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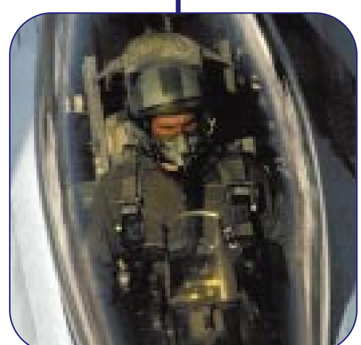

Cover: FSM File Photo

FAREWELL MESSAGE FROM THE CHIEF OF SAFETY

MAJ GEN FRANCIS C. GIDEON, JR.
THE USAF CHIEF OF SAFETY

This job as the Air Force Chief of Safety has been one of the most rewarding of my career. As I retire, I want to express my appreciation to the folks who have made my tenure here a success—the organization I've been so proud to head, the Air Force Safety Center, and those of you in the field, on the "front line" of the struggle for mishap prevention.

It has been a great three years here at AFSC. During this period, the AFSC developed and implemented innovative programs and policies to enhance the overall safety posture of the USAF. Masterful administration of superb programs in flight, ground, space, missile, and explosives safety have saved lives and equipment, and enhanced the Air Force's operational capability.

Among the milestones we've seen are the record-setting years in safety the Air Force has attained. We had the lowest number of Class A flight mishaps and the lowest Class A mishap rate ever in FY98. The numbers of destroyed aircraft and aviation fatalities both tied for the best year ever. Ground safety set a record for the lowest number of on-duty, as well as off-duty, Class A mishaps and the lowest mishap rate ever in FY98. Again in FY99, flight safety set a record with the lowest number of pilot and total aviation fatalities. Ground safety set another new record for the lowest number of off-duty ground fatalities and rate. In the space, missile and explosives safety arenas, zero Class A explosive mishaps or fatalities occurred in FY99. These records helped AFSC earn the Air Force Organizational Excellence Award for FY98-99, though we all know it is you commanders and Air Force members worldwide who are actually responsible for these stats.

Indeed, your hard work is the only way we can continue the positive trend in flight safety. Mishap rates, with few variations, have continued to fall since the 1970s, but they have tended to plateau since 1993. Today is a time of tighter resources and less flying, and therefore, the challenge to lower the mishap rate—to prevent the loss of our resources in lives and aircraft—is tougher than ever. That challenge is borne by those of you on the flightline, and you meet it on a daily basis. Keep up the good work!

To meet the continuing need for mishap prevention, AFSC is developing a new Safety Automated System. This innovation is an internet-based mishap reporting system which will equip commanders with accurate prevention information by providing instant access to mishap corrective actions, safety improvements, and risk factors through the worldwide web. It will reduce reporting paperwork at all levels of command, it will assist us all in doing proactive trend analysis, and it will tremendously aid in our risk management efforts.

Some recent studies have shown other directions we should take. An AFSC study gauged that certain mishap-mitigating technologies (AGCAS, TAWS, TCAS, ECIP) should contribute, on their own, to at least a 15% reduction in Class A mishaps. This is an exciting prospect. Another suggests the importance of monitoring 'recency' of flight—that pilots with below average sorties/flight hours have a greater risk of crew error mishaps—and that just getting in the airplane and flying regularly, at least 6-10 times a month, will enhance safety.

Of course, concepts such as these are good, but our main weapons in preventing mishaps are practicing sound risk management principles, knowing and following the regs, checklists and SOPs, and sharing the benefit of our experiences—talking to each other about what has and has not worked. It is for just this purpose that publications like *Flying Safety* and your MAJCOM safety magazines exist. They are tools to 'get the word out,' that word being innovations and success stories, as well as mistakes and what was done to reverse them and prevent their recurrence. Read those publications and learn from them.

Thanks for a rewarding career. Fly safe! ✈

ANTHRAX

IS THE PREVENTION WORSE THAN THE DISEASE?

LT COL JAY C. NEUBAUER, MC, SFS
HQ AFSC/SEFL

(Note: This article is informational only. It is not intended as a commentary on USAF policy concerning anthrax countermeasures.)

