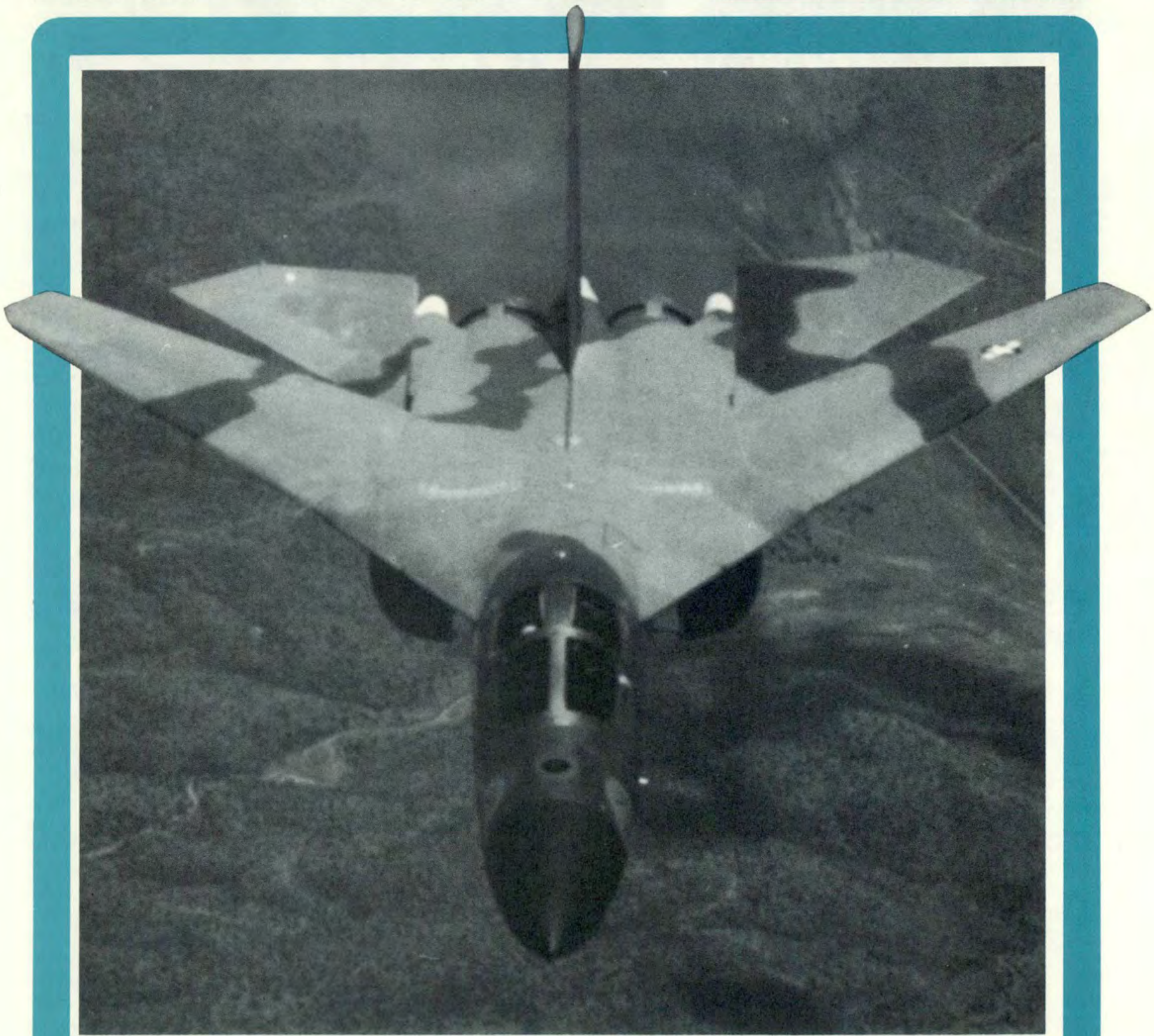
flying

SAFETY

JULY 1986



THERE I WAS

■ We took off out of La Paz, Bolivia's 13,355-foot runway. We'd been there 4 days awaiting a starter for the No. 3 engine (C-130). The takeoff ate up most of the runway; but we got off, made a circular climb to FL 230, and headed southeast to Asuncion, Paraguay.

Then it happened; nothing but unbriefed thunderstorms! Turn left pilot heading 280 degrees, hold it, now right 350 degrees. Continually, back 'n' forth for about 300 NM 'till we reached the edge of the Andes.

I think I got one radio fix while flying through the thunderstorm area. I figured no sweat. I'll get a visual or radar fix; but was I surprised!

I looked outside and saw nothing but a north/south straight line of mountains in either direction with periodic breaks evenly spaced. Which one was which? I had never seen such an unnatural natural phenomena.

Piece of cake — I'll get a fix in the flatlands. Wrong, again! The chart was completely white with a bunch of "squiggly" blue lines (streams) and scattered small black-and-blue circles (villages and airstrips) spaced haphazardly for hundreds of miles in all easterly directions, with big bold letters saying, "Maximum elevation figures are believed not to exceed 3,800 feet." I looked to see if I could get a sun/moon celestial fix. Sorry, no moon.

So, There I Was . . . lost! "Pilot fly heading 305 degrees 'till we pick up the Asuncion VOR, then head toward it." We were *only* about 60 NM north of where I guessed we were.

Next time, nav, check your charts, get a good weather briefing, and copy down headings and times while avoiding thunderstorms so you can retrace your steps. Flying in some of these countries can be more difficult than flying over water. ■

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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The Sweat Box/Deep Freeze . . .

LT COL JIMMIE D. MARTIN
Editor

■ The modern aircraft environmental control system (ECS) is a real boon to pilots and crewmembers. This air conditioning system allows them to work comfortably and efficiently in an environment that otherwise could be life threatening. But, when the aircraft system fails or runs away to an extreme setting, the crewmember's friend quickly becomes an enemy. What was once beneficial and life sustaining may suddenly become life threatening itself.

The results of a faulty ECS may be relatively minor or more serious, even fatal. The figure on Page 4 lists the maximum temperature you can expect in various aircraft. There are many physiological effects that may result. Some we are familiar with, others we may not be. Let's look at some mishaps and some physiological effects we can expect to experience.

High Temperatures

■ The A-10 pilot departed as lead of a 2-ship formation flight. After takeoff, he noticed the cockpit was very warm, and he was unable to cool it off using the normal temperature controls. He selected "RAM AIR" to get some cooler air into the cockpit.

Suddenly, a blast of extremely hot air blew the louvers out of the air conditioning duct. The air temperature was estimated at 500° F, and the pilot suffered second degree burns through his flight suit where the air hit his left arm and thigh.

He turned the bleed air switch off, but this didn't stop the airflow. The hot air temperature control valve had failed full open and the ECS circuit breaker had popped. The pilot jettisoned the canopy to reduce the temperature in the cockpit. He then made an emergency, opposite direction landing on the runway he had just departed.

Have you ever opened an oven door and felt the heat of 375-400° during baking? If so, then imagine trying to sit inside a cockpit with even hotter air coming in. Think you could survive long in such a situation? How well do you think you could fly an aircraft under such extreme conditions?

Not all cockpit overheat problems are so dramatic. Sometimes the problem doesn't seem serious. Even though the temperature is high, it isn't unbearable. So, we press on to

and YOU

complete the mission. This was the situation in the following two mishaps.

■ A B-52H navigator reported to the pilot that the navigator cabin was excessively hot. The pilots attempted to correct the situation, but were unsuccessful. A few minutes later, the radar navigator noticed the navigator was unresponsive to questions and appeared incoherent. Upon a closer check, he discovered the navigator was sweating, and his lips and fingers were flushed white.

The RN put the navigator on 100 percent oxygen, and the copilot turned the cabin temperature to full cold. Shortly after that, the navigator began to respond, but he was still dizzy. The Buff returned to base, and an ambulance took the navigator to the emergency room. The diagnosis was airsickness as a result of the high temperature in the cockpit.

■ On a T-38 student training formation flight, the student pilot in the lead aircraft noticed the cockpit temperature rising. All efforts to reduce the temperature were unsuccessful. About 28 minutes into the flight, the SP experienced dizziness and nausea. The IP declared an emergency, and they returned for a straight-in landing.

Heat Sources

The typical aircraft generates a lot of heat from many different sources. The main factors are:

■ **Kinetic heat** caused by skin friction. As the aircraft moves through the air, the structure is heated by friction between the aircraft skin and the air. The amount of heating is dependent on the outside air temperature and the aircraft speed.

■ **Electrical heat** derived from the aircraft avionics and other electrical equipment. The amount of heat is a function of the amount of electrical equipment installed.

The flight crewmembers' effective temperature tolerance is a rather narrow range. It must be maintained not only for comfort, but for safety. Excessively high or low temperatures can cause rapid degradation of performance capabilities.

■ **Radiant heat,** sometimes called the greenhouse effect, is more of a problem in fighter-type aircraft than in the heavies because of the transparent canopy. The solar radiation comes through the canopy and heats up the areas inside, but the heat does not radiate back out.

In addition to the heat produced by the aircraft, there is the heat produced by our own body. The amount of heat produced is a function of how hard we are working and how much stress we are experiencing. Physical activity and stress both increase the metabolic rate which produces heat by burning calories.

Normally, the aircraft environmental control system has no problem providing enough cooling air to neutralize these heat sources. But, when the ECS malfunctions, it can add an even more serious heat source — engine bleed air.

Physiological Effects of Heat

The body has three main ways to reduce its temperature. They are evaporation, radiation, and convection. As the ambient temperature rises above normal body temperature (98.6), radiation and convection become ineffective as cooling methods. In fact, they can begin to work against us and actually increase the body temperature. At that point, evaporation through our sweating mechanism becomes the primary method for cooling the body.

Our flying clothing and G-suits can actually work against us by interfering with the convective transfer of heat from our body and by absorbing radiant heat. Waterproof flying clothing such as antiexposure suits, pressure suits, and chemical defense ensembles block evaporation of sweat and retain heat.

As evaporation becomes our primary means to combat heat buildup, the body increases the sweat rate. This results in more cooling at the skin surface. The blood then transfers this cooling to the interior of the body.

This increased sweat rate can also be a disadvantage because of increased water and salt loss. As the water loss increases, dehydration occurs if the water isn't replaced. Dehydration then decreases the sweat rate which, in turn, allows the body temperature to begin increasing again. Excessive salt loss produces muscle cramps.

About 80 percent of the body is water, and it is critical that the intake of water match the output. When the output of water exceeds the intake, the body loses efficien-

continued

The Sweat Box/Deep Freeze and YOU continued

cy. Many of us operate at reduced efficiency even before being put in a high heat situation. That's because we depend on our sense of thirst to tell us when we need water. The problem is, we don't feel thirsty until we're about a quart low. Then we drink, but usually only replace about one-half to two-thirds of the water lost. This problem may be further complicated by what we drink such as coffee, tea, soft drinks, etc. Some of these drinks may actually cause a further decrease in water supply.

Thus, we are not at our peak efficiency when we encounter a heat problem. As a result, we may become dehydrated even sooner than expected. As dehydration progresses, the body temperature increases because there isn't enough sweat available for proper cooling. As the body temperature rises and the water level falls, the results of decreased efficiency begin to show.

