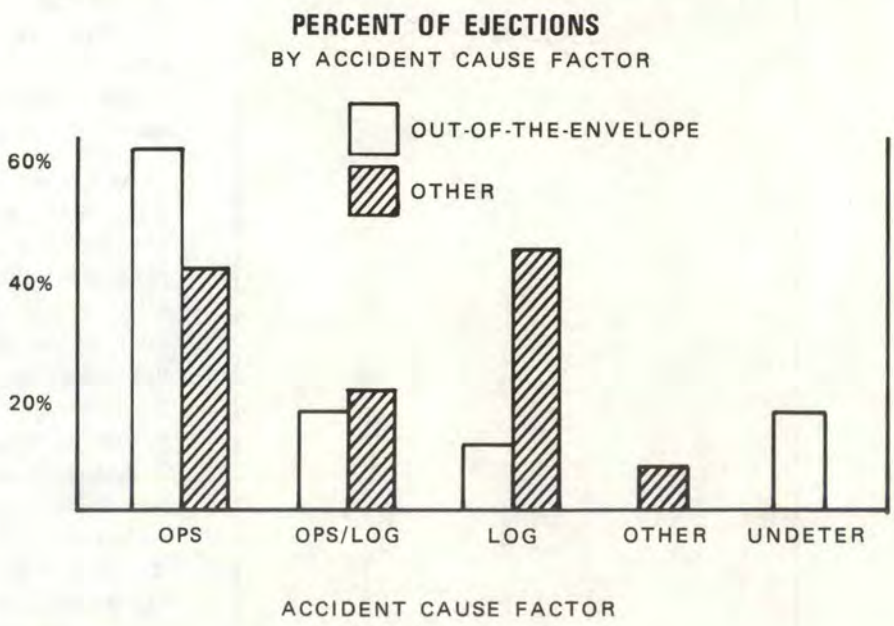


Fig. 3

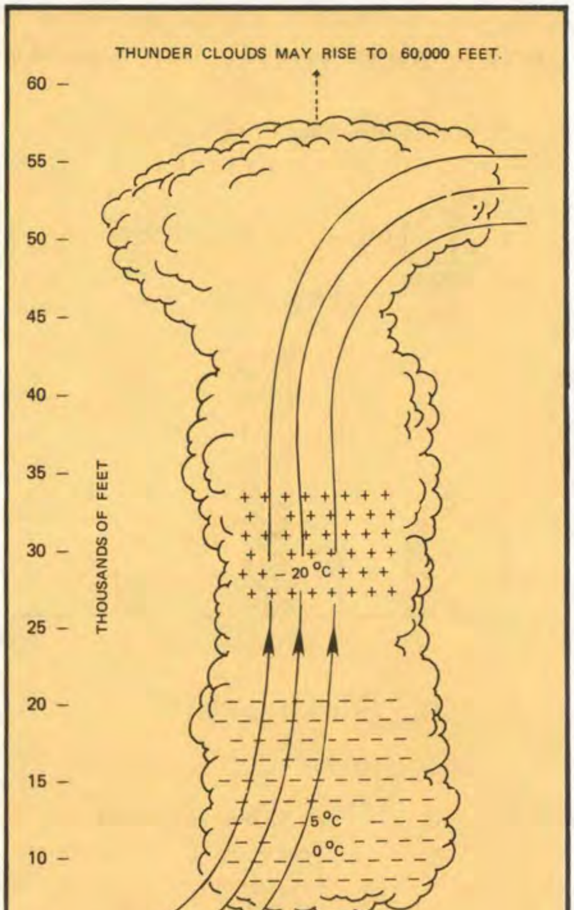
There are probably several things that can cause a pilot to delay his ejection. Either consciously or subconsciously, things such as mission dedication, stigma, ego, career impact, fear of the unknown (ejection environment), etc., invariably come into consideration. In the final analysis, though, all of these can be overcome to some degree, but the alternative—an ejection fatality—has absolutely no appeal process. So, When You Gotta Go—Go! ★

After this article appeared in Aerospace Safety *in June 1977, we had a rash of requests for permission to reprint. We think this is one of the best things on lightning we've read, so it's offered again. Good reading.*

Even though April, May and June are the worst months for lightning strikes, some are reported in each of the other months, too, and to some of you with many flight hours, these encounters may seem routine. But on very rare occasions lightning has brought a plane out of the sky, and on less rare occasions it has caused some very frightening close calls. Thus, it is well to review what lightning is, why your aircraft sometimes gets involved with it, what to expect from it, and how you can help researchers learn more about it and design even better protection from its effects in the future.

Lightning And

FIG. 1



A lightning flash is a very long electrical spark which extends between one center of electrical charge in a cloud and another center of opposite polarity charge in the ground, in another cloud, or sometimes even in the same cloud. The energy that produces lightning is provided by warm air rising upwards into a developing cloud as shown in Figure 1.

As the air rises, it becomes cooler and at the dew point its excess water vapor condenses into water droplets, forming the cloud. When the air has risen high enough for the temperature to have dropped to minus 40°C, all of the water vapor will have frozen to ice. Some of the ice crystals coalesce into hailstones which are heavy enough to fall through the cloud, gathering supercooled water droplets as they do so. According to one theory, as these droplets freeze onto a falling hailstone, small splinters of ice chip off, carrying away with them a positive charge and leaving the hailstone with a negative charge. The vertical air currents carry the ice splinters to the upward part of the cloud, leaving the base of the cloud with a negative charge center. The air currents and electrical charges tend to be contained in localized cells, and there may be several such cells in a single cloud.

Surrounding any electrical charge is an electric field which extends outward a long distance from the charge itself. Close to the cloud charge center the electric field is very intense, and when sufficient charge has accumulated, this field may be strong enough to *ionize* the air, creating a conducting path in the form of a luminous spark which jumps outward towards a region of uncharged or oppositely charged air. Some of the charge from the cloud flows along this spark, charging up a column of air, perhaps a meter in diameter around the spark, and intensifying the electric field in front of it. This causes more ionization and further extension of the spark, and the process repeats itself for many extensions and forms a zig-zagging, luminous column of ionized air called the *stepped leader*. The leader zigs or zags about 50 meters in each step, travelling

Aircraft

MR. J. A. PLUMER, General Electric Co, Pittsfield, MA

at about 100,000 meters per second, and pausing for about 50 millionths of a second between steps while it is supplied with more charge from the cloud.

As the stepped leader approaches the earth, it attracts electrical charges of opposite (positive) polarity and produces ionization from sharp objects such as tall buildings and trees. Fed by the attracted charges, sparks called *streamers* emanate from these points and propagate upward a short way to meet the downcoming leader. When the two meet, a conducting path is formed so that the charge in the leader can combine easily with the opposite polarity charges in the ground.

The process thus far takes only a few thousandths of a second to accomplish. When it begins, the leader moves in the general direction of an opposite polarity charge source, but it does not "know" where it will finally strike. There may be several possibilities, and the leader frequently splits into several *branches* on its way, as happened in the flash of Figure 2. The first branch that reaches a source of opposite charge completes the path and wins the race, so to speak. The leader that began the flash of Figure 2 found this opposite charge in the earth, but it might also have found it in another cloud, or even within the same cloud as the original source of charge. When the leader reaches the ground (or other opposite charge center), the positive charge in the ground rapidly flows into the leader, neutralizing the negative charge in it from the ground up. The head of the region in which this neutralization takes place moves up the leader channel at a velocity of 100 million meters per second—creating a current which reaches, on occasion, as high as 200,000 amperes. This current is called the *return stroke* and is responsible for the bright flash and loud noise we associate with lightning.

Once it reaches the cloud, the return stroke dies out but the charge remaining in the cloud may drain off through the conducting channel to ground, forming *continuing currents*. If additional charge centers are present in the cloud, they may also discharge to ground through the same channel, forming additional strokes, called *restrikes*. Neither the return stroke nor the restrikes last for more than a few thousandths of a second. The continuing currents are of lower amplitude—a few hundred amperes—but last for a much longer time than the strokes. Together, the strokes and continuing currents make up the complete lightning *flash* and flashes may persist for up to a full second. If more than one stroke occurs, the main channel will brighten during each one, causing the channel to flicker.

If your aircraft happens to be near a charge center or an advancing leader, the electric field around the aircraft may be intense enough to ionize the air about its extremities. This ionization often occurs in the form of a corona—a bluish glow visible at night and frequently called St. Elmo's fire. If sufficiently intense, streamers may also form and propagate outward from the aircraft toward the leader or charge center. As this happens, the intervening field will become even more intense and the leader may advance more directly to-

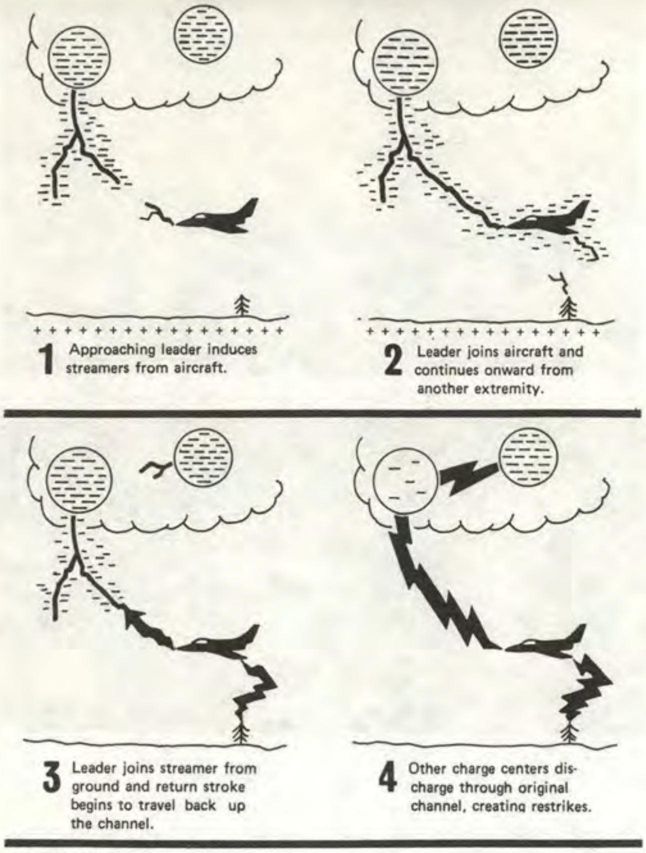


FIG. 3 Strike Sequence

ward the aircraft and meet one of the streamers emanating from it, completing a conducting path through which charge may flow onto the aircraft. Since there is not room for very much charge to remain on an aircraft, charge will "overflow" in the form of intense streamers from other extremities and enable the leader to progress onward, as shown in the sequence of Figure 3.

Thus, your aircraft becomes a link in the conducting channel from the cloud to the ground or another cloud. Whatever strokes and continuing currents pass through the channel will also have to be conducted through your aircraft.

Once within its clutches, you cannot fly away from a lightning flash. When the return stroke passes through the channel, you will experience the bright flash and loud bang so often reported. You will be "let go" only when the flash dies out naturally.