In Sverdlovsk, an out-of-the-way metropolis of 1.2 million, 1400 km east of Moscow, something bad happened on April 2, 1979.

Reports of a livestock anthrax outbreak south of the city began to filter out of the USSR in the early '80s. The reports also documented multiple cases of human anthrax from contact with the deceased animals. As the wall fell and the Soviet Union crumbled, more information filtered out suggesting the outbreak was not your standard animal outbreak. In May 1992, after a government-sanctioned investigation, President Boris Yeltsin confirmed, "...the KGB admitted that our military developments were the cause." Pathology reports from the original autopsies identified inhalatory anthrax as the cause of 68 deaths.

Later epidemiological research demonstrated that the majority of the cases were in a narrow four km corridor extending from the microbiology facility to the southern city limits. In addition, animal outbreaks occurred in six villages along the extended axis of the high-risk zone. It is estimated that the total release of anthrax was only somewhere between a few milligrams and a gram of spores! The little slip-up at the microbiology laboratory caused 79 cases of human anthrax, 68 of which were fatal.

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Anthrax has been around since the dawn of recorded history. Biological Warfare (BW) research is only about 80 years old. Current estimates are that at least 17 nations have offensive BW programs. In addition, the terrorist group Aum Shinrikyo has tried at least eight times to attack Tokyo with both anthrax and botulism, fortunately without success.

In 1970, the World Health Organization (WHO) estimated that a 50 kg aerial dispersion over an urban area of five million would produce 250,000 casualties, including 100,000 deaths. More recently, a 1993 U.S. Congressional Office of Technical Assessment report calculated 130,000 to three million deaths following a 100 kg release over Washington D.C. Seems like there are the means, the method and the motivation for a potential holocaust.

The Agent

Anthrax is a bacterium with the ability to produce spores, hardy microorganisms that can easily survive for decades in soil and other inhospitable environments. These spores readily germinate in the right environment (the lungs, the intestines or open wounds) to produce the bacteria again. With the ability to survive extremes of environment, the anthrax spore is easily weaponized.

In nature, anthrax is more commonly a disease of herbivores such as cattle and sheep that forage on the ground where the anthrax spores are most commonly found. In humans, it tends to be an infrequent but highly lethal occupational hazard for wool sorters, goat hair mill workers, goatskin workers and tannery workers.

Anthrax produces three distinct illnesses, depending on the route of exposure. The most common form is cutaneous anthrax, or anthrax infection of the skin. It is usually contracted by contact with infected animal hair, skins or meat. The infection causes localized swelling which leads to a black ulcer that takes several weeks to heal. Twenty percent of infections are fatal if untreated.

Eating improperly cooked (less than 140-160 degrees) infected meat leads to gastrointestinal anthrax or infection of the stomach and intestines. Although rare, the condition

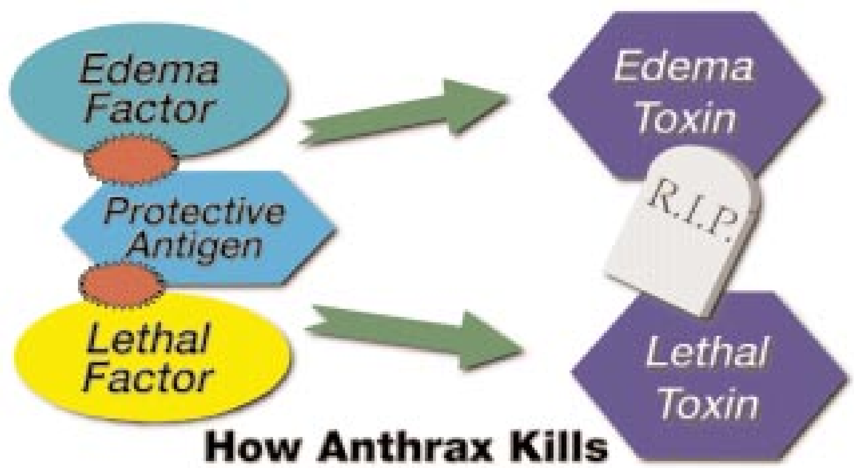

Figure 1

is likely to cause death (50% die even with treatment).