The physical effects of high temperature are weariness, faintness, and difficulty in thinking clearly. The person may feel weak and will experience a reduced G tolerance. As dehydration continues, the victim may become dizzy, develop a headache, have difficulty breathing and, finally, lose muscular function. Unless water is soon made available, a person experiencing such dehydration may die. However, a crewmember in an aircraft may die before this point of dehydration is reached because of inability to mentally keep up with the aircraft and to physically fly it safely.

Obviously, high temperatures in the cockpit are a serious matter. Even though the temperature may not be high enough to cause physical burns, it is still not to be taken lightly. If the cockpit is hot enough to make you sweat, you're losing efficiency at an accelerating rate. Take action to correct the situation. If you can't cool the cockpit down, you need to terminate the mission before you get into trouble. If you react early enough, a simple abort and return to base will be sufficient. If you try to tough it out and begin to develop symptoms of heat stress or dehydration, declare an emergency and get on the ground as soon as practical.

Cockpit Temperatures

Aircraft	Full Cold	Full Hot
F-4	−35 F	230 F
F-5A/B	−80 F	300 F
F-5E	−80 F	190 F
F-15	−10 F	116 F
F-16	0 F	200 F
F-111	−65 F	390 F
A-7	OAT	
	−100 F	220 F
A-10	32 F	500 F
OV-10	OAT	150 F
T-37	Below 32 F	425 F
T-38	−80 F	300 F
B-52	OAT	360-390 F
B-1	35 F	170 F
C-5	28 F	225 F
C-9	32 F	190 F
C-12	OAT	265 F
C-21	OAT	250 F
C-130	OAT	210 F
C-141	28 F	225 F
C/KC-135/137	OAT	250 F
KC-10	32 F	190 F
E-3	35 F	205 F
U-2/TR-1	Below 32 F	187 F
SR-71*	Below 32 F	187 F
Helicopters**	OAT	Not a Factor

*Outside friction and no air condition 680 F

**On board heaters separate from bleed air system

Cold Temperatures

Excessive heat in the aircraft interior isn't the only temperature problem crewmembers face. It can also get very cold. Before you say that's no problem, consider just how cold it can get. From the figure, you can see the range is from ambient outside air temperature to as much as 100° F below zero. Consider what happened in the following mishap.

■ An F-4D had been airborne for about 1½ hours on a transoceanic flight. The air conditioning system went full cold, and all attempts to stop the cold air were unsuccessful. They diverted to an alternate for landing. After landing, both crewmembers were hospitalized and treated for second degree frostbite of their feet.

■ A pilot and navigator in an FB-111A noticed the cockpit cooling off during the climb after takeoff. After level off, they removed their masks and noted their breath formed fog in the cold cockpit. They didn't consider the situation serious and continued the mission while trying to adjust the temperature.

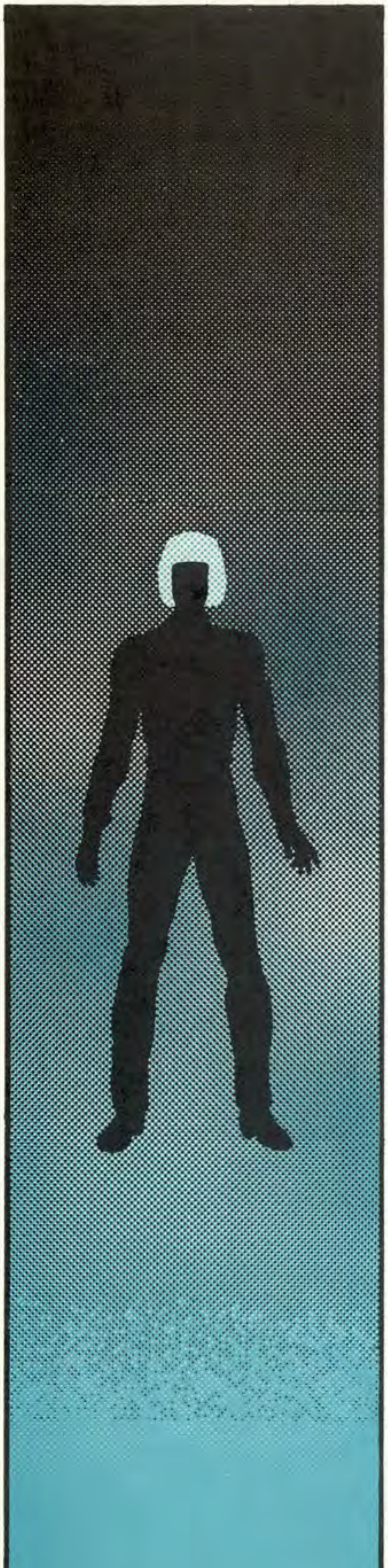
After about 45 minutes of flight, the pilot began to shiver, and they aborted the mission and returned home. The pilot became partially incapacitated as a result of the cold temperature. He was able to complete the landing, but had to be helped from the cockpit.

■ An F-4D crew on a cross-country mission discovered their air conditioning system had stuck in full cold shortly after takeoff. Since the crew was dressed for winter with thermal underwear and extra wool socks, they thought they could complete the scheduled 3-hour flight.

After about one hour and 45 minutes, the WSO's feet began to get numb. The crew diverted to a nearby base for landing.

Physiological Effects of Cold

Cold temperatures are more than just uncomfortable. There are hazards and performance degradations resulting from cold temperatures just as there are for hot temperatures. The first effects are found at the extremities — the hands and feet and certain parts of the head such as cheeks, nose, and ears. The first warning is tingling or pain in the affected area. This is followed by numbness. If corrective action isn't taken and the temperature in-



The aircraft environmental control system allows our modern aircrews to operate efficiently in all conditions from high heat to sub-zero cold. But, a system failure can quickly turn the cockpit into an oven or a deep freeze. Either condition can be extremely hazardous to your health.

creased, the tissues begin to freeze and frostbite sets in.

An additional problem that develops as a result of exposure to cold is the loss of the sense of touch and pressure as the skin cools. This causes a serious loss of manual dexterity. Simple tasks such as changing radio channels, not to mention flying the aircraft, become more difficult. As the exposure to cold becomes more prolonged, the decrease in manual dexterity becomes more severe.

The body reacts to cold by shivering. This is an attempt to increase the metabolism which, in turn, produces heat. A slight shiver won't really cause any problems, but it can progress to the point of interfering with normal movements and the ability to function effectively in the aircraft.

Continued exposure to extremely cold temperatures can produce other symptoms that seriously affect the crewmember's ability to function. These include fatigue, mental confusion, slow movement, and difficulty in speaking. Severe hypothermia can produce swelling of the extremities, slowed pulse and breathing rate, and, eventually, unconsciousness.

It is highly unlikely that such severe hypothermia would be experienced before the aircraft could be brought to a landing, but many of the other symptoms may be encountered.

Corrective Action

The point of this article is this. Don't try to tough out a cockpit temperature problem. Whether it's high temperature or low temperature, it's a potentially serious problem. The effects of the temperature problem may be severe, especially the high temperatures. Less extreme temperatures may result in a slow, insidious onset of effects. These are the ones that tempt us to continue the mission. The symptoms are progressive and may not be recognized early enough because of the mental confusion that may accompany the physical reactions.

Take immediate action. Understand your aircraft's ECS operation and use the appropriate emergency procedures to correct any problems. If the procedures don't work, it's time to get the aircraft back on the ground. The severity of the temperature will dictate whether you return home or land at the closest suitable field. ■

When The Going Gets HOT

PEGGY E. HODGE
Assistant Editor

■ During the summer months, "the going" does get hot on Air Force flightlines across the country. This makes crewmembers prime targets for the problems associated with thermal stress. The most common problem is dehydration. It is one that crewmembers must pay careful attention to as it can happen easily and without forewarning, *and* can adversely affect our performance.

We need to understand what dehydration is, its effects, and what we can do for prevention.

The body is approximately 80 percent water. The average adult loses about 3 quarts of water a day through normal activity. You must at least replace this lost water or suffer the effects of dehydration.

The early signs of dehydration are darkening of urine, dizziness, and headaches. As it progresses, the victim may become dizzy, develop a headache, have difficulty breathing and, finally, lose muscular function. Unless water is soon made available, a person experiencing such dehydration may die.

As crewmembers, dehydration can adversely affect our performance. Many of us operate at reduced efficiency even before being put in a high heat situation. That's because we depend on our sense of thirst to tell us when we need water. The problem is, we don't feel thirsty until we're about a quart low. Then we drink, but usually only replace about one-half to two-thirds of the water lost.

This problem may be further complicated by what we drink such as coffee, tea, soft drinks, etc. Some of these drinks contain caffeine which may actually cause a further decrease in water supply.

If we are not at our peak efficiency when we encounter a heat problem, we will become dehydrated even sooner than expected. As dehydration progresses, the body temperature increases because there isn't enough sweat available for proper cooling. As the body temperature rises and the water level falls, the results of decreased efficiency begin to show.

Let's take a took at the following mishaps where dehydration caused the crewmembers problems serious enough to abort the mission.

■ The mission was a T-38A training sortie. The preflight had been uneventful, but during engine start, one generator would not come on line. Maintenance could not get the generator to work, so the aircraft was aborted and a spare assigned.

During this time, the student pilot remained on the flightline awaiting the spare aircraft. The time on the flightline was approximately 95 minutes from departing the squadron to takeoff at 1515.

Takeoff and departure were normal. On passing 16,000 feet, the student began to feel confused and disoriented (the student's hypoxia symptoms). She gangloaded the oxygen regulator and began a descent below 10,000 feet.

A chase aircraft joined up with the aircraft. The T-38 returned to the area for a straight-in approach. The straight-in approach was broken off due to the student being high and fast on final. Another straight-in approach was required. The approach was slightly fast, and on landing roll, the student was directed to aerobrake.

The flight surgeon examined the student and found significant dehydration. The 72-hour history revealed no previous lack of sleep or nutrition; however, on the day of the incident, there was a lack of fluid intake.

The student's disregard for the time spent in hot temperatures, combined with a lack of fluid, caused dehydration and resulted in a confused and disoriented state.

▪ The mission was an A-10 redeployment sortie. At FL 200 (cockpit pressure 11,000 feet), the pilot began to feel lightheaded and uncomfortable. After checking the cabin pressure, the pilot went to 100 percent oxygen and began checking for signs of hypoxia or hyperventilation. The symptoms continued, and the pilot began to have difficulty breathing normally.

A descent to 8,000 feet was accomplished, but with no improvement in the pilot's condition. The pilot went to the emergency position on the oxygen regulator, an IFE was declared, and a landing accomplished. A flight surgeon examined the pilot and initial testing suggested dehydration.

Rapid fluid losses during athletic endeavors in high temperature and high humidity conditions can lead to rapid depletion of body fluids. A loss of 3 percent total body weight in water can lead to central nervous system disturbances, loss of coordination, and inability to make accurate and consistent decisions when performing in the cockpit.

These incidents involved dehydration resulting in an adverse effect on crewmember performance. Both were Class Cs but could have been worse had greater stresses ensued. And as we mentioned earlier, the crew likely did not even realize they had a problem.

As you can see, we actively prevent dehydration. Dehydration is an inherent problem to crewmembers on a hot flightline.

As you prepare for your summertime missions, remember the rules for dehydration prevention.

It is important to note that consciously or unconsciously, crewmembers are not likely to drink one or two hours before a mission. The absence of any latrine facilities on most flightlines can lead pilots of both sexes to avoid fluids and the resultant inconvenience. This situation predisposes us to heat stress. It will take some conscious attention to this in order to minimize the effect. Accepting the status quo after reading about the problem will not prevent the significant (and, in a hot climate, daily) impact of these basic factors.