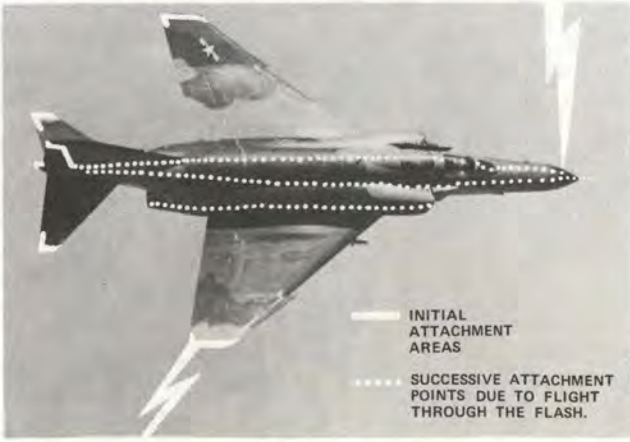
From your perspective in the cockpit, the foregoing events may appear to be caused by the aircraft becoming charged up by some other process and then suddenly discharging itself into the surrounding air, accompanied by a bright flash and loud bang. Sometimes at night the corona and streamering will persist and brighten for many seconds, appearing as a fluctuating column of fire snaking outward from the nose of the aircraft. When the flash finally occurs, the corona and streamering cease because the electric field has collapsed, and it appears as if the aircraft has suddenly discharged. Hence the event is termed a *static discharge* and not a lightning strike. However, a rather large amount of electrical charge is necessary to produce either a bright flash or a loud bang—far more than can be stored on an aircraft, so if either of these symptoms occur, you almost certainly have been struck by lightning. In fact, the loud bang does not even occur on some strikes; only a "whoosh" sound. This is thought to be a cloud-to-cloud flash whose return stroke occurs less rapidly, producing less current and noise.

WHAT PARTS OF AN AIRCRAFT GET HIT?

Since it will be part of a path between two charge centers, there will always be at least one entry and one exit point on your aircraft. *Initially,* these are places from which streamers came during the leader phase described earlier, and may be any of the extremities such as the nose, wing tips, horizontal or vertical stabilizer tips, tail cones and, somewhat less frequently, other protrusions such as propellers and blade antennas.

But, an aircraft flies quite a distance during the lifetime of the total flash, and this may expose other surfaces to flash attachment. A flash striking the nose, for example, may reattach at successive points along the fuselage until a trailing edge is reached, where it will then remain until the flash dies. If an initial attachment point was already at a trailing edge, the flash will simply hang on there. Figure 4 illustrates this process and shows other likely attachment points on a typical aircraft. *(Continued on page 22)*

FIG. 4 Lightning Attachment Points



OPS TOPICS

DAEDALIANS MEET

The Order of Daedalians, the National Fraternity of Military Pilots, is holding its annual convention 1-3 June, in San Antonio, Texas. The Order, founded in 1934, will honor its over 350 Founder Members (commissioned pilots of heavier-than-air aircraft prior to November 11, 1918). Business meetings, safety award presentations, and social events are also planned for the 3-day convention. For further information contact Colonel Robert E. Morris, USAF (Ret), (512) 924-9485.

PILOT TO ATC TRANSMISSIONS

We've covered this subject before, but let's reinforce it with an actual case: Indianapolis Center cleared TWA 373 to descend from FL 310 to FL 280. The crew received the clearance, but they understood the assigned altitude to be FL 230. The first officer promptly acknowledged as follows, "two-three-zero TWA three seventy-three." The controller only received the second part of the transmission, that is, "TWA three seventy-three." The controller assumed it to be an acknowledgement of the FL 280 altitude assignment. The mistake went unnoticed until the descending TWA 373 nearly hit TWA 516, cruising at FL 270. The Airman's Information Manual is very specific in its section on "Radio Communications Phraseology and Techniques." Call sign first—then repeat the clearance. It was written that way to avoid a situation exactly like this one.—Courtesy *Flight Safety Focus.*

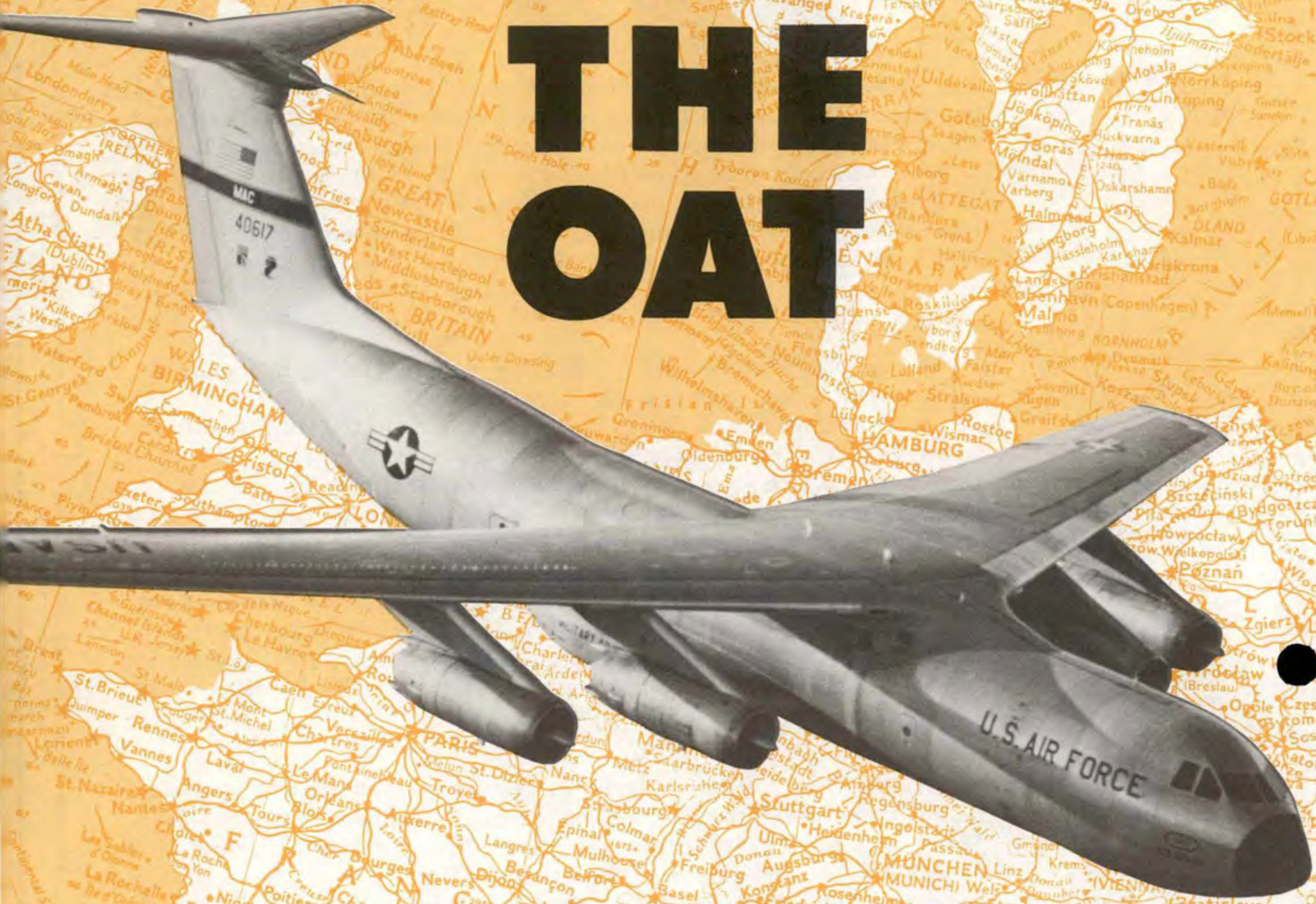
WHAT IS CAP?

CAP is the Civil Air Patrol. In 1977, they recorded one of their most successful years ever. These civilian volunteers are an auxiliary of the US Air Force, and are the only national organization specifically trained and equipped to perform air search. Last year, CAP was directly responsible for saving the lives of 52 persons, and they successfully accomplished 446 finds (search objectives located). This 63,000 member organization has units in all 50 states, the District of Columbia and Puerto Rico. Additionally, the CAP cadet program provides a vehicle for the study of aviation and space related subjects, as well as leadership training, for thousands of teenage Americans.

VALUE YOUR TAIL?

A C-130 was on a support mission to a remote site outside the CONUS. A maximum effort takeoff was made on a specific runway required in the approach plates and IFR supplement. The runway had a downslope gradient of up to 12 percent. The crew members didn't notice anything unusual about the takeoff. However, on postflight inspection at their home base, the maintenance people discovered some damage to the tail skid and urinal drains. Runway gradients can tell you something about your takeoff and landing attitude.—Maj John D. Woodruff, Directorate of Aerospace Safety. ★

FLY THE OAT



COLONEL THOMAS H. YATES • CAPTAIN TERRY W. JOHNSON, EUCARF

Captain Bob Jones relaxed as the Starlifter's Autopilot engaged and set the big bird on a steady climb up into the starlit night. It was going to be a routine 3-day Europe run; so routine in fact that it was almost boring. Two-pallet off-load at Prestwick Airport, Scotland, RON at Mildenhall, shuttle hop to Rhein-Main and back, RON and RTB in time for the Wing Thing at the Club on Saturday. Besides that, his date for Saturday was the newest sensation in the flight nurses section.

Just before changing frequencies to enroute center control, he heard MAC 234 checking in. MAC 234, piloted by his roommate, Maj Bill Smith, was on the same mission profile. Bill had threatened to move in on the new nurse if Bob got held over on maintenance delays beyond the 3 day TDY. Bob had heard rumors of a probable "industrial action" among U.K.

Air Traffic Control personnel and the possibility of "sympathy slowdowns/strikes" on the continent. Such trivia however was of slight concern to the fearless aviator who had flown through the worst that SEA had to offer. Alas, five ramp-pounding, bone-weary days later, he dragged his hang-up bag through the front entrance of his BOQ. 5 days!! How could this happen?

The transatlantic flight had been uneventful until they were handed off from Oceanic to Domestic Control. The one hour holding pattern for approach clearance due to civil ATC industrial actions (slowdowns) had been irritating, and the three hour departure delay had put them beyond crew duty day, forcing an RON at Prestwick. A two hour departure delay the next day put them into Mildenhall too late for the scheduled shuttle to Rhein-Main, delaying them until the next day. The three-hour round trip flight turned out to be over ten hours from crew brief to debrief due to multi-hour delays in departure clearances and lengthy approach delays.

All the way back across the Atlantic, Bob was mumbling something about lousy air traffic controllers who are supposed to be providing a service, but instead are disrupting the best laid plans of mice and men. The last straw was when he stumbled through his BOQ door and saw his roommate, refreshed after two days of crew rest following the TDY, sitting on the sofa with his prospective new nurse friend.