The last type of anthrax and the one of most concern, inhalational anthrax, is contracted through inhalation of spores. This form of the illness is uniformly fatal, up to 99%, even with treatment. Researchers estimate that it only takes 4000 to 10,000 spores (can easily fit on the head of a pin) to produce a fatal infection. In the lungs, the spores germinate into live bacteria in two to 60 days. The bacteria rapidly reproduce and spread. Unfortunately, the illness first manifests with non-specific symptoms of fever, cough, headache, chest pain and abdominal pain typical of the flu. Once the symptoms start, death is usually only two or three days away.

The Toxins

The anthrax bacteria don't cause illness in and of themselves. Instead, they produce three different proteins called protective antigen, edema factor and lethal factor, which by themselves are not harmful. When linked, however, these proteins produce two toxins, edema toxin and a lethal toxin.

The protective antigen is common to both toxins. Protective antigen and edema factor link to form the edema toxin, whereas the protective antigen and the lethal factor must combine to create the lethal toxin (Fig. 1). The proteins, including protective antigen, are common to all lethal strains of anthrax, and therefore the vaccine is effective against them all.

Animal studies (obviously we can't do this in humans) show that the edema toxin causes marked swelling where it is injected. The lethal toxin, of course, causes rapid death. Hang with me now; this will be important when the subject of vaccines comes up next.

The Vaccine

As most are well aware, the current human vaccine is Food and Drug Administration (FDA) approved and has been licensed since 1970. The vaccine has no organisms, only proteins similar to the tetanus and diphtheria vaccines.

The protective component of the anthrax vaccine is the protective antigen mentioned earlier. The components of the vaccine are attached to an aluminum hydroxide compound. The vaccine also contains small amounts of stabilizers and preservatives. The goal is for the body to produce antibodies to the protective antigen. These antibodies would then fix to the protective antigen during an actual anthrax infection and prevent it from binding with edema factor or lethal factor and, presto, no toxins (Fig. 2)! And just in case there was a concern, the vaccine cannot cause an anthrax infection.

The vaccine is a six-shot series (ouch!) given over 18 months, followed by an annual booster. Naturally, it is not without some side effects. Specifically, the Anthrax Vaccine Expert Committee, a civilian medical committee, reviewed data collected on reported reactions to the vaccine and found that as high as 30% of recipients had a mild local reaction with swelling and tenderness (anything less than an inch in size is considered mild). Approximately four percent had a moderate reaction (greater than two inches) and less than one percent manifested a more

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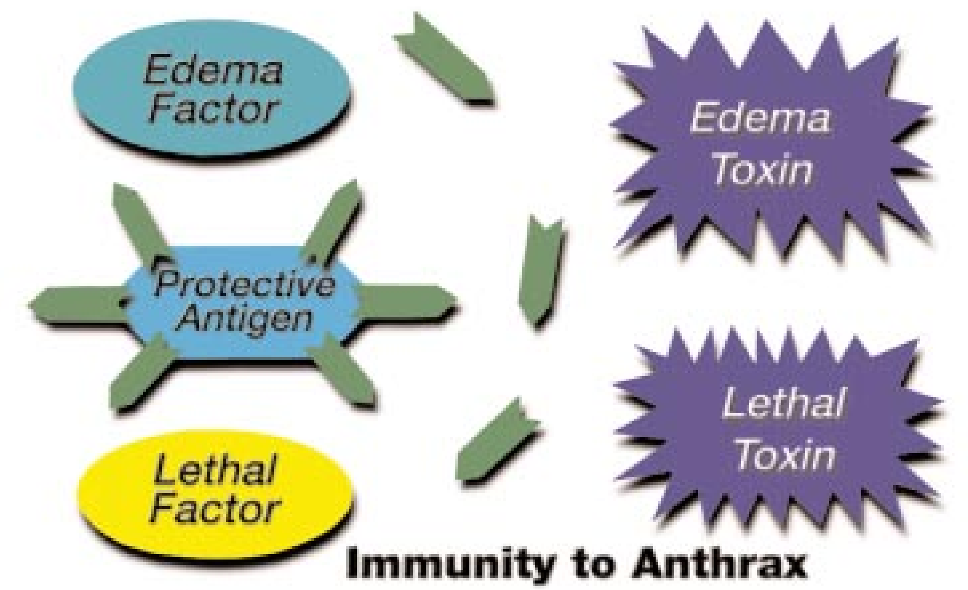