It is important to remember that often one of the drinks included in your flightline dinner is milk. Many adults cannot, because of lactose intolerance, drink milk. Flight surgeons should work to ensure the option for nonmilk fluids is available to all aircrew members.

The Fighter Index of Thermal Stress (FITS) is another valuable safety method to aid us in preventing dehydration. For example, with increasing ambient heat and humidity, a supervisor should consider limiting ground time; requiring some minimum time between flights (to let fatigued, dehydrated crewmembers rest and recoup); or canceling flights.

Heat stress can be moderated somewhat. "When the going gets hot," safe flying is a direct result of an effort to keep your cool. Provision in the form of work schedules, fluid availability, and convenient latrine facilities are examples of effective coping. Awareness has to be coupled with subsequent action as the key to prevention. ■

DEHYDRATION PREVENTION

▪ Drink more liquids — preferably water rather than caffeine or sugar-laden fluids — than thirst requires. Avoid coffee and alcohol as they tend to further dehydrate you by their diuretic effect. Avoid sugar-laden fluids as sugar delays fluid absorption.

▪ Increasing water intake to a point where you feel you will float away is beneficial when working in the heat.

▪ Make a habit of drinking water on a scheduled basis that begins *before* heat exposure by up to an hour.

▪ Drink one or two hours before a mission. Our kidneys do regulate the balance of water very effectively. You can't really overdo it.

▪ Take fluids with you on your mission.

▪ Make sure the fluids you will be receiving in your dinner from the flightline kitchen are acceptable to you.

Fighter Index of Thermal Stress (FITS) °F

Instructions: Enter chart with local air temperature (°F) and relative humidity (%). At intersection, read FITS value and determine Zone.

Air Temp (°F)	Zone	Relative Humidity (%) 10	20	30	40	50	60	70	80
70	Normal	67	70	72	74	76	78	81	83
75		71	74	77	79	82	84	86	88
80		75	79	81	84	87	89	92	94
85		79	83	86	89	92	95	97	99
90		83	87	91	94	97	100	103	105
95		87	92	96	99	102	105	108	111
100	Caution	91	96	100	104	108	111	114	117
105		95	100	105	109	113	116	120	122
110		99	105	110	114	118	122	125	128
115	Danger	103	109	115	119	124	127	130	134
120		107	114	119	124	129	133	136	140

Comments:

1. Chart is valid for clear sky to light overcast (shadows visible).
2. **Caution Zone:**
   a. Be aware of heat stress.
   b. Limit ground time (preflight, cockpit standby) to 90 minutes.
   c. Recovery time minimum 2 hours between flights.
3. **Danger Zone:**
   a. Limit ground time to 45 minutes or less if possible.
   b. Avoid more than one flight a day if possible.
   c. Low-level mission with temperatures in this zone are not advised.
   d. Recovery time as above.
4. When index is greater than 115, consider canceling all nonessential flights.

Be kind to your

safety officer

An effective safety program requires prompt reporting of mishaps and hazards. Knowing what needs to be reported can not only alert others to the danger, but also keep your friendly safety officer friendly.

CAPTAIN LARRY DANNER, USAFR
System Safety Engineer
Pratt & Whitney

■ Have you ever wondered why your squadron safety officer pings around like a superball in a racquetball court when he finds out (usually the next day) you have had one of the following problems:

- Loss of thrust sufficient to preclude maintaining level flight at a safe altitude.
- Engine case penetration by shrapnel from internal engine component failure.
- Engine case rupture or burnthrough, engine bay fire, or massive fuel leak.
- Emergency landing of a single-engine aircraft with imminent engine failure confirmed after landing. (Includes precautionary landing by helicopter with imminent engine or rotor drive system failure confirmed after landing.)
- Unselected propeller or thrust reversal.
- Flight control malfunction (including helicopter flight control, stability augmenter, autopilot, and trim systems) resulting in an unexpected, hazardous change of flight attitude, altitude, or heading.
- Spillage or leakage of radioactive, toxic, corrosive, or flammable material from aircraft stores or cargo which, in the judgment of the reporting official, is a significant hazard to the crew, passengers, or aircraft.
- In-flight loss of all pitot-static instruments or all gyro-stabilized attitude indications.
- Any other event which, in the judgment of the reporting official, is a significant hazard to the crew or aircraft.

If you are flying the F-16, you can add the following items to the above list:

- Any loss of thrust.
- EPU failure, hydrazine leak, or EPU failure to augment in the hydrazine mode.
- Catastrophic JFS failure.
- Any fire.
- Loss of aircraft control or aircraft departure from controlled flight.
- A flight control malfunction involving two or more branches of the FLCS.
- Uncommanded nosewheel steering inputs.
- Brake failure.

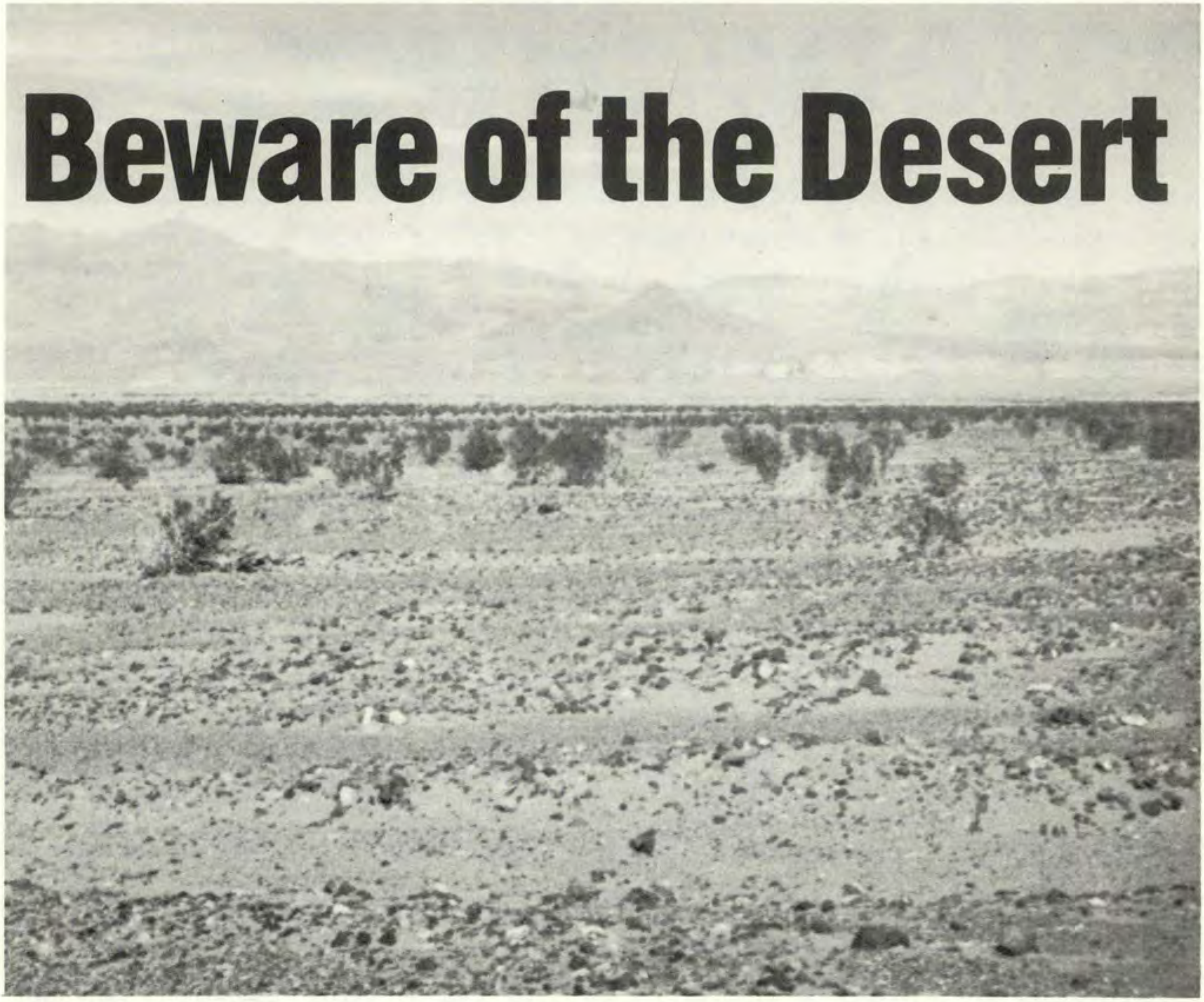
Having spent several of my active duty years as a safety officer, I am here to tell you why. The message report has to be written, massaged, approved by the wing commander (you should see the DCO and DCM also), and in the mail by the end of the next working day. If the safety staff learns of your Thursday mishap at 1630 on Friday, it means they don't see happy hour, kids, wife, dinner, or anything else until the report is done. If you want to see real fireworks, try being around when your squadron flight safety officer (FSO) gets called at 2130 to investigate one of the above items and can't make his o-dark-early brief merely because the need to report the mishap wasn't determined until some sharp maintenance type figured it out from the pilot's write-up.

Well, this is a plea for help. You can make a world of difference by providing the safety staff with the information they need right after the incident — instead of letting them "discover" it by themselves. Take a moment now and review the above list ("*they*" make all the FSO's memorize the non-F-16 items at the Safety School) and get an appreciation for what must be reported. Now, if you find yourself involved in one of these high accident potential situations, turn yourself in to your FSO and provide details of:

- Who you are (name, rank, SSAN, AFSC, age, flight duty).
- Where you were (range, LL nav, traffic pattern, etc).
- When the incident occurred (local time).
- What the flight conditions were (VMC/IMC, altitude, airspeed, G-load, bank, AOA, etc).
- What kind of maneuver you were doing (double inverted Australian snatchback, or whatever).
- Flight information and mission (No. 3 in a 4-ship 2 v 2 intercept ride, 1230 takeoff, 1.3 en route, etc).
- Which jet it was (tail number, configuration, fuel on board, etc).
- A summary of what happened and the actions you took.
- Any problems you had with any aircraft equipment.

Spending about 15 minutes with the FSO will allow an accurate report to be written without spending hours trying to get the same information from squadron, wing, and maintenance records. Telling the FSO you had a reportable mishap as soon as you can allows the message to be written and sent to the right people a lot sooner. The FSO can now make that morning flight (that will definitely make that safety officer and the scheduler happy). It will also allow the message report to reach the right people during duty hours which makes everybody, including O-6s, happy. Check six. There's an IFE sneaking up on you. ■

Beware of the Desert



SMSGT LARRY D. SHOLLER
3613 CCTS
Homestead AFB, FL

■ Even under the best egress conditions (if such a thing exists), crewmembers forced to eject over the desert will carry limited resources for survival. Beyond that, the natural environment will provide for their needs. To take advantage of the desert's natural environment, a crewmember must develop a general understanding of the desert and its hazards. Knowing what to expect and how to use the desert's limited resources will greatly improve your chances for survival. When you know what's ahead, you can eliminate certain problems. The desert is largely unforgiving, and "learning from experience" about its harsh nature can be a deadly alternative.

There is a lot to learn about survival in the various kinds of deserts. All deserts do not present the same environment. There are hot, cold, high, and low desert environments, all of which will require protection from the existing elements.