"How in the world did you do it," Bob mumbled. "Simple," explained the more Europe-wise senior pilot, "when we coasted in and discovered all the delays and problems due to ATC disruptions, we filed OAT and experienced no delays on the whole mission." "OAT," said an exasperated Bob, "that sounds like something to feed horses or eat for breakfast."

The names and times in the above scenario may be fictitious, but the places and circumstances are based on composite experiences of USAF aircrews. A good basic understanding of the air traffic control system in Northern Europe can permit miltary flights to circumvent disruptions within the civilian air traffic control environment and complete their mission on time.

The United Kingdom, Netherlands, Belgium, Luxemburg, Germany and France all have a dual enroute air traffic control system, one civilian and one military, known respectively as General Air Traffic (GAT) and operational Air Traffic (OAT). Generally speaking, aircraft flying on published air routes (other than TACAN) are controlled by civilian ATC personnel. Aircraft flying on TACAN routes or point to point off airways are controlled by miltary controllers. The OAT ATC system is not subject to the slowdowns, sick outs, strikes, etc., of the GAT system. Equipment, phraseology, and aircraft separation standards are the same for both civil and military controllers. In some of these countries civil and military controllers are even co-located in the same building. The OAT and GAT systems are fully coordinated and aircraft operating under one system can be safely transited through airspace controlled by the other system.

OAT is for military aircraft only and is intended primarily to facilitate movement of aircraft that, because of communications equipment, navigational equipment, or operational and mission characteristics, are not wholly compatible with the civil GAT system. However, military aircraft, such as the airlifters, SAM, VIP, etc., that can fly GAT are not prohibited from flying OAT. (Note: OAT in France is restricted to fighter type aircraft.) During periods of civil ATC disruption within the GAT system, all military aircraft may file OAT and avoid the restrictions and delays placed upon GAT traffic.

The OAT capability is generally available in the enroute altitude strata only, although in the UK, France and Netherlands, OAT can be filed from takeoff. In Germany in the miltary TMAs (Eifel and Ramstein) aircraft may also depart OAT. In the absence of OAT availability up to the enroute system, a composite GAT/OAT flight plan may be filed. In this instance the changeover point should be a NAVAID to facilitate inter-system coordination and hand-off. The OAT controller will automatically transfer aircraft to the appropriate terminal arrival controlling agency.

Additional information on OAT routings, applicable altitudes, filing procedures, and ICAO addressee identifiers for flight plans, are contained in the DOD FLIP AP/2. Aircrew members should periodically fly OAT in Europe to familiarize themselves with the procedures, flex the system, and be prepared for the next time the air traffic control slowdown whistle blows. Your knowledge of these dual ATC systems will provide you viable alternatives in any situation so that you can continue flying and airlifting.

The European Central Reservation Altitude Facility (EUCARF) Rhein-Main Air Base, Germany, was established in 1973. It provides altitude reservations for inter-theatre movement of large scale DOD aircraft forces within the European, North Atlantic, Midle Eastern and North African theatre. ★

USAF IFC APPROACH

Altimeters are probably one of the least understood instruments installed in our aircraft. Pressure altimeters are calibrated to indicate true altitude under international standard atmosphere conditions, and any deviation from this standard will result in an erroneous reading on the altimeter. When the temperature is colder than standard, this error will cause the aircraft to be lower than indicated on the altimeter. The amount lower will depend on the difference between the standard temperature for that altitude and the actual temperature. This difference equates to approximately four feet per thousand feet for each degree Celsius of difference. The Canadian IFR Supplement (GPH205) prints a Temperature Correction Chart for use by the pilot in determining the amount of error he can expect when colder than standard temperatures are encountered. The chart is printed here for your perusal along with the example given in the IFR Supplement on how to employ the chart.

As can be seen, the errors in the altimeter can be quite significant, especially with high MDAs or DHs and extremely low temperatures. This chart was tested by flying aircraft to PAR and ILS glide path interception points. When chart corrections were applied, the aircraft intercepted the glidepaths at the correct heights. Without corrections applied, the aircraft intercepted the glidepaths at altitudes lower than normal. We thought you might like to be made aware of this chart in case you ever fly in cold temperatures. It should be noted that Canadian pilots are not required to use this chart, but are encouraged to do so.

Since the error increases with altitude, remember that this can also be applied to the enroute portion of flight, i.e., when operating in areas of cold temperature and uneven terrain, you should file for an altitude above the minimum IFR altitude. Get a good weather briefing and be aware that often something as subtle as temperature can make a big difference in where you are with respect to the terrain you are flying through.

Fig. 1

TEMPERATURE CORRECTION CHART

AERODROME TEMP °C									
0	0	20	20	20	40	40	40	40	60
−10	20	20	40	40	60	60	80	80	80
−20	20	40	60	60	80	100	100	120	140
−30	40	60	60	80	100	120	140	160	180
−40	40	60	80	100	120	140	160	200	220
−50	60	80	100	120	160	180	200	220	260
HAT or HAA	200	300	400	500	600	700	800	900	1000

Due to altimeter error in extreme cold weather, the values derived from this chart should be added to the published DH or MDA by the pilot to ensure adequate obstacle clearance.

Example: On a Hi TACAN rwy 36 approach at Winnipeg Elevation 783' ASL

Published MDA 1180' ASL

HAT 397

Temp −30°C

Correction 60'

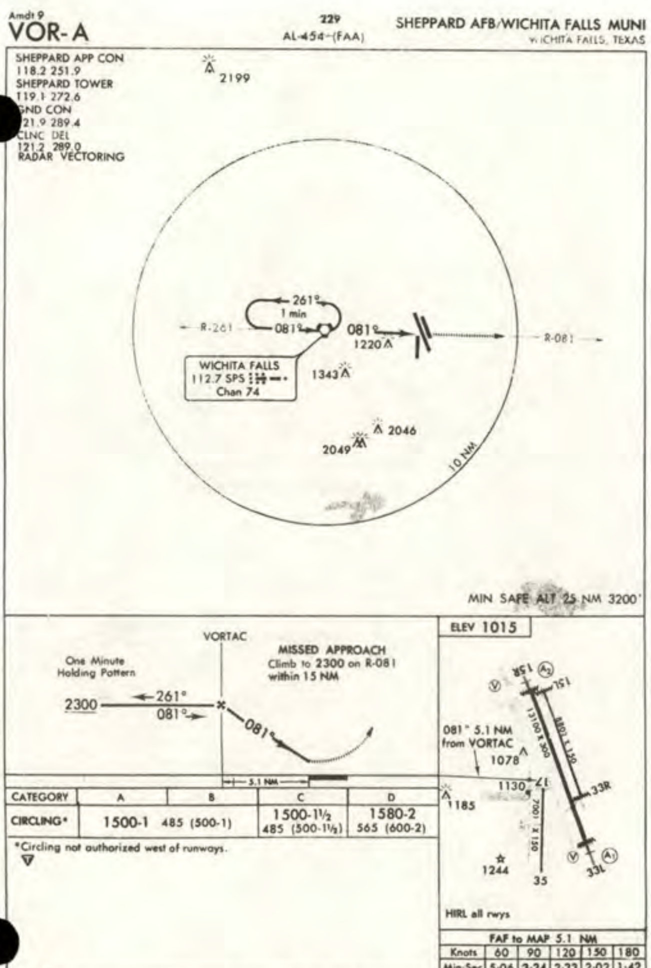
MDA to use −1180 + 60 = 1240' ASL

By the USAF Instrument Flight Center
Randolph AFB, Texas 78148

Q. I have been cleared to Wichita Falls VORTAC from the Southwest on a heading of 040° at 3,500 feet (see Figure 4). Approaching the VORTAC, I am then cleared for the approach. When can I commence descent to 2,300 feet?

A. The last assigned altitude must be maintained until on a published portion of the approach procedure. In the case of Holding in Lieu of a Procedure Turn, the holding pattern is part of the published approach procedure; therefore, once established in the holding pattern (which, in this case, would be on VORTAC passage) descent may be accomplished from 3,500 feet to 2,300 feet.

Fig. 2



Q. I have been cleared to Wichita Falls VORTAC from the Southwest to hold in the depicted holding pattern (see Figure 2). After turning outbound to 261° on VORTAC passage, I am then cleared for the approach. If my airspeed is in excess of 180 KTAS, must I then correct back toward the holding course using an intercept angle of at least 20° as stated in AFM 51-37?

A. No. The note in AFM 51-37 after paragraph 6-12c is being deleted in Change 1 to AFM 51-37. This is being done to bring holding in-lieu-of procedures in alignment with normal holding pattern procedures. ★

SAFETY AWARDS NEWS

Congrats! It was recently announced that the Air Defense Weapons Center (ADCOM) located at Tyndall AFB, Florida, has been selected as the USAF winner of the System of Cooperation Among Air Forces of the Americas Flight Safety Award (SICOFFA) for 1977. The Air Defense Weapons Center was selected from a total of eight USAF nominations to receive the award which recognizes outstanding accomplishments in aircraft accident prevention.

* * *

A new safety award has been created and is in the development stage! When approved, the "Director of Aerospace Safety Special Achievement Award" will be presented annually to one individual or one organization for outstanding safety contributions or achievements. All military organizations (MAJCOM and below), all USAF military personnel (O-6 and below), and all USAF civilian employees will be eligible! Watch for more details; we'll keep you posted! ★

BACKACHE IN HELICOPTER PILOTS

MAJ RON GOEDE
Base Surgeon
CFB Portage La Prairie, Canada

One does not have to spend much time in a helicopter squadron flight room before it becomes very obvious that a large number of helicopter pilots suffer from chronic backache. In fact, this author has on occasion experienced low back pain on some especially long trips in the Kiowa helicopter.

A French researcher found that 87.5% of helicopter pilots investigated, all of whom had at least 500 hrs, suffered from backache while flying. While the majority experienced pain in the region of the lower spine, the incidence of neck pain was also high. He found that the pains started after approximately 300 hrs of flying and were more likely to occur if the previous intensity of flying had been high. It was interesting to note that in pilots with co-existing spinal disease, the pain appeared between the 50th and 100th hr. Once the symptoms were established, any flight which was prolonged or difficult brought on the pain. This was especially true of flights which required considerable concentration by the pilot, i.e., confined area operations.

The development of symptoms is basically a function of the flying intensity. The flying rate which seems most likely to promote back pain is more than 5 hrs per day, more than 40-50 hrs per month.

There appear to be two factors which promote the occurrence of back pain, the posture of the pilot and the vibration generated by the machine.

POSTURE

The unique control system in the helicopter requires the adoption of an abnormal sitting posture by the pilot.

In order to control the collective, the pilot is obliged to lean to the left. The left hand, which activates the collective lever, is half flexed. The right arm, which activates the cyclic, is bent at the elbow, almost at right angles. Generally the handle is too high for the forearm to rest on the thigh. Hence the pilot holds his hand as low as possible to compensate.