Figure 2

The vaccine is a six-shot series (ouch!) given over 18 months, followed by an annual booster.

severe local reaction. Systemic or body-wide reactions have occurred in well less than one percent, in most studies.

In all the past studies, there were no long-term effects, except for one case in a Canadian Armed Forces study, which was still under investigation at the time of the report. The Department of Defense gave 1,023,460 doses between March 1998 and July 1999. Using the standard FDA/CDC reporting system called the Vaccine Adverse Event Reporting System (VAERS), the military has reported 215 possible adverse events and 22 serious events (0.02% and 0.002%, respectively). More recently (as of Jan 00), VAERS has received a total of 620 reports (0.04% of 1,534,304 doses given) on potential adverse reactions to the anthrax vaccine; 488 resulted in no lost work time, 106 resulted in more than 24 hours away from work, and 26 resulted in hospitalization.

Of the reports that resulted in lost workdays, only 70 of the 106 were determined to be certainly or probably caused by the vaccine, and of the 26 hospitalizations only six were probably due to the vaccine as determined by the independent Anthrax Vaccine Expert Committee. The VAERS is a passive reporting system, which requires physicians and other medical personnel to make the effort to report. Understandably, the passive report system could result in some under-reporting.

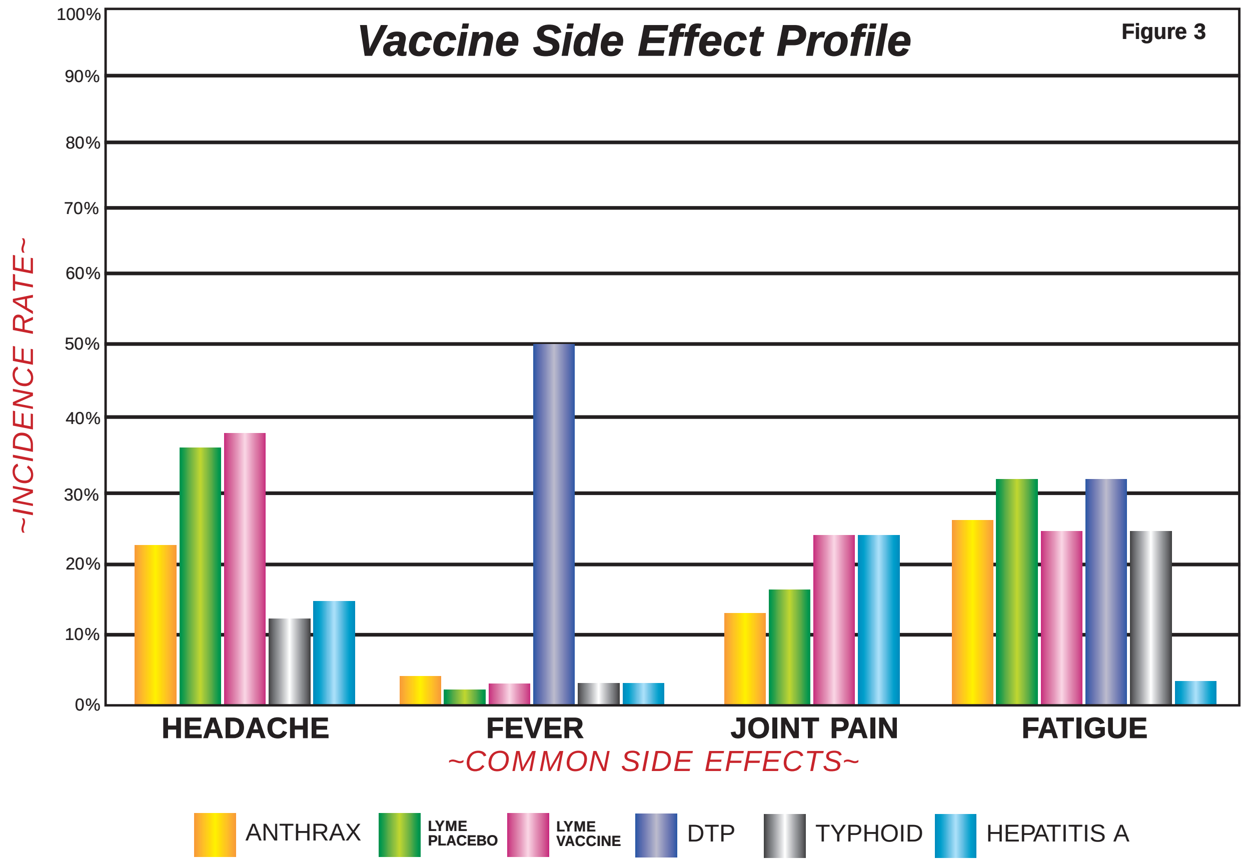
The side effect profile for the anthrax vaccine is very similar to other common vaccines such as tetanus, diphtheria, lyme, typhoid and Hepatitis A (Fig. 3).