Because of the debilitating effect extreme heat has on mental and physical capabilities, you must take immediate protective measures. Desert air temperatures can measure between 120 and 130 degrees during the day. Surface temperatures will be even higher and have been measured between 160 and 180 degrees!

An increase of just 2 degrees in your normal temperature of 98.6 degrees reduces your mental and physical capabilities. An increase of 6 to 9 degrees can cause death.

As a downed aircrew member, you probably will not have a hat. An unprotected head rapidly promotes heat exhaustion and heat stroke. Improvise an Arab-style turban from parachute material to provide protection from the sun's rays and shade your eyes. This is important because severe headache and eye strain develop quickly in this environment.

The sun will also burn any exposed skin and could quickly disable you. Drape loose layers of parachute material over your flight suit to insulate yourself from the sun's penetrating rays.

Desert air not only can be very hot, but very dry as well. Humidity in this environment is commonly 2 to 3 percent, rarely more than 15 percent. This condition quickly robs your body of vital moisture. The loose layers of parachute material will preserve your moisture and slow dehydration.

The body is approximately 80 percent water, and any reduction in this level results in reduced operating efficiency. The average adult loses about 3 quarts of water a day through normal activities. In the desert, the loss can be significantly greater if you don't take steps to reduce it. You also must replace the lost water or suffer the effects of dehydration. The early signs of dehydration are: (1) Darkening of urine, (2) dizziness, and (3) headaches. Drink at least 3 to 4 quarts of water a day, if available. Limit your activity, not your water.

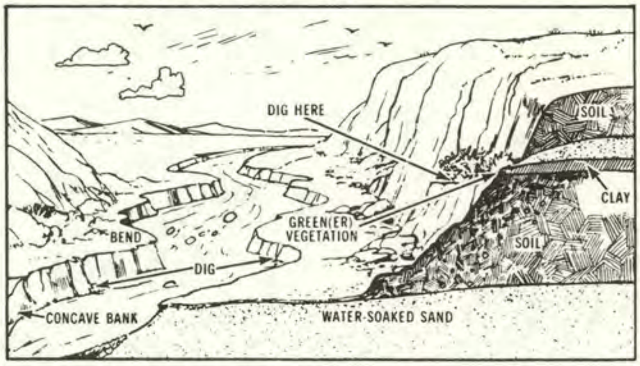
The first available water will be that carried in your aircraft survival kit. This water will be helpful in combating the immediate effects of the shock of finding yourself in a survival situation. But your continued survival depends on finding more sources of water.

Although limited, there are places where water may be found in the desert. Make sure you purify any water you find by boiling it or by using purification tablets. You may be able to find water in the sandy areas along dry lake beds. Dig a hole in the first depression behind the first sand dune. Stop digging when you hit damp sand. Wait for water to seep into the hole you dug. In dry stream beds, dig at the lowest point on the outside of a bend in the stream channel. Dig at night or in the coolest part of the day to limit your water loss through sweating. Also, dig only where water seems likely.

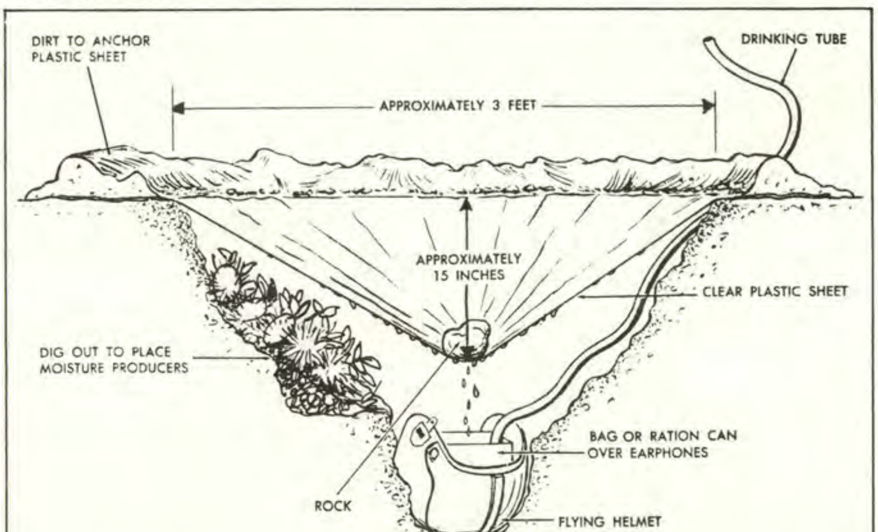
If the conditions are right, you may be able to collect dew in the early morning. The dew may form on metal parts such as aircraft surfaces, on stones, or on desert plants. Collect the dew by mopping up with a cloth or by draining into a cup or other container.

If available, cactus and various succulent plants can be a good source of water. However, avoid any that have a milky sap. Also, the roots of some desert plants that have their roots near the surface may provide water.

An important part of desert survival is slowing the dehydration process. You can use several layers of parachute material to protect you from head to toe. This will not only prevent sunburn, but the dead air space between the layers of material will provide very effective insulation from the heat and help you conserve body moisture.



When looking for water in the desert, be careful you don't expend more water through your efforts than you can get. Dig only in places that are likely to bring results. Dig in the late evening, at night, or very early in the morning when it is cooler. Work slowly and avoid overexertion.



The solar still may be your best friend in the desert. It will provide a limited, but steady source of water. Depending on the location and conditions, the still can yield from 1/2 to 3 pints of water per day. This output can be increased to as much as a gallon a day by placing fresh vegetation in the hole. The water collected is pure and ready to drink.

A solar still can provide a regular, though limited, supply of fresh water if you have the necessary materials. You will need a 6-foot square piece of clear plastic, a container to catch the water, and a drinking tube. See example above. The heat of the sun through the plastic will cause moisture in the soil to condense on the plastic and run down into the container. The water yield can be increased two or

continued

Beware of the Desert continued

threefold by cutting vegetation and placing it along the sides of the hole. Cactus is particularly good for this. The best locations for a solar still are in a dry wash or a depression.

Another natural source of water in the desert may be found in rock basins, especially in lava rock. These are usually widely scattered and difficult to find. Watch for birds flying to an area or circling over it. Also, game trails may lead you to water. But avoid wandering aimlessly over the desert searching for water. Remember, don't expend a lot of water in a fruitless search. Stay out of the sun as much as possible to reduce your water loss.

If you are in a position to stay put and await rescue, you will need protection from the extreme surface temperatures. Use any available source of shade and get 12 to 18 inches above or below the surface. This will make your shelter temperatures as much as 30 degrees cooler than the actual surface. Underground, temperatures can range from 50 to 100 degrees cooler than the outside temperature. However, as with any activity, digging will quickly rob your body of moisture and energy. Dig only when the end truly justifies the means.

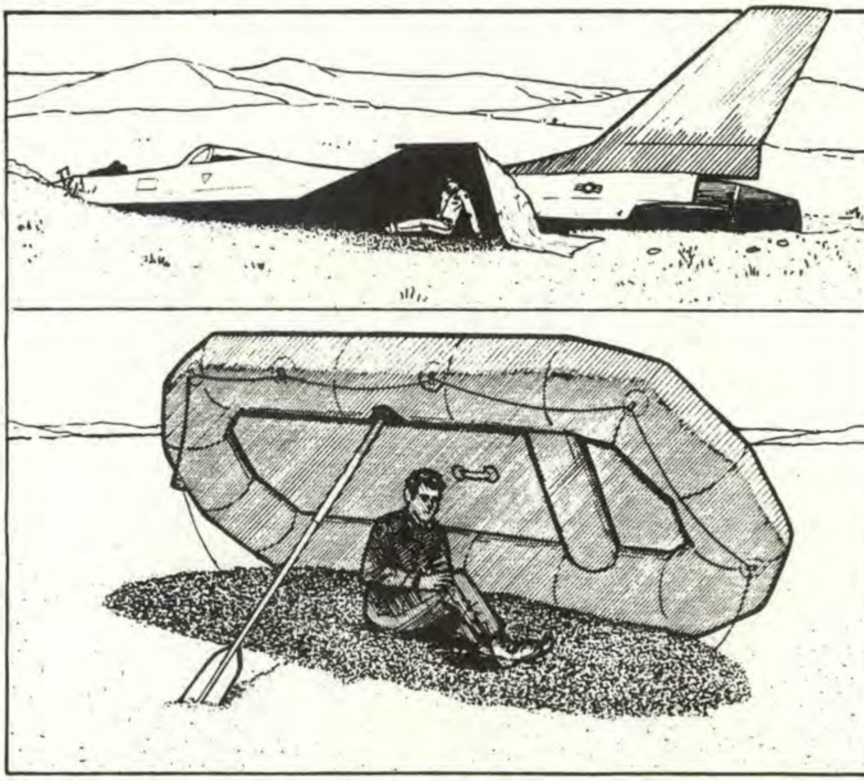
If you must travel, do so at night or during the coolest part of the day. Move slowly and rest often. (Remember, traveling is another moisture-robbing activity.) Adverse terrain features can make traveling a painful experience if you do not protect your feet. Flight boots should be large enough to accommodate two pairs of heavy wool socks without restricting circulation. This will insulate your feet from the hot ground and cushion them from the gravel that is predominant in most deserts. Wrap layers of parachute material around your boots and secure them with suspension line to provide more cushion and insulation. Also, this will make it easier to obscure your footprints under evasion conditions. In sandy areas, this wrapping may keep dust, sand, and grit from penetrating your boots and causing chafing.

Animal holes are nearly nonexistent in barren deserts but become plentiful in areas with surface vegetation. Stepping into a hole where larger ground animals and reptiles reside could cause a sprained or broken ankle. Obviously, a complication to your survival situation that you don't need.

Washouts often abruptly disrupt the terrain and pose a threat of injury. Large washouts have steep sides that are a serious hazard at night. You can usually see them on starry or moonlit nights, and they may provide concealment during evasion travel.

Typically, deserts receive 10 inches or less of annual rainfall. When rain does occur, it is often in the form of severe storms that can quickly create flash floods. The real hazard for you is that the actual storm can be miles away and yet cause flash flooding at your location. Key in on the earliest signs of a storm, however distant, and seek high ground immediately. The worst places to be are in low depressions, gullies, washouts, dry stream beds, and dry lake beds. You will probably hear a flash flood before you see it. The effect is devastating. It will carry not only masses of water but also dirt, rocks, boulders, bushes, and trees.

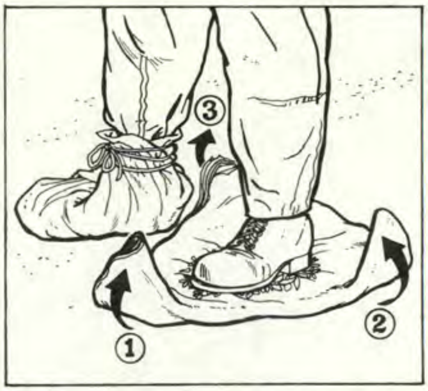
You also have to protect yourself against other types of storms — dust, sand, and lightning. Occasional high winds can kick up dust and sand storms. If it is not necessary to travel, stay put and wait out the storm. Generally, such storms appear worse than they really are. They can carry intense heat and sand, but are relatively short-lived. If you must travel during a



The main function of desert shelters is to provide shade. Use your imagination and whatever is at hand. If possible, you should sit on something or dig below the surface to keep cooler.

storm, cover your nose and mouth with part of the improvised turban (fasten securely so the turban is not removed by the wind). Protect your eyes from the abrasive, wind-driven sand. Do this by using your helmet visor or a piece of strap from your parachute harness with slits cut for eye openings.