The pilot then hunches over the cyclic (fig. 1) and as a result, the spine is moved away from the back of the seat rest and cannot be supported by it. In order to see over the instrument panel, the pilot must hold his head tilted slightly upwards. This is especially true of shorter pilots.

The lower limb rests on the rotor pedals with the legs and thighs slightly flexed. The knee is tensed and maintaining this posture over long periods of time causes fatigue.

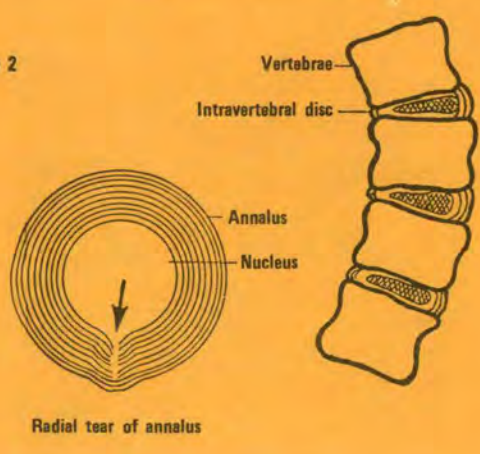
This posture is bad because the position is rigid, asymmetrical and the pilot is forced to maintain it for the duration of the flight. It is this constant state of tension in the musculature that results in the eventual production of pain.

The sitting position adopted tends to press the vertebral bodies together at the front and pull them apart towards the back (fig. 2). This difference in

Fig. 1.

Posture adopted by helicopter pilots.

Figure 2



Radial tear of annalus

hydraulic pressure on the inter-vertebral discs will tend to force the nucleus of the disc rearwards.

Fig. 2 depicts radial tears in the anulus (washer) as a result of the aging process and repeated trauma. These begin centrally and near the nucleus (ball bearing) and progress outwardly. Due to the uneven hydraulic pressures within the nucleus, the torn ends of the fibre are forced outwards, when these tears reach the outer margin of the discs, they can produce a bulge. Now the conditions are prime for a minor stress, i.e., hard landing, to "tip the scales" and precipitate a complete prolapse of the disc.

The spine of the helicopter pilot, weakened by numerous small injuries, is particularly vulnerable to degenerative injuries to the fibro-cartilage of the disc. These injuries set the stage for the ultimate extrusion of the nucleus rearward. This will irritate the ligamentary system, and even the nerve roots, resulting in back pain.

In the case of heavy or crash landings, this vulnerable posture may cause serious injuries to the vertebrae, i.e., compression or chip fractures.

VIBRATION

Vibrations are considerable in helicopters. These become greatly intensified on takeoff and landings. They are complex, of varying frequencies, and significant in the vertical, lateral, and horizontal axis. Helicopter vibrations arise from a number of mechanical sources.

Vibrations in the 3-12 HZ range are induced by rotor blades, the frequency being related to the number of blades. Tail rotors induce high frequency vibrations in the 20-25 HZ.

The lowest tolerance of the human body to vibration is in the 4-8 HZ range due to the amplification of vibration by the natural resonance of the human body.

A fundamental problem is vibration isolation between the rotor and fuselage. Excitation of the fuselage by low frequency rotor vibrations adversely affect aircraft controls, subsystem operations and crew comfort.

Efforts to reduce oscillatory forces have had limited success. Tailoring the rotor and/or fuselage to avoid resonance is usually attempted. Some form of isolation system is also desirable. This is particularly true of two bladed rotors because of the low frequency and high magnitude of the rotor hub forces produced.

Vibrations are transmitted to the pilot through his feet and the seat. The magnitude and frequency varies from one machine to the other.

From a mechanical point of view the human body is a complex elastic structure in which visco-elastic soft tissue elements are supported and coupled to the skeleton, made of bone, and behaving more like a solid.

The human body is considered as a system of suspended masses separated by springs. When excited with certain input frequencies, resonance of the body parts can occur, i.e., the deformation or displacement of body organs is much larger at resonant frequencies than at other frequencies. Changes of phase of resonance will act particularly on lumbar discs. Supporting musculature "springs", must consistently work to absorb the vibration and hence rapidly become the source of the pain.

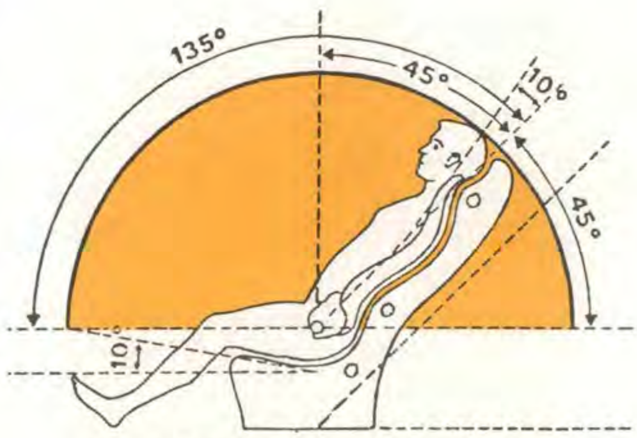
The chronic effects on the disc itself have already been described. The load on the spinal system will increase the problems already caused by the vulnerable posture.

Poor posture and vibration therefore are the two main causes of low back pain experienced by helicopter pilots. However, one must take into consideration the frequent minor injuries of the spines of the pilots, as a result of poor posture, and their resultant long term effects.

PREVENTIVE MEASURES

The most ideal method of preventing back pain and spinal injury in helicopter pilots would be to ensure adequate human engineering at the time of design conception. For example, helicopter controls can be redesigned to improve the posture adopted by the pilot.

The cyclic control should be close enough to the body and its handle sufficiently low for the forearm to rest on the right thigh.



Relaxed sitting posture according to Krämer.

Backache In Helicopter Pilots continued

The length and travel of the collective control should be such that it would prevent the body from being tilted to the left. Adequate support should be given to the left elbow.

The rotor pedals should be adjustable, not only fore and aft but vertically as well, to ensure that the foot forms a right angle with the leg and the heel can rest on the floor. The instrument panel should not restrict the field of view and must be sufficiently close to the pilot so that the reading of the instruments does not cause an accentuation of the forward leaning position.

The seat should be adjustable, not only fore and aft but vertically as well. The wide range in the size of helicopter pilots will bear this out.

The seat back should match the contour of the human spine. An adjustable lumbar support would ensure the retention of the normal curvature of the lumbar spine and prevent the forward bowing of the spine as a whole.

The seat cushion should be of such shape that it would give a certain degree of support to the thighs. There should also be design considerations to prevent transfer of vibration from the airframe to the pilot and to attenuate decelerative crash forces.

REMEDIAL ACTION

Remedying the pain is an immediate problem: present helicopters will remain in service for a long time without any possibility of retro-fit modifications.

Since helicopter pilots will have to live with the current design for some time, there are numerous remedial programs that can be undertaken to delay the onset of back pain and minimize the degeneration of the structures of the spine.

- There should be adequate medical screening of potential helicopter pilots, including x-ray examination of the spine, to rule out pre-existing spinal disease and deformity.
- Flying hours should be limited to a maximum of five hours per day and fifty hours per month.
- Provisions of lightweight helmets for helicopter pilots.
- Rotary wing tours should alternate with fixed wing tours to prevent the rapid accumulation of helicopter hours.
- Pilots should maintain their ideal body weight to prevent added stresses on the spine.

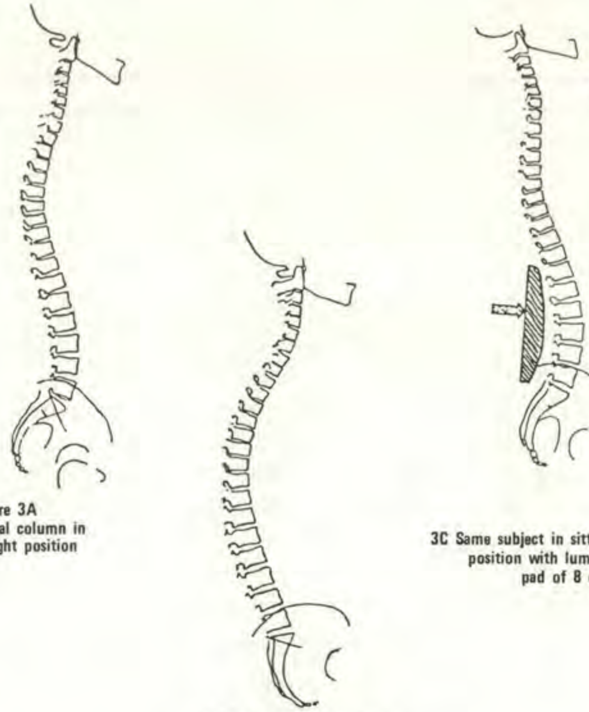


Figure 3A Spinal column in upright position

3B Same subject in sitting position adopted by helicopter pilots.

3C Same subject in sitting position with lumbar pad of 8 cm.

- Pilots should undertake regular exercise programs designed to strengthen their abdominal and spinal musculatures and increase flexibility.

Studies conducted by Beach and Killus of the German Air Force Institute of Aviation Medicine demonstrated that seat positions are better tolerated for prolonged periods if the forward protrusion of the lumbar spine is encouraged and supported (fig. 3).

This can be accomplished by a custom designed lumbar cushion of approximately 8 cm thick and high enough to support the full lumbar region. This could be attached to the seat back with velcro fasteners and adjusted to a height suitable for the particular pilot.

CONCLUSION

It has become evident to most helicopter pilots that very little human engineering has gone into the design of cockpits. Helicopters are making up an ever increasing percentage of Canadian Armed Forces aircraft inventory. Both the pilots of Rotary Wing Aircraft and the medical profession should ensure that the inadequacies of our current inventory are not repeated in future generations of helicopters.

In the interim, the remedial measures outlined should be encouraged. These would delay the onset of back pain experienced by Rotary Wing pilots and minimize the permanent damage produced.—Courtesy **Flight Comment,** Canadian Armed Forces ★

The Day Charlie Died

CAPTAIN DAVID V. FROEHLICH
Directorate of Aerospace Safety

Author's Note: Charlie is a fictitious flyer. He is the guy who sat in the left seat, flew on my wing "up North," yelled at me from the back seat or hovered over me while I was pulled up on a cable. Charlie is the aviator who has the mental and physical ability and skill, but through some disregard of rules, limits or flight discipline, he kills himself (and mayhaps others). Those of us who fly, either have known or will know, a Charlie, before he kills himself.

Charlie was a good stick! He was always the tightest in formation when we flew white rockets at Laughlin airpatch. His landings and acro were used as examples of perfection when the rest of us were getting the UPT—chew! When it came time for the fledgling aviators to leave the ATC—UPT nest, he got a "fantastic Phantom" when I (and others) headed for "Buffs." Charlie went to sunny Miami (HST) for his RTU and true to form, he garnered the TOP GUN and other ace of the base awards. Good stick! No doubt! Charlie's reputation grew as he headed west across the pond for a tour in "the only war we've got." He progressed from Blue 4 up to Blue Lead and got himself credit for 800 trucks, two sampans and a couple of MIGs. When he returned stateside, he walked back into the old niche at the squadron as an IP, flight commander and "dazzler of young lieutenants." The only problem Charlie had was that he couldn't follow "those dumb peacetime rules." One of them killed Charlie.