Many of the local reactions are thought to be due to the aluminum hydroxide used to carry the proteins in the vaccine. One possible way to limit the reaction is to make sure the technician *shakes the bottle well* before drawing up the vaccine for injection.

Vaccine Efficacy (How Well Does It Work?)

Due to the rarity of the disease, there are very few human studies to evaluate the efficacy of the anthrax vaccine. There are two retrospective looks at the vaccine. One was in goat hair mill workers between 1955 and 1959 where vaccinated workers were compared to non-vaccinated workers. During the five years there was only one case of cutaneous anthrax in the vaccinated workers, as compared to 13 cases of cutaneous and two inhalation cases in non-vaccinated workers. A CDC study looked at anthrax cases between 1962 and 1974. During this period there were 27 cases of anthrax; all but three were in unvaccinated patients. The remaining three were partially vaccinated with only one or two shots.

Animal studies are more abundant. In non-human primates, the vaccine proved to be very protective against aerosolized anthrax. Of a total of 65 monkeys in several



NOTE: Anthrax rates derived from combined experience of TAMC-600 Survey and USAMRIID Reduced Dose Study

studies, 62 survived with only one or two doses of vaccine. All 18 controls died. In rabbit studies, 114 of 117 survived; all of the 88 unvaccinated controls died. The vaccine is by no means perfect, but it comes close. In addition, two or three doses probably confer adequate immunity in most individuals but six doses are given to ensure immunity in all.

Other Options

There are only a few other options for protection against an anthrax attack. First, fine-pore BW masks can be utilized, but, of course, this supposes they are worn at the right time and worn correctly. If indoors, high-tech air filtering systems can work, but limit mobility and certainly won't work for aircrew or soldiers. Finally, there is chemoprophylaxis or use of continuous antibiotics to protect against the infection. Suffice it to say that antibiotics are not without side effects and complications, and must be taken continuously and at the right time. On the other hand, each of these options are useful adjuncts, and their use in combination provides for increased protection over single strategies.

The anthrax vaccine is just one part of the strategy to combat a known BW agent that could potentially produce thousands of casualties before detection. It really is the only strategy that can be planned and executed before there is an obvious known imminent attack. The concept of vaccination to prevent infectious disease is a common proven methodology. We all grew up on it and that's why we don't have friends who died of polio or measles. In fact, these conditions are so rare now that few doctors have ever seen a case. As mentioned earlier, the anthrax vaccine has a similar side effect profile to the vaccines we give to children every day (yup, the same ones you received as a child). More than likely, the anthrax vaccine will produce nothing or a mild local reaction, but it will provide excellent protection against a uniformly fatal infection.