Lightning storms in the desert are often severe with numerous cloud to ground lightning strikes. Most everyone has heard the advice to avoid open areas during an electrical storm. This goes for the desert, too. Of course, you may not have any shelter so the best you can do is minimize your exposure. Lightning seeks the high ground so avoid the highest spots, or those where you become the high spot. Remember though that lightning almost always means rain, and rain in the desert usually means flash floods. In your effort to avoid the lightning, don't forget that gullies and washes are even more dangerous. The best area is probably somewhere in the region of the "military crest" of the hills. This is a point somewhat over three-quarters of the distance up a hill but low enough for you to avoid appearing above the top of the hill. Staying in such an area should reduce the chance of electrocution while still being high enough to avoid flood waters.



Wrapping your boots with 4 to 5 layers of parachute cloth will provide several benefits. It will insulate and cushion your feet while keeping sand and dirt out of your boots. It will also help you conceal your footprints, if necessary.

To further reduce the risk from lightning, sit on any available insulated material. Piles of vegetation or an inflated life raft are the best options available for insulation. If enemy activity is present during such a storm, travel in surface depressions, staying out of any water to reduce the possibility of lightning strike.

For the unsuspecting crewmember, a cold or freezing night after the heat of the day will be unpleasant. The same loose layers of parachute you used to combat the heat will also provide insulation from the cold. During the day, large rocks absorb heat and radiate long after sunset. Dirt and sand, however, cool off quickly. It will be a little warmer at higher elevations than in the depressions. You can gather grass, bushes, or other vegetation, if available, to form a bed (taking care that you do not expend too much moisture and energy). This will give you additional protection and warmth against cold evening temperatures.

You will find undesirable animal life of various sizes and shapes in the desert. During the hottest time of the day, these creatures will seek the same shady spots you seek (or create). Given a chance, they will avoid humans. However, when you're resting, a snake, lizard, scorpion, or spider may join you. If this happens, don't panic or make rapid movements. A little stick or similar object kept close at hand can be used to ease them off your body. When resting, keep garments closed to keep these creatures out.

Flies, mosquitoes, and ants can be a nuisance. Attempt to ignore them. They tend to be fond of the corner of the eyes, areas on and in the nose, on the lips, and in and around the ears. They are attracted to a clean and scented body. Use repellent when available. Apply it around the wrists, ankles, and neck. These are all points of entry for the pests. Repellent rubbed into garments near openings will help fend them off much longer than if applied directly to the skin.

The desert environment is diverse and harsh. The potential adversities examined here are not an all-inclusive list of desert hazards to the crewmember, but I hope it was extensive enough to prompt you to properly prepare for a desert survival. To face such an environment with no understanding of its nature or the knowledge of how to protect against its hazards will leave you vulnerable to dehydration, heat exhaustion, heat stroke, drowning, electrocution, hypothermia, and toxic bites. It seems unnecessary to point out most of these conditions can be terminal.

Obviously, as a crewmember, you will make your own choice. This one chooses to survive and fly again. ■

NO WALKING AT ALL

MAXIMUM DAILY TEMPERATURE (°F) IN SHADE	AVAILABLE WATER PER MAN, U.S. QUARTS					
	0	1 Qt	2 Qts	4 Qts	10 Qts	20 Qts
	DAYS OF EXPECTED SURVIVAL					
120°	2	2	2	2.5	3	4.5
110	3	3	3.5	4	5	7
100	5	5.5	6	7	9.5	13.5
90	7	8	9	10.5	15	23
80	9	10	11	13	19	29
70	10	11	12	14	20.5	32
60	10	11	12	14	21	32
50	10	11	12	14.5	21	32

WALKING AT NIGHT UNTIL EXHAUSTED AND RESTING THEREAFTER

MAXIMUM DAILY TEMPERATURE (°F) IN SHADE	AVAILABLE WATER PER MAN, U. S. QUARTS					
	0	1 Qt	2 Qts	4 Qts	10 Qts	20 Qts
	DAYS OF EXPECTED SURVIVAL					
120°	1	2	2	2.5	3	
110	2	2	2.5	3	3.5	
100	3	3.5	3.5	4.5	5.5	
90	5	5.5	5.5	6.5	8	
80	7	7.5	8	9.5	11.5	
70	7.5	8	9	10.5	13.5	
60	8	8.5	9	11	14	
50	8	8.5	9	11	14	

This chart is old, but the message is still valid. If you can stay put, you can survive longer on the same amount of water. This is true even if you travel only at night.

For Distinguished Contributions

SAFETY

DIRECTOR OF AEROSPACE SAFETY SPECIAL ACHIEVEMENT AWARDS

INDIVIDUAL AWARDS

Major Roger M. Cude
Captain Donald D. Hall

Headquarters Air Training Command
Directorate of Safety
Randolph AFB, TX

Major Cude and Captain Hall conceived, designed, and assembled a unique multimedia aircrew safety briefing, entitled "Enemy In The Mirror," that addressed human factors and operator-caused aircraft mishaps. The presentation was seen by more than 5,000 people during 1985 and led to increased awareness of human factors involved in aircraft mishaps and a decrease in operator-caused mishaps.

Technical Sergeant Dwight G. Royal

57th Aircraft Generation Squadron
Nellis AFB, NV

As Noncommissioned Officer In Charge of the End-of-Runway Section at Nellis Air Force Base, Nevada, Technical Sergeant Royal ensured safety of aircraft takeoffs for an average of 140 sorties daily. He identified a crack in an F-5 aircraft main landing gear that could have caused a mishap, assisted with extracting a crew from a burning aircraft, and then extinguished the aircraft fire. Since assignment to these duties, there have been no mishaps involving any end-of-runway crewmember.

ORGANIZATIONAL AWARDS

919th Special Operations Group

Eglin AFB, FL

The 919th Special Operations Group completed nearly 50,000 hours without a Class A or Class B aircraft mishap spanning a period of more than 14 years. This outstanding record was accomplished while performing demanding and hazardous night gunship missions and participating in numerous Total Force exercises and deployment. Ground and weapons safety accomplishments were equally impressive, attesting to dedication and professionalism by all members of the organization.

Air Forces Iceland

Keflavik, Iceland

The Air Forces Iceland record of flying more than 40,000 hours spanning a period of nearly 13 years while carrying out missions as diverse as air defense, air refueling, strategic operations, airborne warning and control, and rescue is a remarkable achievement. Ground and explosive safety accomplishments were equally impressive and were achieved in a highly demanding environment requiring dedication and professionalism by all members of the organization.

AWARDS During 1985

THE KOREN KOLLIGIAN, JR., TROPHY

The Koren Kolligian, Jr., Trophy was established in 1957 in memory of First Lieutenant Koren Kolligian, Jr., declared missing in the line of duty off the coast of California on 14 September 1955. The Kolligian family established this memorial because of Lieutenant Kolligian's great feeling for the Air Force and love of flying. The award recognizes outstanding feats of airmanship by individual aircrew members. The trophy is awarded annually to the UASF aircrew member who most successfully coped with an in-flight emergency situation during the preceding calendar year.

Major Larry G. Brooks

305th Aerospace Rescue and Recovery Squadron
Selfridge Air National Guard Base, Michigan

Major Brooks was performing copilot duties when the No. 1 engine of his helicopter accelerated uncontrollably to maximum. A highly experienced instructor pilot, Major Brooks immediately and instinctively initiated actions to bring the runaway rotorspeed under control and the No. 1 engine back into the normal operating range.

Within seconds, the engine suddenly exploded, engulfing the forward cabin and cockpit with flames and thick, acrid smoke. The pilot could not see outside, nor could he see the instruments or the other crewmembers.

The flight engineer was critically burned by the massive fireball at his back, and he finally succumbed to the intense heat and smoke. Unable to see or breathe, Major Brooks had to rely solely on his flying instincts to keep the crippled aircraft under control over the densely populated area.

During the descent, Major Brooks was finally able to catch fleeting glimpses of the ground through the helicopter's chin bubble. Despite flames burning his face, shoulder, and arm, Major Brooks successfully guided the helicopter to a safe landing in the only open area available. Although he suffered a broken wrist and severely bruised hip during the egress, Major Brooks went back into the smoke-filled cabin, and with the pilot's help, pulled the unconscious flight engineer to safety.

The professionalism and extraordinary flying skills demonstrated by Major Brooks limited the aircraft damage to only that caused by the explosions and fire, and property damage was limited to mere shallow ruts in the ground. More importantly, the crew injuries were minimized, and Major Brooks' decisive actions undoubtedly saved the lives of some civilians of the community.

Why Mishaps?

LT COL JIMMIE D. MARTIN
Directorate of Aerospace Safety

■ Why do we continue to have mishaps? Are they the result of our new, sophisticated, computerized everything?

When I started flying (more than a few years ago), the F-4C was the state-of-the-art fighter. With manual fuel controls, standard instruments, and very little computerization, everything was pretty easy to understand. Now we have electronic engine controls, head up displays, fly-by-wire control systems, instrument displays, etc. Have we developed such sophisticated equipment we can't keep it operational? No. In fact, our logistics mishap rate has declined dramatically over the years. A part of that sophistication is increased reliability.

We still have logistics failures. While we try to improve designs and inspections so we can prevent these failures, we never will fully succeed. We will never be able to achieve 100 percent reliability.

But, even if we were able to create a perfect aircraft, we would still have mishaps. Why? Because we would still have the aircraft maintained, controlled, and flown by *imperfect* humans.

This is what concerns me. While our Class A mishap rate reached a record low in 1985, there have been a disconcerting number of mishaps directly attributable to human error. In most cases, luck was with the crewmembers and relatively minor damage resulted. In other cases, their luck ran out. Let's look at some of the lucky ones.

■ An instructor pilot (IP) and student pilot (SP) were returning from a day/night out-and-back sortie in an Air Force trainer. Both legs of the sortie had been uneventful. As the aircraft was approaching a turn along the taxi route to parking, the IP cautioned the SP to slow his taxi speed. The SP responded by retarding the throttles to idle. When he did so, the left engine flamed out because he had inadvertently grasped the left throttle finger lift and shut that engine down.

It seems the SP had not closed the throttle gate as called for in the pretaxi checklist, which would have prevented the accidental engine shutdown. In this case, they were lucky, but what if it had happened at a more critical time? What if it had happened in-flight during an emergency or along with some other distractions? This checklist deviation could have been disastrous.

■ An F-111 pilot declared an inflight emergency following a bird strike. After landing, the aircraft was checked for damage and hot brakes by crash crews and maintenance. No problems were found, so the ground crews departed, and the aircrew continued their after landing checks.

The pilot released the 26-degree wingsweep lockout and brought the wingsweep handle back to the next stop, which he assumed was the 54-degree lockout. As the wings began to sweep aft, the pilot's attention was diverted by a call on the radio. While talking on the radio, the pilot felt a crunch and looked at the wingsweep gauge. The gauge showed 72 degrees — full aft. He swept the wings forward to 45 degrees and noted the 54-degree lockout was unlocked. The crunch was caused by the GBU-15 being carried under the right wing hitting the fuselage and causing almost $7,000 damage.

The pilot was relying on the 54-degree lockout to stop him from sweeping the wings aft of 54 degrees, but at some undetermined time, he had released the lockout. When he swept the wings, he didn't check the gauge; he just moved the handle to the stop — the 72-degree stop. The combination of these two errors and the subsequent distraction caused by radio transmissions resulted in this mishap.