It was in November, about a year after Charlie's return to the states. The mission was a night range sortie, and he was lead. His briefing to the other seven Phantom riders contained most of the required items, but there was also a notable number of references to "the way we did it in SEA," and "we've got good weather, so that's no sweat." There were no questions from the flight (Charlie had a way of briefing which discouraged "dumb" questions).

The group piled into the blue bread truck and arrived at their aircraft on time. Charlie rushed his usually sketchy preflight, but found nothing amiss and was ready for the prestart check-in about 5 early. "Damn, three's crying about an electrical problem and says he won't be able to start on time. Well, we'll start without him, and he can meet us in the arming area. I don't need another late takeoff or missed range time. On top of that, I've got a new brown-bar in the back. Means I'm going to have to do it all myself.

"What? Oh, yeah! Crosscheck the altimeters! Mine reads. . . . What? 280 feet different? Well, it's okay! We'll watch 'em when we get airborne. Yes!! I know it's out of tolerance. I said we'd check 'em again later!!"

"Blue Flight check! 2, . . . 4. Damn it! Where's three?"

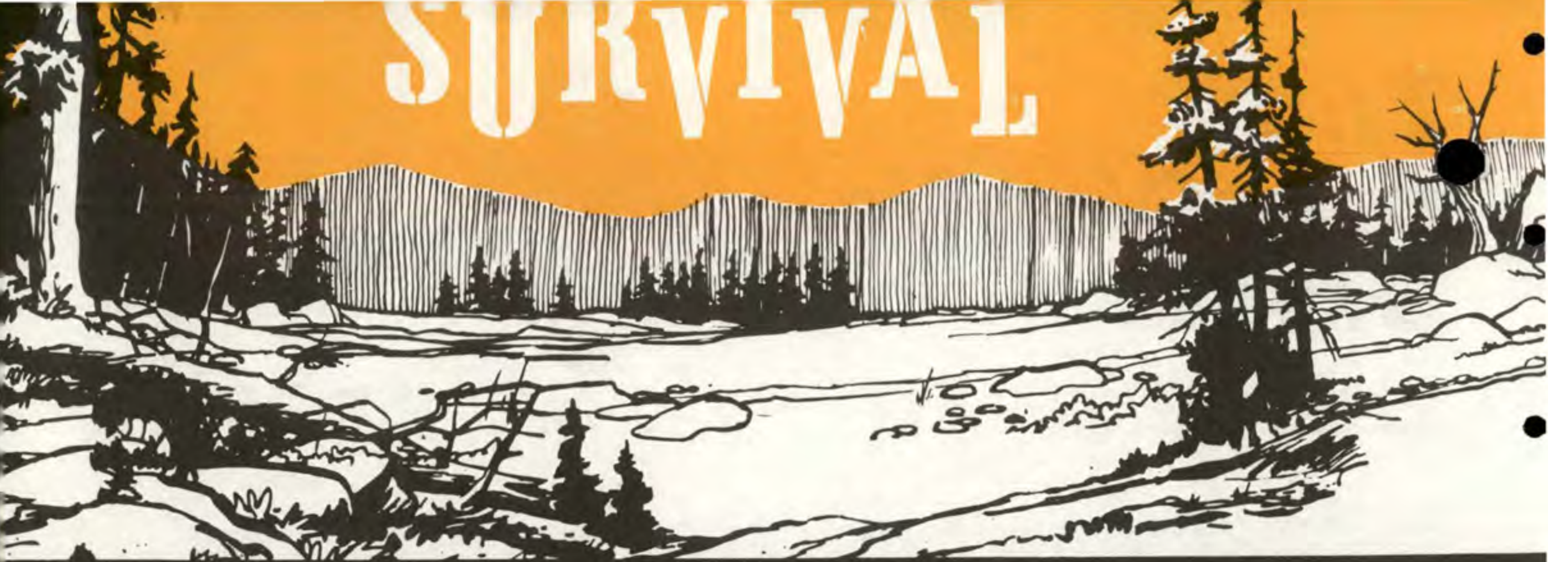
"Lead, this is 3. Maintenance says ETIC is 20 minutes."

"Okay, three; we're gonna go! You can catch up with us! I'll tell center you'll be coming."

Later, there are three F-4s winging their way to the range. The descent checks have been accomplished. Charlie's altimeter is still out of tolerance, but he has dismissed that as a minor problem since "it is a good clear night" and he has more to worry about anyway. His range time will be good, but three hasn't arrived yet! Preoccupied with the range, center and three, Charlie "rogers" the back seater's reminder about resetting the altimeter for the range. Charlie rolls in for the first one.

"What? Yeah, I set it! Yours says what? No, we're okay. I've got a good visual on the target! Down the chute and a little extra pull will get us out with plenty of. . . ."

An altimeter killed Charlie. The cause will be "undetermined." The entire squadron will testify as to Charlie's flying ability. His wife states that "no, there were no problems at home and, yes, he had good meals and plenty of rest." The accident board picked through the smoking hole, but could only find a few gauges and miscellaneous parts. CAUSE: UNDETERMINED. That was the first day that Charlie died. ★



FAT AND HAPPY

SGT HERBERT A. KUEKER | Operations and Requirements Branch
3636th Combat Crew Training Wing (ATC) • Fairchild AFB, WA

Bill Winston gazed across the table at his wife and children and thought of how well he had done over the years. With his children almost out of high school, the mortgage on his home almost paid, this recently retired Air Force Chief Master Sergeant was securely situated in his community and justly proud of his accomplishments. As the family dinner prayer was said, and they all began to eat, Winston thought of other times—times not quite as serene.

His thoughts went back to a time in his military career when he was a 26-year-old staff sergeant.

He recalled that as a member of the Air/Sea Rescue Service he was enroute to a training exercise in some nearby mountains in an H-19 helicopter. There were transmission problems—the helicopter went down.

After an unknown period of unconsciousness, he discovered he was the only survivor of the mishap. After somewhat overcoming the stunned feeling from this unexpected turn of events, he started getting his stuff together. Having laid out his signal in a nearby meadow, he waited for four days—miserably crouched next to some rocks. His hunger became noticeable on the second day. He surprisingly discovered obtaining food by killing a small bird with a rock was a piece of cake. The gut wrenching vomiting associated with eating the raw meat was almost more than he could stand. Procuring the meat was easy, but not knowing how to adequately prepare it made the food virtually useless. As a matter of fact, it compounded the problems he already had. By the fourth day, he decided that he had to walk out or starve.

The next three weeks weren't pretty!

He began walking. He roamed from one mountain ridge to another, continuously violating a cardinal rule of survival by traveling without purpose and not knowing where he was going. He just had to do something and moving seemed to be the thing to do.

The exact series of events that went on during those three weeks were still kind of fuzzy in his mind. The part he can vividly recall was when he was finally found by the rescue party. He recalls that moment very clearly, and how thankful he was to be alive—barely.

Many people have encountered the possibility of starvation. Some were able to adequately deal with it, others weren't. With today's quick rescue capability, starvation isn't a major problem—at least in peacetime. However, in an extended survival environment the knowledge of how to prepare food for consumption could save your life.

As Bill had found, in most areas of the world, finding or procuring animals and edible plant life is relatively simple—the catch is, most people aren't knowledgeable on how to prepare the food after they have obtained it. Almost all food stuffs you may obtain in this sort of situation require some sort of preparation prior to its consumption. Consequently, it is essential for all of us to know some basics about "primitive" cooking methods.

Even though the methods of food preparation are limitless, a survivor should keep the efficiency of each method in the back of his mind. Remember that boiling, roasting, baking and frying, in that order, are the most efficient ways to prepare food. Boiling is most desirable because you can drink the broth the food was cooked in and, thus, retain a majority of the nutrients that have been cooked out of the food. Each of the other methods wastes food nutrients due to the loss of fluids or by burning the food.

Once the method has been selected you must determine what sort of container can best be used to prepare the food. There are several which are easy to construct. Anyone who has been through the Air Force Survival School will remember how to lash an empty ration can to a stick to make a small cooking pot. Just remember to open the ration can on the end where the opening key is soldered. This end has been weakened by the soldering process and could burn through if exposed to heat.

An easy way to fry food over an open fire is to wrap heavy aluminum foil around a stick with a large Y in it. Holding on to the handle, you can easily fry meats on your improvised aluminum foil frying pan. (I would recommend all aircrew members carry several feet of aluminum foil folded up in their personal survival kit.) A roasting spit can easily be made out of any small limb, of a type wood which leaves no bitter taste after the bark is removed—such as maple. Place the meat securely on the stick and prepare a fire which is hot enough to cook on, yet not so hot that it would burn the meat. Throw a handful of dried leaves or small, dead twigs into the coals, causing a flare-up. This quick flame will sear the meat and seal in any tasty juices.

Always roast meat as fast as possible to avoid toughness. Boiling the meat from animals such as deer, fox, and other larger animals for a few moments prior to roasting will eliminate some of the toughness from the meat.

Boiling is just as easy as frying, but requires a better container for the food. As I mentioned earlier, containers for boiling can be made from a ration can, or if clay can be found in your area, pottery. With the exception of your ration tins, other alternatives will require considerable work, but are feasible if you want to take the time to construct them. Additionally, birch bark and other peeled barks which are very pliable can be folded into a container for boiling. Just remember, when cooking with this type of wooden container, place it near the edge of the fire away from any flames so the container itself doesn't catch on fire. Check your AFM 64-5 for other ideas.

There are certain things to remember when boiling foods that may enhance the edibility of the sustenance as well as benefit you physically. First, when cooking plants such as dandelions, bistort or the like, leach them (boiling the plant in several changes of water) thoroughly to eliminate some of the bitter taste. Another idea is to drink the water you have used to boil meat, since this broth contains all the nutrients extracted by the boiling process.

Much can be said in favor of baking foods in a survival situation. The primary advantage, be it plant or animal life, is the lack of a requirement for a cooking container. Have you ever considered coating meats such as fish, venison, birds, and small game animals with a half-inch layer of mud and placing them into the fire coals to bake? This procedure hardens the mud and

BAKING GAME IN MUD MIXED WITH GRASSES – ½" THICK

BAKING USING HEAVY DUTY ALUMINUM FOIL (INCLUDE THIS IN YOUR PERSONAL SURVIVAL GEAR)

BAKING GAME WRAPPED IN LARGE WET LEAVES. (PLACE DIRT OVER COALS AND LEAVE OVERNIGHT.)