Remember: SHAKE THE BOTTLE! ✈

There are very few human studies to evaluate the efficacy of the anthrax vaccine.

Illustration by David C. Baer II

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Many flight safety officers and commanders have requested a briefing on "the pilot personality." The "Failing Aviator" talks occurred years ago and may ring a bell for those of you who have been around and are taking your ginkgo biloba. Anyway, after yet another rousing presentation to a group of aviators, and based on feedback to continue spreading the gospel, here are some basics you should know about aviator, aircrew and pilot personalities.

Before you go and hang out your shingle and start telling your buds how they really ARE weird, consider this: In order to know what's "abnormal" you need to know what's "normal" and just how much deviation is really "deviant." So, the following are considered "normal" aviator characteristics. If you want references, see the back of this article. As always, researchers lump people together and some folks really resent this. Those of you who feel this way may want to read on anyway, if only to then give us your feedback. Granted, you are each unique human beings who may display all, some, or none of these characteristics. In general, researchers find that aviators DO show a clustering of personality traits. Here they are:

"Normal" Characteristics

• Superior physical health, strength and endurance
• Involvement in athletics, athletic achievement
• Good motor / hand-eye coordination
• Above-average intelligence but not academically oriented (no more school!)
• Cope using rational denial (e.g., "Flying's not dangerous—walking across the street is dangerous")
• High need for mastery ("I'm gonna figure this out!!")
• Generally well adapted, free from mental disorders, and not neurotic (not Ally McBeal-ish)
• Female pilots are more similar to male pilots than non-pilot females
• Matter-of-fact, pragmatic and not introspective
• "Intimate relationships characterized by emotional distance"
• Conventional, conservative relationship with parents
• Supportive mother / successful father
• Close / healthy relationships with male peers
• Compartmentalizers ("I don't take work home with me and vice versa")
• Self-confident
• First-born or first-born male (often of a first-born father)
• High in risk-taking, and novelty / excitement seeking
• Action-oriented
• "Controllers"
• Cope with emotional and life disruptions by seeking constructive solutions
• "Unusually focused and impervious to stress"

Oh, by the way... "Controllers marry controllers" (This might explain a couple of situations at home, eh?)

OK, that's enough. Studies on "pilot personality," after statistical factor analysis wizardry, have grouped aviators into three categories—the right stuff or "competitive individualist," the wrong stuff or "introverted worrier," and the typical pilot or "methodical extrovert." Interesting stuff, don't you think? By now you are probably thinking of some of your peers from UPT and your squadron(s). Anyway, the majority of pilots fall into the "typical" category, some fall into the "right" category (and IPs are disproportionately represented here), and some fall into the "wrong" category.

Some may wonder if these traits are learned or exist naturally. Certainly a discussion of environmental influence is warranted this Friday after your aircrew meeting. As well as "How have people in the 'wrong' category actually performed?" See, you too could be a scientist in this field. But the purpose of this article is to help you recognize what a troubled aviator acts like, to better recognize these traits in yourself / peers / students / etc., and offer some suggestions on appropriate responses.

The Rogue Pilot… shows contempt for rules and those who observe them.

PERSONALITY VARIATIONS

The Rogue Pilot

Well, the first, most obvious, and clearly dangerous category is "The Rogue Pilot." Please read Lt Col Kern's book (*Darker Shades of Blue: The Rogue Pilot*) on this subject for great illustrations and a clear methodology to address it.

Rogue Pilot characteristics:
• Disregards rules, guidance and instructions
• Shows contempt for rules and those who observe them
• Believes he is better than the rest
• Has committed previous minor infractions
• Shows a pattern of misbehaviors / violations

Rogues are especially dangerous because aside from the potential carnage they may ultimately create, "Old rogues beget new rogues." We learn from what others do, right? The rogue is outright dangerous.

The Failing Aviator

This term is known by some within Navy / Marine Corps and Air Force aviation. Capt Frank Dully, a Navy Flight Surgeon and psychiatrist, originally coined this term and spoke to groups on how to recognize this. Some of you may remember Lt Col Joyce Teeters speaking to aviators and spouse groups.