■ Less than 2 months later, another F-111 taxiing in after a GBU currency mission experienced almost the same problem. In this case, there was no emergency. The pilot just pulled the wingsweep handle to the stop during his after landing checks. He didn't hear or feel anything unusual and didn't realize what had happened until he looked at the wingsweep gauge a few moments later and saw the wings were at 72 degrees. He moved the wingsweep handle forward to 54 degrees and continued taxiing. The damage was discovered after shutdown. Once again, the GBU-15 struck the fuselage and caused approximately $6,000 damage.

What was the common thread through these mishaps? — poor checklist discipline and lack of awareness by the crewmembers.

■ An F-16 pilot on a conventional range mission had to manually load his avionics information, including the weapons inventory, because the data transfer cartridges weren't properly loaded. He incorrectly entered the practice bombs on stations four and six which were actually configured with external fuel tanks. At the range, he was unable to release his bombs normally, so he decided to use selective jettison. When he did this, the right external fuel tank and pylon released from the aircraft. Selective jettison is an emergency procedure and should not have been used in this case.

When the bombs wouldn't release normally, the pilot elected to use an unauthorized procedure to get the mission completed and cost the Air Force almost $49,000.

continued

The aircraft today are extremely complex and sophisticated. The technology needed to build them, maintain them, and fly them is greater than ever before. But, is it the complex technology that causes mishaps?

Why Mishaps? continued

■ An RF-4C flight of two was participating in an exercise and was late for takeoff due to maintenance delays. They were further delayed during their prestrike refueling by tanker problems. The lead pilot coordinated for a new TOT and proceeded toward the target. En route, they encountered multiple attacks by aggressor aircraft. During this time, the lead crew lost situational awareness of the time and assumed they were late. As a result, they arrived in the target area one minute early. They met an exiting aircraft almost head-on and had to take evasive action which resulted in over-G damage to the lead aircraft. The damage was in excess of $20,000.

■ A UH-1N was being flown on a copilot upgrade sortie. After flying several transition maneuvers, the IP simulated a fuel control failure on the No. 1 engine. The copilot retarded the No. 1 throttle to idle in accordance with the emergency checklist, and the IP placed the fuel governor switch to manual fuel. However, he got the wrong switch and placed the No. 2 engine fuel governor switch to manual fuel. As a result, the No. 2 engine immediately failed because of a catastrophic internal turbine overspeed, and an emergency landing was necessary.

Several factors combined to contribute to the IP's mistake. To maximize training, they were flying smaller-than-normal traffic patterns. This made for a short downwind and minimal time to accomplish required checklists and manual fuel entry procedures. Also, a student flight engineer was reading the checklists, which took longer than usual. These things caused the IP to hurry and to depart from his normal technique of having a second crewmember verify the governor switch prior to placing the switch to manual fuel. This cost the Air Force almost $14,000.

■ An MC-130E was struck by approximately 30 birds while flying on a low-level route. The birds hit several spots on the fuselage, engines, wings, and tail section. The pilot decided to complete the low-level mission. After landing, they discovered a hole in the vertical stabilizer. The actual damage to the aircraft was relatively minor, slightly over $13,000, but the risk involved while continuing this mission after multiple bird strikes was tremendous. The pilot put the aircraft and all his crew in jeopardy to complete a routine mission. His luck held this time. . . .

■ An A-10 pilot was lead for an uneventful formation full-stop landing. After touchdown, he delayed full speed brake extension until the wingman was well aft. He then applied moderate braking until the wingman cleared him to the cold side of the runway. The mishap pilot then engaged nosewheel steering, disengaged antiskid, and reapplied brakes at approximately 95 knots. The right brake immediately locked, ultimately resulting in tire failure and fusing of the left brake due to excessive heating from using the left brake to keep the aircraft on the runway.

The Dash One procedures call for the antiskid system to be disengaged after clearing the runway. This violation of tech data only cost the Air Force $3,150. It could easily have been more.

■ A T-38 student made a full-stop landing at the end of a night

Failure to follow Dash One procedures has caused many mishaps over the years. Improper engagement of nosewheel steering or disengagement of antiskid are recurring problems on runways. Use the correct procedures. If you feel the published procedures are wrong, submit a change.

Student pilots must be taught from the first day of training that all the hazards associated with landing aren't on final approach. Experienced pilots need to periodically remind themselves of this fact. You have to keep "flying" the aircraft after touchdown. The flight isn't over until the aircraft is shut down in the chocks.

solo sortie. After normal aerodynamic braking, he began light to moderate braking. The student couldn't remember the aircraft tail number to report it to the RSU. He turned up the cockpit floodlights so he could read the tail number off his knee board. After giving his tail number to the RSU, the student once again looked out and realized he had excessive airspeed for the remaining runway and began heavy braking. The aircraft engaged the barrier and came to a stop 20 feet into the overrun. Minor damage to the aircraft cost the Air Force about $2,200.

A simple case of the student becoming preoccupied with giving his tail number to the RSU and failing to maintain aircraft control.

I could go on with more mishaps such as these, but I hope you get the idea. All these mishaps were relatively minor. All had the potential to become major mishaps. All were caused by human factors — checklist deviations, relying on habit patterns, distractions, trying to complete an assigned mission using unauthorized procedures, etc.

These were not deliberate failures. The crewmembers weren't trying to perform unauthorized maneuvers for thrills. They were just trying to do the job. In most of these cases, the mission was completed, but at what cost? Was the mission worth the risk or the subsequent costs to repair the damage?

In these days of reduced flying hours, it's important to get the most out of our flying time. But, we can't afford to cut corners or work around procedures to try to salvage a mission. Such things sometimes work, but more often than not they only lead to more problems. The only solution is to follow the procedures and fly the sortie another day, if necessary.

We also need to be very careful in relying on habit patterns and memory. Habit patterns are a mixed blessing. They can be real lifesavers or they can lead to severe complications. No matter how good your memory may be, it's still not perfect. No matter how many times you've performed the climb check or before landing check, use the checklist. Try not to let anything interrupt your completion of a check. If you can't avoid the interruption, make sure you get back to the check as soon as possible. When you do get back to the checklist, don't pick up where you left off. Start at the beginning. This will ensure you don't skip a step.

The basic steps for any emergency procedure are: (1) Maintain aircraft control, (2) analyze the situation, and (3) take proper action. Don't these three steps make sense for normal procedures, too?

Can we eliminate mishaps by following these steps? No. We will always have imperfect aircraft built, maintained, and flown by imperfect humans. But, *we* are the weak link. If each of us takes a good, hard look at ourselves, we may well see where some real improvements can be made.

It's too late for New Year resolutions, but how about a mid-year resolution? Resolve *now* to do everything you can to make sure *you* aren't the cause of a mishap. If we all make that resolution and *keep it*, we'll profit from a record low mishap rate and the chance to fly again another day. ■

Safety Warrior

A Gathering of Eagles

PEGGY E. HODGE
Assistant Editor

■ Three generations of airmen met in Las Vegas for an exposition of past, present, and future airpower. Aerospace experts and enthusiasts from all over the world and "Eagles" — people who have served in or supported US, allied, or friendly air forces — gathered in Las Vegas from 27 April to 1 May.

This "Gathering of Eagles" saluted military aviation progress and accomplishments over the years. American participants included heroes of three wars. Among them were Air Force and Army Air Forces Medal of Honor recipients General Jimmy Doolittle and his Tokyo Raiders; Gen Curtis E. LeMay, former Commander in Chief of the Strategic Air Command and later USAF Chief of Staff; and noted test pilot Brig Gen Charles Yeager.

The Gathering celebrated the establishment of the Strategic Air Command, Tactical Air Command, Aerospace Defense Command, and the founding of the Air Force Association 40 years ago.

With activities in the air and on the ground, these airmen relived events from the past and enjoyed getting together to share memories as well as contemplate the future.

In the air, the audience witnessed vintage warplanes recreate the major air engagements of World War II, a current USAF tactical capabilities exercise, and a USAF Thunderbird practice aerial demonstration.

The following is extracted from the agenda of activities at the "Gathering's" airshow. It serves as a reminder of a tragic time in our history, a time in which the citizens of this Nation can take great pride, and facts and capabilities of our aircraft today.

The Confederate Air Force flew those aircraft which defended our nation in the greatest conflict in the history of the world from 1941 through 1945. The prominent American combat aircraft types which were flown by the US Army Air Force, US Navy, and US Marines during World War II were flown again at this airshow. Also participating were aircraft of the Royal Air Force, German Luftwaffe, and replica aircraft of the Imperial Japanese Navy.

In just 4 years, this Nation and other free people of the world overcame the 10-year premeditated lead of the aggressor nations to win unconditional surrender in the greatest conflict the world had ever known. The technology and industrial might of the men and women of American industry and the courage, ability, and sacrifices of America's 16,000,000 fighting forces won that victory in just 4 years.

We who experienced those years should not forget them, while our younger generations of Americans should be made aware of the accomplishments of this Nation during that period.

We must also be reminded that this Nation — and the free world — must never be caught asleep again as we were on 7 December 1941 — and that we must always be as relatively strong as we were in 1945 when these machines were first-line combat aircraft.

What followed was a current USAF tactical capabilities exercise. Units from Nellis AFB, NV, and other TAC bases participated in a tactical capabilities exercise (TCE).

The TCE was designed to provide TAC aircrews with live, heavyweight weapons delivery training to develop their confidence in weapon sys-

tem dependability and lethality. It also enabled various types of different Air Force aircraft to work together in uniquely complex war-fighting scenarios.

The battle scenario began as an RF-4 provided air reconnaissance of a suspected target area. The RF-4 has electronic and photographic equipment which allows essential information on targets to be transmitted to fighter and attack aircraft on alert status.

The aerial dogfight began as F-15 Eagles attempted to clear the skies of enemy aircraft by achieving air superiority against adversary F-5E Tiger IIs. The F-15 is an all-weather, extremely maneuverable tactical fighter designed to gain and maintain air superiority in aerial combat. It can outperform and outfight any current or projected enemy aircraft worldwide and is designed to penetrate enemy defenses.

The Tiger II is a single-seat, supersonic aircraft and is the mainstay of the aggressor force based at Nellis. It closely resembles the Soviet MIG 21 aircraft in size and performance.

Following the air battle, the F-15s carrying AIM-9 "Sidewinder" heat-seeking missiles demonstrated their lethality against an airborne target.

With air superiority secured, the ability of tactical aircraft like the F-16 Fighting Falcon and F-4 Phantom II to locate and destroy enemy targets was then exercised.

With the way now clear to attack the airfield's runway, the F-111 multipurpose tactical fighter-bomber penetrated at low altitude and attacked the airfield from 1,000 feet using a string of 500 pound bombs.

continued

A Gathering of Eagles continued

With the major ground threats now neutralized, an OA-37 identified remaining enemy targets that needed to be destroyed before ground troops moved into the area.

The A-10 Thunderbolt II then exercised its capability to provide close air support for ground forces by attacking ground targets with high-drag bombs followed by firing its GAU-8 gun to destroy vehicle targets. The lethality of the A-10 gun is formidable as it fires up to 66 three-quarter pound projectiles a second. Each round impacts with eight-million foot pounds of energy and can penetrate over four inches of steel.

The A-10's outstanding maneuverability enables it to work effectively at low altitude to defeat the enemy.