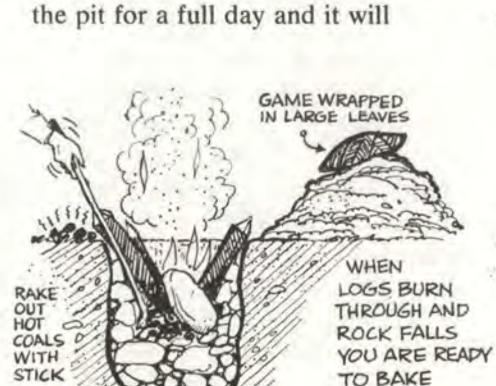
SURVIVAL: FAT AND HAPPY continued

cooks the meat allowing the mud to be flaked off in hard pieces. As the mud flakes off, fish scales or bird feathers will be removed at the same time. Pretty simple, huh!? Another way of baking meats is to wrap them in layers of wet leaves and place them on dirt-covered fire coals. Allow the meat to bake overnight and you'll have a tasty breakfast in the morning.

A more exotic and fascinating method of baking is to make a rock oven. This works especially well for seafoods of all types, but anything can be cooked in one. Dig a pit approximately two or three feet deep and line it with non-porous rocks—avoiding rocks located in or near drainages, streams, or standing water as they may explode if subjected to intense heat. Start a bonfire in the pit and place two 3-inch diameter green logs across the burning pit. Next, place a large rock on the green logs and wait for the fire to burn through the logs enough to allow the rock to fall into the fire. This signals the readiness of your oven. Rake out as many of the hot coals as possible. Don't worry if you can't get all the coals out, because it should be as hot as possible in the pit itself. Wrap the meat or plant life you want baked in large green leaves, aluminum foil, mud or grass, and place the bundle into the bottom of the fire pit. You can even use parachute material to wrap your foods, provided the exposed hot rocks and coals have been covered with a thin layer of dirt. This prevents the nylon material from melting and ruining your repast. Cover the entire pit with dirt, hot ashes, hot rocks, then sit back and relax. Your meal, depending upon the size of the food, should be done in eight to twelve hours. If you're not sure of how long to bake your food, just leave it in the pit for a full day and it will still be hot and juicy when you uncover it. If you've never tasted food prepared in a rock oven, find a safe place and try it out —it sure impresses the neighbors.

We've talked about many different ways of preparing foods but really haven't even touched the surface. There are still many other ways to prepare food in the wild, such as frying food on hot rocks, drying meats and plants in the sun or in a smoke rack, or even baking in a wilderness reflector oven. As I mentioned earlier, your imagination is the limit.

Sergeant Winston had a tough time surviving and became weak and scared because of his inability to prepare foods without the modern conveniences of a stove. That doesn't have to happen to you, if you'll take just a small amount of time to prepare for a possible future conflict with the wild. If you do it right, you can come home "fat and happy." ★



an hour late and a dollar short

Anonymous

Aerospace Safety solicits articles from aircrew who have a story to tell that is relevant and would be of interest to fellow air-crewmen. We'll print your byline or run it anonymously. Please let us know who you are, however, so we can contact you if necessary.—ed.

The telephone rings at 0700. The command post controller has called to advise you that you overslept and missed the first launch on your Supervisor of Flying duty. The deputy commander for operations is on board the plane and your squadron commander covered the launch for you. The reason the command post controller did not call you earlier is: *You forgot to pay your phone bill prior to going TDY.* After returning from TDY, you were issued a new telephone number. Your squadron commander *knows* your number (he gave it to the command post controller and does not want to talk to you until he cools down.) Your day starts. . . .

Command Post Controller: "Good morning, Captain Sunshine. Are you planning to come to work today?"

Captain Sunshine: "Oh, wow! What time is it?"

Controller: "The little hand is on seven and the big hand is on the twelve."

Captain Sunshine: "Don't tell me I slept through another tour!"

Command Post Controller: "Well, let me put it this way. You aren't exactly five minutes early. The D.O. would like to talk to you when he lands and your squadron commander said he did not care to talk to you. You can pick up the brick at the squadron building. Have a good day."

Captain Sunshine: "Thanks!"

After muttering a few words of profanity, Captain Sunshine gets dressed and reports for duty.

Captain Sunshine: "Good morning, boss. I guess I did it again, didn't I?"

Squadron Commander: "You sure did, Captain Sunshine! What was the problem this time?"

Captain Sunshine: "Well, uh. . . ."

Squadron Commander: "Never mind, Sunshine. I don't even want to hear it. You can save it for the D.O."

Captain Sunshine: "Uh, yes, sir. I guess I better get to work now."

Squadron Commander: "Just a minute, Sunshine. Most of the time, you do a fine job. You fly a good airplane and seem to be interested in your job. Lately, however, you've missed several scheduled activities. Why? Do you want me to float you a loan for a new alarm clock?"

Captain Sunshine: "Well, sir, I know there's no excuse for my tardiness. All I can say is that I'll do better."

Squadron Commander: "The D.O. will probably want to hear more than that. He lands at 1300. Pick me up at 1245 and I'll go with you to see him."

Captain Sunshine: "Yes, sir. I'll be by at 1245."

After talking with your squadron commander, you think long and hard about ways to keep the same thing from happening again. You realize that you're the world's worst procrastinator. This could be your whole problem. Your philosophy of "Never do today what you can put off until tomorrow" has finally caught up with you. You tell yourself: "Self, I'm going to make a conscientious effort to change. I'm going to complete all those things that I'm supposed to prior to the suspense. Instead of floating with the current, I'm going to paddle downstream! If you "stick to your guns" and follow this plan through, you will probably not have any other problems.

Thinking to yourself, you realize the time is 1240. *Wasn't I supposed to do something? That's right, pick up the squadron commander!* How many times has your squadron commander told you: "If you can't be on time, be five minutes early." At 1245, the squadron commander is waiting outside the front door of the squadron building. You pick him up and get back to the flight-line in time to monitor the D.O.'s final landing. After landing, the D.O. comes over to the S.O.F. vehicle.

D.O.: "Oh, hello Captain Sunshine. Did you get enough sleep last night?"

Captain Sunshine: "Uh, yes, sir. Sorry about dropping the ball this morning."

D.O.: "Well, Sunshine, let me relay a story that an old commander once told me. He asked me if I knew the difference between players and professionals. I gave him what I thought was a fair answer. He said, 'Players go to the game and they play and perform. Professionals, on the other hand, play, perform, and are interested in the results of the game as well.' And Sunshine, we need professionals on our team."

Captain Sunshine: "Yes, sir."

D.O.: "And Sunshine, remember the five P's. Prior Planning Prevents Poor Performance. A word to the wise is sufficient."

Captain Sunshine: "Yes, sir. I'll do better!"

The previous story is true. The names have been changed to protect the guilty. ★

LIGHTNING AND AIRCRAFT

continued from page 4

CAN YOUR AIRCRAFT TRIGGER A STRIKE?

A question often asked is, "If an aircraft cannot produce its own lightning flash, can it trigger a natural one?" Stated another way the question might be, "Would the lightning flash have occurred if the aircraft were not present?"

While there is still much we don't understand about lightning formation process, most researchers conclude: (1) that aircraft are usually struck by flashes that would have occurred anyway, but (2) the aircraft, being conductive, is attractive to a nearby leader and causes it to divert towards the aircraft rather than continue on in some other direction. There is some evidence that jumbo-jets sufficiently "squeeze" and intensify the electric field around a nearby charge center to cause a stepped leader to form before it otherwise would have, thus triggering a strike; but this seems improbable for smaller aircraft.

WHEN IS A STRIKE MOST LIKELY?

Erratic as they are, it is impossible to predict just when or where a lightning strike will occur, but some idea of when to be on the alert for one can be obtained from study of past experience.

Figure 5 shows flight and weather conditions summarized in a recent survey of 200 commercial airline strike reports, and Figure 6 shows the flight altitudes at which most of these aircraft were struck. The outside air temperature reported in most instances was within a few degrees of the freezing point (0°C). From this data one might draw the conclusion that a strike is most probable to an aircraft flying at an altitude between 10,000 and 15,000 feet, within a cloud, experiencing rain and light turbulence and with the outside air temperature near 0°C. Strikes have been reported under many other combinations of circumstances, however.

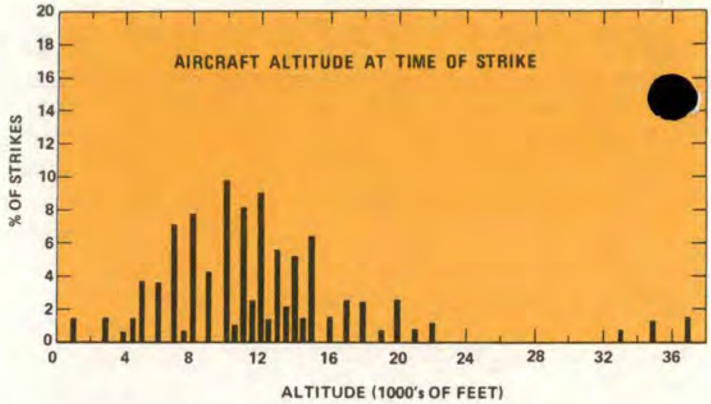


FIG. 6 Altitude Where Most Strikes Occur

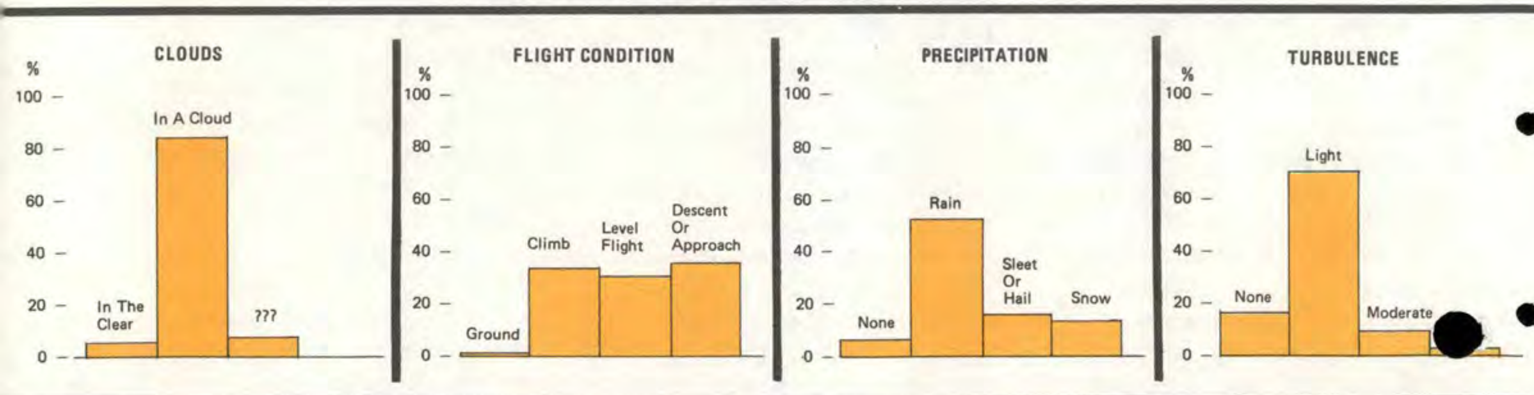
WHAT ABOUT AVOIDANCE?