The airshow concluded with a USAF Thunderbird practice aerial demonstration.

The Thunderbirds are named after one of the most famous legends in American Indian folklore. The majestic Thunderbird was believed to cause thunder and lightning, to grant success in war, and to ensure good conquered evil. In 1953, the newly formed Air Force demonstration team searched for a symbol that would capture the thunder of their jet fighters as well as their mission of good will. There seemed to be no more fitting choice than this powerful bird of American Indian legend.

In the three plus decades since the team was formed, the Thunderbirds have performed in all 50 states and in 47 foreign countries for combined audiences of more than 196 million spectators.

The Thunderbirds' current aircraft, the F-16, built by General Dynamics Corporation of Ft Worth, Texas, is the newest fighter in the

The Gathering's airshow served as a reminder of a momentous time in our history, a time in which the citizens of this Nation can take great pride, and facts and capabilities of our aircraft today. Pictured above are machines that made history, as well as some aircraft of today. L to R: Japanese Kates recreating Pearl Harbor attack, F-16 Thunderbird, A-26 Invader, Japanese Zeros, A-10 Thunderbolt, and a Boeing B-17G Flying Fortress.

Air Force inventory. It is designated as a multirole combat fighter. Nicknamed the Fighting Falcon, it serves in eight Air Force fighter wings in the United States, Japan, Korea, Germany, and Spain . . . and is also being flown by the Air National Guard, Reserves, and by a number of allied nations around the world.

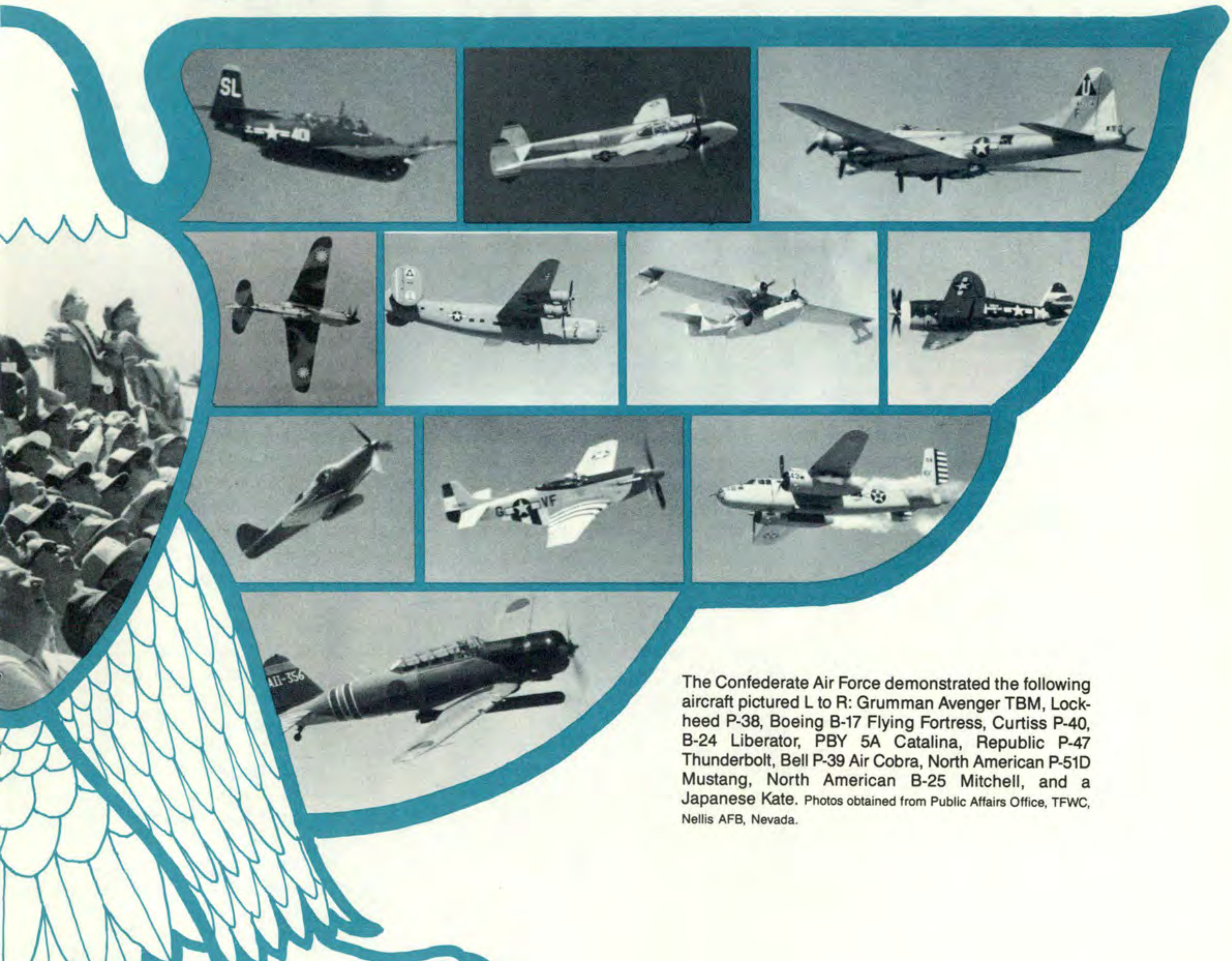
Designed to be small and maneuverable, it is 50 feet long and has a 32-foot wingspan. The F-16's engine is built by Pratt and Whitney and provides more pounds of thrust than the F-16 weighs, which gives the F-16 its exceptional acceleration and sustained maneuverability.

Except for being flown in tight formation at very low altitude, the maneuvers performed were representative of those taught to every Air Force pilot from initial flying training to follow-on continuation training as a combat ready pilot.

On the ground, the "Gathering's" participants attended four top-level symposia/workshops featuring aerospace leaders from throughout the world. Symposium/workshop topics included "Global Aerospace," "Educating for Leadership in Space," "Your Air Force — Today," and "Designing Tomorrow's Air Force."

Participants also enjoyed exhibits sponsored by more than 150 aerospace companies.

The Gathering of Eagles opened a door to the past and showcased military aerospace accomplishments of four decades. Eagles were in the company of acutal people (and their machines) who made history. But the event was far more than an airmen's reunion. It was a major exposition of the free world's military and civilian aerospace achievements, expectations, and challenges. It was a look at aviation — yesterday, today, and tomorrow. ■



The Confederate Air Force demonstrated the following aircraft pictured L to R: Grumman Avenger TBM, Lockheed P-38, Boeing B-17 Flying Fortress, Curtiss P-40, B-24 Liberator, PBY 5A Catalina, Republic P-47 Thunderbolt, Bell P-39 Air Cobra, North American P-51D Mustang, North American B-25 Mitchell, and a Japanese Kate. Photos obtained from Public Affairs Office, TFWC, Nellis AFB, Nevada.

Only An LRU

MAJOR GARY R. MORPHEW
Directorate of Aerospace Safety

■ "Now, let me get this straight, colonel. You are the item manager for a universal aircraft LRU (line replaceable unit) — one that is used in every aircraft in the inventory, and you are telling me that it malfunctions occasionally, often results in the loss of the aircraft, and there is, seemingly, no way to make it more reliable?"

The item manager (IM) twisted slightly in his seat at the long table. He glanced around the room at the members of the council looking for a shred of support. There was none.

"Yes, sir. I guess that's about the size of it. We've looked at it from nearly every angle and can't seem to get a handle on just why it continues to malfunction. The initial design and manufacturing process seems OK. It's the state of the art. The primary programming is good, but not perfect, primarily due to the fact the same LRU is used to program other units."

"Excuses! There has to be a solution! Not many years ago we were thinking we could never get our mishap rate down to anywhere near what it is today. This single system is directly responsible for, or at least influences, nearly every loss! We've got to make it better, and that's *your* responsibility!"

Beads of sweat formed on the lieutenant colonel's brow. He had anticipated the briefing would be difficult but that did not help any. The more reliable other systems became, the harder it was to explain the malfunctions of his LRU.

"Tell me, colonel. . . ."

He looked across the room at the new speaker. He felt some relief to be able to redirect his gaze.

". . . just how do we go about getting the system ready for flight? Maybe we can improve its reliability by better preflight maintenance and preparation."

"Sir, I have looked into that many times. . . ." He pulled a file from the bulging briefcase at his side. ". . . and each time we make an improvement, something else malfunctions. Ah, yes. Here we are.

"Following the initial LRU acquisition with its basic programming, we built more sophistication into it by giving it more memory, using high speed chips, and trying in some cases, to bypass routine logic paths directly. All in all, from ops checks on systems in the field and LRUs received each month, we find them reliable and capable of performing all their normal assigned functions without detriment to the aircraft or mission effectiveness. From there we go through a continuous process of programming specific mission details and tasks as well as creating redundant paths for routine functions.

"This is where we really start getting into the mystery areas. An LRU malfunction which may lead to a mishap won't necessarily show up before the mishap, nor will it be duplicated at anytime following the incident. (That assumes, of course, that we receive a repairable LRU after the mishap.) Even on those occasions when we do discover a faulty logic path, it seldom manifests itself again in that LRU throughout its service life."

Another council member to the IM's right spoke. "In short, we can't fix something that won't show you where it faulted or never duplicates the malfunction. Too bad we can't just replace the whole LRU like we do with so many others."

"That sounds too easy," the Vice said. "I only wish we could procure them in sufficient quantities to even discuss that. But at the cost of each unit, not to mention the follow-on programming and maintenance . . . by the way, what's that running us now?"

"About $9-10 million to get each unit through its service life," the item manager replied. "However, we often don't get a full life out of them due to removal from service for other reasons."

The continuity of the briefing broke down at that point as the generals turned to each other in private conversations.

"Colonel," the Vice brought everybody's attention back to the issue. "What about the final programming — the one completed just prior to engine start? Any clues in that process?"

"Yes, sir. That's about the only area that keeps repeating and can be traced fairly easily. When any final preflight programming is incomplete or goes against previous programming, we get less mission reliability and a higher probability of a mishap. But this type of failure is decreasing as we get better quality control on mission programming, data transfer, and the final verifications on the LRUs."

"What about mission demands on the system?" the IM heard from his left. "Are you able to correlate a failure potential with an overload of required functions?"

"Frequently, sir. The LRU demonstrates a greater potential for failure when operating near task saturation. We have successfully brought task management circuits under some control, usually by designing and installing other systems to share the workload. Unfortunately, there isn't a one-on-one correlation. While we can predict a failure potential for circuit overload, we can't predict just how many or what type of simultaneous inputs will overload on a specific LRU."

"What about the reliability monitoring subsystem. Doesn't it report a degraded capability before failure?" The Vice took on another angle.

"Sir, in many instances it does just that. The reliability checks will cause the LRU to report a degraded capacity, and we are able to take maintenance measures to replace the unit prior to flight. Most of the time, the LRU is out of the aircraft for only a few days, and its performance afterward is not in any way diminished. Sometimes, however, these checks do not manifest themselves sufficiently strong to alert either the internal system monitors or the quality control experts. In these cases, the underlying problems may not adversely affect the normal LRU performance. It can result, however, in these insignificant problems recurring simultaneously at the point of peak demand on the system, resulting in an overload and a mishap."

"Can we improve the reliability checks?"

"Only by recognizing that the small, usually unremarkable errors need as much maintenance attention as the major malfunctions. This would, however, require more diligence on the part of our supervisors to detect the smallest degradation of performance, interrogate the LRU for the problem, and see that it's fixed."