Good flying practice and USAF flight manuals call for avoiding thunderstorms at all cost—not only to avoid lightning strikes but also to avoid the other manifestations of a good thunderstorm: turbulence, hail and rain. Careful study of weather reports and use of radar can help you avoid areas of precipitation, but unless you can circumnavigate these by well over 25 miles, an occasional strike may still reach out to greet you. There are many reports of strikes occurring to aircraft operating between clouds or in other areas where no thunderstorms were forecast, and a few pilots have even reported "bolts from the blue." Thus, even if you fly diligently by the book, you can probably expect to be "zapped" sometime during your flying career.

WHAT EFFECTS CAN YOU EXPECT?

As we said before, electric currents of up to 200,000 amperes will flow through your aircraft between lightning entry and exit points when you are struck. Owing to its short duration, most of this current will remain in the skins, with relatively little of it diffusing into interior spars and ribs. Fortunately, aluminum is a very good electrical conductor and there is enough of it in most aircraft to conduct this current.

FIG. 5 Commercial Aircraft Lightning Strike Experience



In most cases the only noticeable effect of this current having passed through your aircraft will be small pit marks where the lightning flash momentarily attached, as shown in Figure 7. At trailing edges or other places where the flash can hang on longer, a hole might be melted. Holes can be prevented by making the skin thick enough (0.080 inches will usually suffice) but skins that thick are heavy and are usually used only over fuel tanks or other critical places where penetration of the hot arc cannot be permitted.

Lightning may do a lot more damage to nonmetallic structures such as the fiberglass radome shown in Figure 8. In this case, a streamer induced from the radar dish probably punctured the radome wall and reached the approaching leader. Then when the return stroke followed this path, its explosive blast pressure shattered the radome. The radome contained the blast until its pressure had built to a very high level, resulting in a "violent explosion," forcing the crew to eject.

If there is a pitot probe on the radome, as is the case on most fighters, the probe forms a good lightning rod. Usually the pitot probe is grounded to the airframe by a wire inside the radome. Sometimes these ground wires are too thin to carry severe lightning currents and have exploded on several occasions, with damage similar to that of Figure 8. Sometimes the aluminum tubes which bring pitot static pressure back to the instruments have acted as the ground conductor, but the intense magnetic fields surrounding lightning currents often crimp such tubes, cutting off instrument air. To make matters even worse, the cord which brings electric power out to the probe heater is also susceptible to the lightning magnetic fields. These fields may induce severe surge voltages in the heater power circuit. Since the heater is usually powered from the essential bus, other equipment powered from this source is exposed to the same surge. The immediate result has been damage to a variety of other electronic equipment, and has led, in a few cases, to loss of the entire aircraft. Figure 9 shows typical lightning damage to pitot static lines and a heater power cord. Much more is known today about how to protect against these effects, so that radomes and pitot systems in the aircraft now being built are not likely to be as vulnerable.

Because they are usually located on wing tips or other extremities, navigation lights are frequently struck. Normally, the flash attaches to the metal lamp housing and does little damage, but once in awhile it will break the globe and light bulb, as happened to the

FIG. 7 Pit marks where flash attached

FIG. 8 Radome shattered by glass effect

FIG. 9 Typical lightning damage to pitot static lines and heater power cord

FIG. 10 NAV light globe broken by lightning, leaving a path for lightning current to enter aircraft's electric system.

LIGHTNING AND AIRCRAFT
continued

lamp in Figure 10. If this occurs, a portion of the lightning current may get into your aircraft's electric power distribution system and damage electronic equipment powered from the same bus. This, like the pitot heater situation above, is another of the more hazardous lightning effects for it may cause loss of instruments or communication equipment you rely on in bad weather. The circuit breakers for this equipment will usually pop, but not before the lightning surge has already passed through and done whatever damage it can. Surge arrestors are available to suppress these surges before they get this far, but they are not found on all aircraft. If this happens to you and some circuit breakers pop, try to reset them, but be aware that some equipment may be permanently damaged.

FUEL SYSTEMS

The vapor over a partially filled tank of JP-4 can be explosive at the flight altitudes and temperatures where lightning strikes most frequently occur, as indicated by the flammability limits of a JP-4/air mixture shown in Figure 11. The overpressure which such a mixture can produce when ignited is shown in Figure 12, and these figures show that the maximum degrees of flammability and overpressure occur near the flight altitudes and temperatures at which most lightning strikes to aircraft are reported to occur.

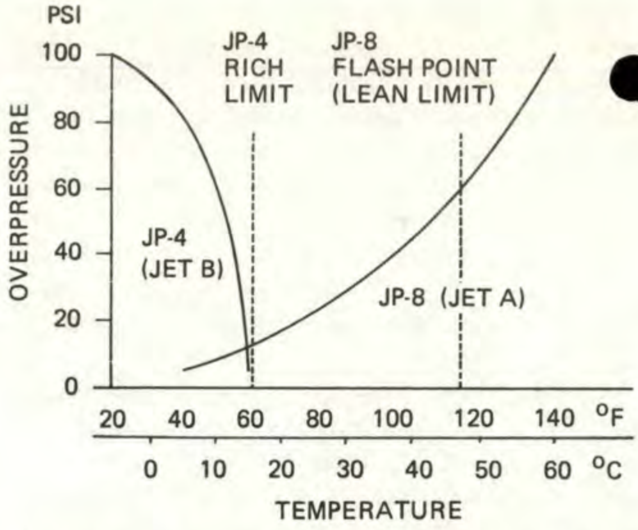


FIG. 12 Pressures generated on ignition of partially fitted fuel tanks under sloshing conditions.

There have been many laboratory studies made of the ways a lightning flash might produce a source of ignition within an aircraft fuel tank. Flashes attaching to access doors and filler caps have been found to cause sparking across inadequate joints or bonds; and flashes attaching to the surface of an integral tank skin have been shown capable of burning a hole if permitted to dwell long enough at one place or if the skin is too thin. Also, simulated lightning flashes have been shown to be capable of igniting vapors at fuel vent outlets under certain airflow conditions—conditions that almost certainly would not exist in flight. Protective measures for each of these situations have been developed, however, and incorporated into today's aircraft, so that the probability of fuel ignition from a lightning strike is remote.

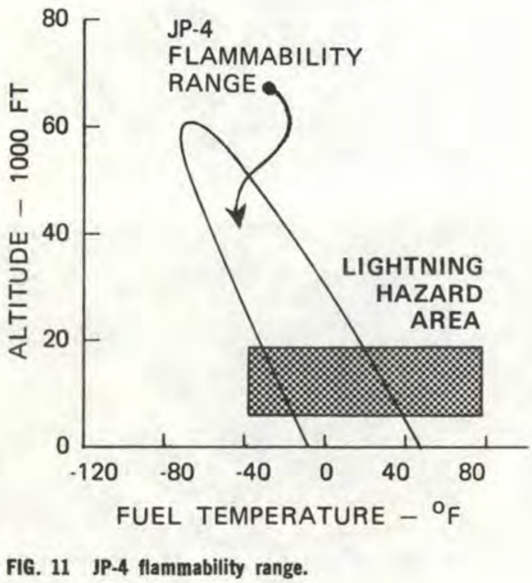


FIG. 11 JP-4 flammability range.

Since the causes of some in-flight fuel tank explosions have never been found, there may still be lightning-related ignition mechanisms which are not fully understood. This is another reason why thunderstorm areas should be avoided, and why operations involving the fuel system, such as in-flight refueling or dumping of fuel, should be avoided while flying in conditions where lightning strikes may occur.

INDIRECT EFFECTS

The lightning effects discussed thus far are frequently termed the *direct effects* because they involve some sort of physical damage. In recent years it has become apparent that there are other *indirect effects* produced by lightning strikes. Flight and engine instruments and other electronics have occasionally malfunctioned even though no direct connection with any part of the lightning flash existed. Because electronic systems are being increasingly depended on to perform critical functions in military and commercial aircraft, the Air Force Flight Dynamics Laboratory (AFFDL), National Aeronautics and Space Administration (NASA), and some of the manufacturers have initiated research programs to find out more about these indirect effects. Thus far, it has been learned that the electromagnetic fields which accompany lightning stroke currents may find their way inside an aircraft, where they induce transient voltages and currents in the aircraft's electrical wiring. This occurs even if the aircraft is all metallic, because there are still a lot of nonmetallic windows through which these fields may enter, and the fields themselves can be very intense. This summer, AFFDL, working in conjunction with NASA, will fly an instrumented Lear Jet aircraft near thunderclouds in Florida, in an attempt to record and measure the electrical transients which nearby lightning flashes induce on several electrical circuits in the aircraft.

These data will further our understanding of indirect effects and help validate test techniques that are presently in use to study induced voltages in aircraft in the laboratory.

WHAT ABOUT YOU?

The most hazardous effect you are likely to receive from a lightning strike to your aircraft is temporary blindness from the bright flash, if the strike occurs near the cockpit. This blindness usually (but not always) occurs at night and may persist for up to 30 seconds, during which time you may not be able to read your instruments. If you have a copilot, one of you may minimize this problem by keeping your eyes lowered when you think a lightning strike is imminent. Turning up your instrument lights may help by reducing your eye sensitivity before the flash occurs and making the instruments easier to regain afterwards. Keeping one eye closed is another technique.

Some pilots also report receiving a mild electric shock when lightning strikes occur. Since you are inside a conducting enclosure, the electric potentials of everything around you remain very nearly the same with respect to one another—even during the lightning strike—and you are not in danger of being electrocuted. The strong electric fields which can pass through the windows as the leader approaches, however, may give rise to streamers from your head or shoulders, causing a slight shock as the minute currents which feed these streamers pass through your body. Just as often though, the shock is simply your startled reaction to the loud bang accompanying the strike.

The effects on you may be much more serious, however, if you are flying in a nonmetallic airplane, such as a glider. In such a craft, the control cables may be the only electric conductors and place you in a direct path between attachment points, with fatal consequences.

PRECIPITATION STATIC

Our discussion thus far has dealt with lightning strikes. Another electrical phenomenon which may be even more annoying is precipitation static, more commonly called "P-static." When an aircraft is flying through rain, sleet, hail, or snow, the impact of these particles on the aircraft will cause a charge to separate from the particle and join the aircraft, leaving the aircraft with a preponderance of positive or negative charge (depending on the form of precipitation) and thereby elevating its potential with respect to its surroundings. Since the aircraft has room for only a small amount of this charge, some of it will begin to leak off in the form of ionization at sharp extremities. This ionization continues as long as the aircraft is flying in P-static charging conditions (precipitation) and is visible as a bluish corona (St. Elmo's fire) at night. Unfortunately, this ionization radiates broadband electromagnetic radiation (EMR) throughout the low and high frequency radio bands. This EMR is often received as interference, or "static" by the aircraft communications or low-frequency automatic direction finding (LF-ADF) or communication receivers, and may render this equipment temporarily unusable. The static dischargers usually found on tips and trailing edges reduce this interference by making it easier for the charge to leave the aircraft, but they are not always 100 percent effective, especially in heavy precipitation. Since the conditions that produce P-static may also produce lightning, a strike should be considered possible when P-static appears, but except for providing an easily replaceable attachment point, the static dischargers provide little protection against lightning strikes.