"Do you need the assistance of the Council to initiate such a program?"

"No, sir. This program is continuous. However, a little added emphasis from the most senior commanders always carries a lot of weight with those charged to ensure the LRU's in-service reliability."

"All right, then. We'll see that the staff takes the additional tasking to effect that emphasis. Rest assured, Colonel, that we on the Council haven't lowered our standards on getting this system into the same league as other LRUs. Repeated malfunctions which cost us resources cannot be tolerated. I hope to see better results in the coming year. That's all."

As the Council moved out of the room, the lieutenant colonel began placing his notes in his briefcase. "Whew," he thought, "why can't we just go back to the way it was before? It was so much easier when my line replaceable units were known as crewmembers and their malfunctions simply reduced to "human error." □

In the preceding article, we euphemistically looked at what it might be like if we attempted to manage our human resources like we manage other materiel assets. Obviously, that method is impractical and impersonal. To keep the proper perspective on how our human frailties result in catastrophic losses of lives and equipment, we must never lose sight of the fact that each of us has an influence on how we all do business in the Air Force.

Keep in mind, however, that this attitude shelters us from the pressures and demands placed on an item manager. A component that had the malfunction rate equal to the "operations" share of our total mishap rate would be difficult to explain away. Two-thirds of the total Class A losses can be assigned to operations "human error." If we consider the maintenance personnel errors on the logistic side, the proportion is significantly greater.

The bottom line is that we all need to evaluate ourselves and those around us as if we were responsible for their "reliability." In that way, we can replace those potentially malfunctioning "LRUs" before the mishap occurs. ■

OPS TOPICS

It Isn't Just Birds . . .

■ The pilot of an F-4D was making a single-ship takeoff at dusk. As the aircraft accelerated through 120 knots, a deer suddenly attempted to cross the runway. The pilot was unable to avoid a collision and only had time to yell "deer" to the backseater before impact. He initiated an abort at 130 KIAS and brought the Phantom to a safe stop.

The pilot turned off onto the taxiway and stopped the aircraft for inspection. The deer was found lodged between the right external tank and the right gear door. After shutting down the engines, the crew ground egressed, and the aircraft was towed back to the ramp.

Total aircraft damage was almost $15,000. Investigation revealed the deer was not in radio contact with the tower and had not received the required training for operating on or near runways — fatal mistakes on his part.

T-37 Slalom

A T-37 student pilot (SP) was making his first full stop landing on his second flight in UPT. There was a 6-knot crosswind from the right, and the SP applied proper crosswind control throughout the landing flare. However, after touchdown on the left half of the runway, the SP relaxed his controls. The Tweet weathervaned into the wind and crossed the runway centerline. The IP told the SP to use left rudder to correct back to the left side of the runway. Then things got exciting.

The SP made, in his words, an "aggressive" correction with left rudder. He also accidentally engaged nose-wheel steering, and the aircraft quickly veered to the left and off the runway before the IP could take control. The IP shut down both engines just before they departed the paved surface to avoid engine damage. The aircraft came to a stop undamaged about 250 feet after leaving the runway.

The age-old dilemma of all instructors — when do you verbally correct the student, and when do you take control of the aircraft? We can't lay down hard and fast rules for every possible situation — only guidelines. That's why we select pilots as IPs who have demonstrated good judgment. Some general guidelines are: Always try to err on the safe side; be especially cautious during critical phases of flight; never relax; expect the unexpected; and always remember Murphy's Laws.

Night Lights

A C-141B was on a night precision radar approach (PAR). The crew noticed they were being vectored to the left of the runway lights and questioned the heading given by the PAR controller. The controller told them they were aligned with the correct runway and a turn to the right would line them up with a closed runway.

The crew then suggested the tower should turn on the lights for the open runway. The lights came on, and the aircraft landed uneventfully. The tower controller had turned on the wrong runway lights due to a poorly marked switch panel.

Swift action by the crew prevented any serious problems from developing. What if they had canceled IFR and proceeded visually to the lighted runway?

Going, Going, Gone

An F-15 pilot on a DACT training mission had just completed his first engagement when the bingo fuel light came on (set at 5,000 pounds). The pilot checked his fuel and found only 4,600 pounds remaining. Other flight members noticed fuel streaming from his fuselage.

The mishap pilot and his wingman began an immediate RTB. Three minutes later, the fuel was down to 2,500 pounds, and the pilot shut down the left engine to try to stop the leak. He also jettisoned the centerline tank to extend his range.

The fuel leak continued unabated, and the pilot decided to land at a nearby civilian airfield. The field has three concrete runways and very little traffic. There was no time to restart the left engine, so the pilot made a single-engine landing, stopping with approximately 1,500 feet of runway left. He shut the engine down 30 seconds later with the fuel gauge showing zero fuel.

The total elapsed time from discovery of the fuel leak to fullstop landing was less than 9 minutes. Only quick, decisive action by the pilot saved this Eagle to fly another day.

Initial investigation revealed the leak developed at the Wiggins Coupling on the left heat exchanger, upstream of the fuel shutoff valve.

One More Time

The pilot of a single-seat fighter was flying as No. 3 in a 4-ship DACT mission. He made a formation takeoff and closed to one NM behind the lead element. Passing 4,000 feet in a right 30-degree turn, the mishap pilot turned his head to watch his wingman cross under from right to left.

When he brought his head forward, the mishap pilot experienced tumbling vision followed by uncontrollable, rapid eye movements. He immediately informed lead of his problem, turned the autopilot on, and selected 100 percent oxygen. After 15-20 seconds, his vision returned to normal. The mishap pilot declared an emergency, dumped fuel, and returned to base for an uneventful straight-in landing.

The flight surgeon met the pilot at the aircraft and took him to the clinic for an evaluation. The flight surgeon learned the pilot had been suffering from symptoms of upper respiratory infection for approximately 48 hours prior to the flight. Instead of going to the flight surgeon, the pilot took an over-the-counter cold tablet approximately 6 hours before the mishap flight.

During the physical examination, the flight surgeon discovered the pilot had ear blocks in both ears. The doctor's opinion was that the tumbling vision and vestibular disorientation were most probably the result of these ear blocks combined with the effects of the cold tablet.

Another example of the dangers of self-medication by fliers. This pilot was lucky. What if he had experienced the disorientation during the DACT portion of the flight? During close formation? On short final? I'm sure you can conjure up many visions of potential disaster in this situation. The message is clear. Leave the diagnosis and treatment of physical disorders to those who are trained for it — the flight surgeons.

You're Not Alone

A B-52G had just passed a turn point in the low-level route when the pilot saw a red-and-white high-wing light aircraft at 12 o'clock, co-altitude on a reciprocal heading about 1 to 1-½ miles away. The B-52 pilot made a hard right climbing turn, and the light aircraft passed by about 400 feet to the left. The Buff pilot tried to contact the Flight Service Station, but couldn't because of the low altitude and surrounding terrain.

As if this near miss wasn't enough, the pilot had already taken evasive action twice on this same low-level mission to avoid light aircraft at his altitude. He had also spotted two other light aircraft at his altitude, but not close enough to create a hazard.

None of the light aircraft gave any sign of having seen the B-52. (I guess they must have been practicing blind flying.)

With the coming of spring and the return of warm, sunny weather, expect to see a big increase in general aviation flying. Keep your eyes out of the cockpit, especially at low altitudes. See and avoid. ■

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 Mishap Prevention Program.

MAJOR
James L. West

CAPTAIN
Alan D. Ray

19th Tactical Air Support Squadron

■ On 25 July 1985, Major West and Captain Ray were on a local OV-10 transition mission when, shortly after takeoff, the right engine failed causing an immediate loss of torque and thrust, severe right yaw, and a rapid uncontrolled right roll. Already in a right turn at the departure end of the runway, the aircraft's low altitude of 400 feet AGL and slow airspeed were rapidly deteriorating as Major West attempted to reestablish a wings-level condition. With the aircraft below the recommended minimum altitude and airspeed for single-engine flight, Major West quickly cleared the projected impact area, jettisoned the external stores, and feathered the right engine. Both pilots completed the required checklist procedures. With rising terrain directly in front of the aircraft, Major West began to maneuver to downwind at minimum safe, single-engine airspeed for an immediate recovery at home base. Although never able to gain recommended airspeed and altitude for single-engine conditions due to a combination of gross weight, high temperature, and pressure altitude, Major West successfully maneuvered the aircraft for an uneventful single-engine landing. Despite flying the OV-10 on only three previous occasions, Major West's quick reactions and flawless airmanship, along with Captain Ray's indepth knowledge of the aircraft and emergency procedures, prevented possible serious damage to civilian personnel or property and the loss of a valuable Air Force aircraft. WELL DONE! ■

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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 Mishap Prevention Program.

LIEUTENANT COLONEL

Robert H. Boehringer

144th Fighter Interceptor Wing
Fresno ANG Base, Fresno, California

■ On 10 July 1985, Colonel Boehringer was on the return leg of a cross-country passenger pickup flight in a T-33 aircraft. During takeoff, everything was normal until the aircraft reached 1,500 feet above the ground; at 250 knots and 100 percent, the engine flamed out. He immediately hit the gangstart switch. The gangstart system is designed to give you everything you need to effect an airstart. The airstart ignition and emergency fuel control systems were, in fact, activated, but the RPM continued to decrease to 8 percent and the EGT to 300 degrees. (Due to a dual pump shaft failure, there was no way to start the engine.) At such a low altitude, Colonel Boehringer realized there was not time for any more airstart attempts and turned his attention to making a forced landing. He started a right turn back to the runway, declared an emergency, and picked up a glide speed of 180 knots. Now the 18 to 24 knot headwind was a very welcome 18 to 24 knot tailwind. Once he was sure of making the runway, he lowered the gear using the normal system. During gear extension, the aileron boost cut in and out. Just prior to the flare, he lowered the flaps and made a "normal" flameout, opposite direction landing, clearing the runway at the departure end. The pilot turned off the main fuel shutoff switch and, along with his passenger, made a normal, but rapid, egress from the aircraft. The quick thinking and superior airmanship demonstrated by Colonel Boehringer resulted in the safe recovery of his passenger and the aircraft. WELL DONE! ■

Project Warrior

1986 Warrior Ten Books

1. **Command in War**
   Martin van Creveld Harvard University Press, 1985

2. **A Time for Courage: The Royal Air Force in World War II**
   John Terraine Macmillan, 1985

3. **The 25-Year War: America's Military Role in Vietnam**
   Bruce Palmer, Jr. University of Kentucky Press, 1985

4. **Into the Mouth of the Cat: The Story of Lance Sijan, A Hero of Vietnam**
   Malcolm McConnell Norton, 1985

5. **Leaders and Battles: The Art of Military Leadership**
   W.J. Wood Presidio Press, 1984

6. **The Foundations of U.S. Air Doctrine: The Problem of Friction in War**
   Barry Watts Government Printing Office, 1985

7. **Maximum Effort: B-29s Against Japan**
   Kevin Herbert Sunflower University Press, 1983

8. **Strange Defeat**
   Marc Bloch Octagon, 1967

9. **The Defense Reform Debate: Issues and Analysis**
   Asa Clark et. al. (Eds) Johns Hopkins Press, 1984

10. **The Patterns of War Since the Eighteenth Century**
    Larry D. Addington Indiana University Press, 1984

To obtain copies of these highly recommended books, visit your Base Library or Project Warrior office.