LIGHTNING AND AIRCRAFT
continued

We have reviewed the conditions where lightning is most prevalent and discussed some of the more common things to expect when you are struck. There are new structural materials and electronic devices becoming available whose susceptibility to lightning effects is not known, and there are still aspects of lightning itself which we do not fully understand. Therefore, a considerable amount of research is under way at present to learn more about lightning and its effects, and how to design even better protection into new aircraft.

To date relatively few serious incidents or accidents can be attributed to lightning, but there are two trends in aircraft design which promise to aggravate the problem unless positive protective measures are utilized. The first of these is the increasing use of miniaturized, solid-state components in aircraft electronics and electric power control systems. These devices are more efficient, lighter in weight and far more functionally powerful than their vacuum tube or electromechanical predecessors, but they operate at much lower voltage levels and thus are inherently more sensitive to overvoltage transients such as those induced by lightning.

The other trend is toward the use of nonmetallic materials in place of aluminum in skins and structures. This reduces the amount of electromagnetic shielding which the airframe provides and increases the exposure of wiring to electromagnetic fields. Nonmetallic materials may also aggravate some of the other effects noted earlier. Streamers may be drawn from conducting objects inside plastic wing tips or radomes, for example, puncturing them on their way out to meet an oncoming leader. The stroke current may then do extensive damage to the plastic sections. Fortunately, most manufacturers recognize this problem and provide *diverter* strips to minimize punctures of plastic extremities which enclose vulnerable items such as fuel cells or electrical wiring. Together, these two trends present a challenge to the designer of lightning protection for aircraft of the future, but the challenge can be successfully met if it is recognized early in design.

FIG. 13 Simulated lightning tests on wing-tip fuel tank at the GE High Voltage Laboratory, Pittsfield, Massachusetts.

Usually, the vulnerability of new materials or devices to lightning, and the adequacy of protection systems, is determined by subjecting them to simulated lightning strikes in a laboratory. The Air Force Flight Dynamics Laboratory has recently installed a lightning simulation facility for this purpose, as have some of the aircraft manufacturers. Others utilize facilities such as the GE High Voltage Laboratory pictured in Figure 13. The GE Lab was originally built to help design lightning protection for electric power systems, but much of its equipment is applicable to aircraft testing as well.

Much is being learned in the laboratory, but our progress there is only as good as our ability to simulate the real-life environment. Thus, we continually seek reports from you who experience the real thing in flight—reports especially of incidents that seem unusual for some reason, or ones that cause a malfunction of some piece of equipment. You can help by providing complete information on these incidents to the Air Force Inspection and Safety Center. Those of most importance are the ones involving electrical or electronic equipment malfunctions. Describe the malfunction as you experienced it and try to follow up with maintenance and repair personnel to see if you can find out what exactly burned out or malfunctioned. Photographs of unusual damage will also be helpful as will retention of damaged parts for further inspection. Of course, many lightning strikes are "routine" events and need not be elaborated upon except as requested in AFR 127-4. But the extra time you take to report the unusual ones will help designers provide better lightning protection in the future. ★

NEWS FOR CREWS

Information and tips to help your career from the folks at Air Force Military Personnel Center, Randolph AFB, TX.

LT COL HENRY VICCELLIO, JR.
Chief, Rated Officer Career Management Branch • Air Force Military Personnel Center

FIRST IMPRESSIONS

Imagine my surprise when the Colonels' Group recently called me with an assignment notification that directly reflected my AF Form 90 desires: Having wanted a job in personnel for some time, I eagerly accepted, and began preparation for the change in emphasis from the day-to-day operational worries of a wing ADO.

After a few weeks in this job, several strong impressions seem more than worthy of mention. The first is the widespread misunderstanding of current personnel management policies and systems that exists in the field. Upon arrival, I found myself totally in the dark on the basic concepts of rated officer management, along with such key career management factors as weapon system identity, fair-share duties, and the Rated Supplement. In the field, assignments flowed down to us at the unit level with little corresponding logic as to the "why" of each action and how it fits into a career pattern. As a wing supervisor, I had been groping without fully realizing it—career counseling without any real knowledge of the subject matter myself. Several important dangers are inherent in this situation. The supervisor cannot perform his tasks in the personnel arena, and as a result it could lead to misunderstanding his options. So the first big impression I have is of the overwhelming need for education—everyone involved needs to understand both the plan and the system used to effect it. We're taking some positive steps to make that more of a reality.

A second impression is of the potential that exists for a truly personal approach to career management. Built around the establishment and utilization of weapon system identity, the rated resource management system was designed by and is operated by rated officers—guys who have been qualified in the aircraft they are manning and who have shared the experiences of those individuals whose assignments and careers they manage. Sensitivity, credibility, first-hand knowledge of the requirement, and even subjectivity where it's called for—all are natural spin-offs from this arrangement.

After two years at Wing level, I was truly staggered to discover the wide variety of job opportunities available to the individual rated officer, regardless of his rated background. Each of the ten weapon system worlds we use for management has training, crew force, and unit-level staff jobs in large quantities, and every rated officer is familiar with these. But I was amazed to discover that these represented only one-half to two-thirds of the total positions requiring rated officers, **all** of which offer opportunity and challenge to the right guy at the right time. A few include:

- Instructor duty at the RTU/CCTS level.
- Special-mission flying units like FACs, aggressors, Tactical and Strategic Reconnaissance, Wild Weasel, Special Air missions, Flight Test Units, etc.
- ATC/IP duty.
- MAAG/Attache duty worldwide, including many cockpit jobs.
- Staff duty including high-visibility jobs at the Air Staff/OSD level, NATO jobs, jobs with other services, etc.
- Exchange duty worldwide.
- Instructor jobs at AU, ROTC detachments, and the AFA.
- Supplement duty in any one of 44 support fields that can put your exotic academic background (or just plain common sense) to management tests beyond what you'll find in the average flying squadron!

The Rated Supplement suffers from its position as probably the most maligned and misunderstood personnel program we have. Designed as our quick-reaction pool of ready rated assets in case of a contingency, it provides a real broadening opportunity to young, rated officers with current flying experience. Like most guys, I had totally incorrect impressions formed by third-hand stories about people "dumped" in the Supplement—few of which I now find to contain any truth. The Supplement image is one misconception I intend to clear up right off the bat. We'll be increasing the publicity on just what the

Supplement is, why we have it, and what type of officer makes it a reality in terms of both a contingency asset and a career enhancement.

A final impression, and one that goes hand-in-hand with all the others, is the real opportunity the system offers each of you to participate in the career management process—and the widespread misconception of that fact! While Air Force requirements are the bottom line in assignment policies, personal desires are given more weight than I had imagined possible. The sad state of Form 90s in general, however, makes it difficult to achieve the level of personal involvement both we and you would like to see. My career managers simply don't have time to call every individual about every assignment or opportunity. You have got to let us know the whole story. Part of the problem lies in our court. We're taking strong initiatives to get the word out to the field on how your career fits into a bigger picture, with details on many of the career opportunities I mentioned above. However, until such time as we have the problem solved institutionally—and that may be a while—every rated officer should take the following actions:

- Research current personnel directives to determine career progression guidance and job opportunities corresponding to your grade and experience.
- Contact your career manager and discuss the pros and cons of various assignment options. Remember the primacy of Air Force requirements.
- Fill out a Form 90 to include several additional assignments in which you have interest beyond your first three choices. Include Supplement career fields and any special duty interests. Nothing is more difficult than making an assignment in the blind, and your Form 90 is the key to our meeting your desires. Keep it up-to-date!
- Maximize your self-improvement efforts commensurate with your interest and time available. A lack of civilian education or PME can severely limit what you're eligible or acceptable for in the way of interesting jobs—it's hard to sell you as a "comer" if you haven't shown interest in yourself!

In essence, today's career management system provides you with a functionally qualified equivalent of yourself—another pilot or navigator with similar experiences—to plan, execute, and develop your career in concert with Air Force requirements. Regardless of what assignment you may get, where you go, or what you do, that individual—the resource manager—always has a strong input to the final decisions. He helps you build your rated credentials, protects your operational viability, monitors your career progression, and gives weight to your personal interests. To ensure that each rated officer gets equal opportunity for career-enhancing opportunites, we conduct an annual review of all rated officers eligible for PCS; it gives you visibility, and helps us pick the best man or woman for the job. We feel the system works better than it ever has before—to meet Air Force requirements with full consideration of your career needs. While we're receiving some feedback from the field that "no one cares" above squadron level, I can assure you that's dead wrong! Don't forget, it's a two-way channel for communication—give us a call, establish the dialogue, and I think you'll agree with my overall impression—the rated force management system works! ★

ABOUT THE AUTHOR

Lieutenant Colonel Viccellio is a graduate of the USAFA. He is an 0-6 select whose prior assignments have included tours of duty on the Air Staff and as an F-4 squadron commander. He assumed his current position in December 1977.

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UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Accident Prevention Program.

MAJOR

Robert L. Merrill

CAPTAIN

George Macken, III

Detachment 2, 1400th Military Airlift Squadron (MAC)

Randolph Air Force Base, Texas

On 10 June 1977 Major Merrill, aircraft commander, and Captain Macken, copilot, were on a local T-39 training mission when the master caution light illuminated along with the DC generator off light. Major Merrill checked the loadmeters and noted a zero reading for the left generator and 1.5 for the right generator. Following checklist procedures, the generators were alternately turned off, reset, and then on. No circuit breakers had popped. The left generator could not be reset, and the right generator could not be returned to normal operating limits. Preparations for a battery-only return to Randolph AFB were begun. The cabin was filling with dense smoke which continued to increase in intensity with the possibility of an aft fuselage fire, since the source of the smoke was coming from the aft circuit breakers and load equalizer circuit area. Without the benefit of navigational aids and with partial obscuration of the ground by a low stratus deck, they started a VFR letdown. Since the smoke continued to increase, the crew decided to make an emergency landing at Kimble County Airport, Junction, Texas. One pass was made over the field to determine wind direction and speed, runway condition, and safest landing direction. On downwind, the gear was lowered using the landing gear emergency lowering checklist. The electrical master switch was momentarily turned on to lower the flaps, extend the speed brake, check for a safe gear indication, obtain fuel quantity readings, and trim the aircraft for a minimum run landing configuration. On short final, the electrical master switch was again turned on to provide hydraulic pressure for braking and electrical power to raise the flaps following touchdown. The aircraft touched down 300 feet from the threshold and stopped 1,800 feet down the runway with no tire damage. The professionalism, skill, and courage displayed by Major Merrill and Captain Macken in the face of a critical inflight emergency probably saved a valuable aircraft. WELL DONE! ★


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