A Failing Aviator doesn't start out that way. Usually, situational stress (life stressors) becomes so overwhelming that "normal" coping methods fail (big list at the beginning of the article). This can happen for a variety of reasons but is equally dangerous.

continued on next page

Failing Aviator characteristics:
• Loss of ability to compartmentalize (bleeding over)
• Increased irritability
• Withdrawal
• Increased contentiousness (arguing / quibbling)
• Poor communication / CRM
• Increase in denial ("I'm fine, I'm fine")
• Sleep loss, sleep problems
• Excessive use of alcohol / tobacco / caffeine
• Auto mishaps / tickets
• Misconduct (sexual, financial, etc.)
• Domestic violence (spouse, significant other, children)
• Flight violations

The Failing Aviator is dangerous because he's using flying to compensate for other problems or deficits.

The Distressed Aviator

The most difficult to assess is what's called the "Distressed Aviator." Many of you have been or are "distressed aviators." This is a much more common occurrence than you might think.
• Do you have a sick child? Spouse? Or a family member with special needs?
• Are you feeling burned out, unappreciated?
• Do you feel like you're being tasked to do more than you have the resources / training to handle?
• Are you involved in some required, distracting process like a Safety Investigation Board?

Sometimes, admittedly, we ponder what "normal" really is. The Ops Tempo / Pers Tempo / Parts / Manning / Mid-level deficit, etc. problems are not new. It's chronic, in fact, and there is a price we pay for that. That doesn't mean you aren't capable of doing your job—you are. That doesn't mean you can't have a successful career—you can do that too! Often, the causes of distress are situational. Therefore they can be resolved with time and creative problem-solving. In general, the distressed aircrew (and controllers, by the way, can fit these categories too) is at higher risk—higher risk to get sick, to overlook an item, to forget something, or to make a mistake.

SO WHAT'S A GOOD CREW DOG OR OPS OFFICER TO DO?

Strategies depend on your personnel mix of people, support (helping / medical) resources, and histories. Here are some ground rules:

The Rogue Pilot needs to be weeded out (read: "FEB") if the behaviors persist. Suggested interventions:
• Increased mandatory supervision with clearly defined goals
• Zero tolerance (punishment) for willful violations
• Communication between IPs and squadron leadership—a must
• Document, document, document

The Rogue Pilot is dangerous because he thinks his skills are superior (wrong—they're usually mediocre), or that the rules apply to others (wrong—duh). The Rogue influences others in the squadron. Some will want to imitate him, some will want to avoid him, and some will want to take him out back for a blanket party. Rogues think they are fine, and that the rules and rulemakers are the problem—those unskilled bores are trying to ruin their fun. The prognosis for the Rogue Pilot is *poor*.

The Failing Aviator is very different. A Failing Aviator needs 1) a "time-out" or temporary removal from the cockpit until healthy coping abilities return, and 2) help. Strategies for helping include:
• Formal or informal (DNIF / DNIC or off the schedule)
• Getting them help (e.g., referral to chaplain and time off to take care of the problem)
• Increased supervision / buddy care
• Consult your flight surgeon regarding other appropriate referrals
• Modify training (FLUG / NVG) timeframe to accommodate other responsibilities

The supervisor must decide the best intervention—not the Failing Aviator. The Failing Aviator has lost the ability to accurately self-assess. Example: Our hero is dedicated to making it through FLUG in four weeks even though he just got back from deployment, his wife is pregnant, another child is sick, he has a cold, his widowed father's been diagnosed with Alzheimer's disease, he's got two months to finish ACSC, he's the POC for the Thunderbird airshow this spring, he's just shown up ten minutes late to brief the 4-ship he's leading, dropped charts and paper all over the place on the way in, and is now chewing out some admin guy for not opening the door sooner. The Failing Aviator is dangerous because he's using flying to compensate for other problems or deficits. The prognosis for the Failing Aviator is *fair*.

The Distressed Aviator is often a precursor to the "Failing Aviator." He / she is much more difficult to pick out because coping mechanisms haven't broken down yet. Remember, the research says you guys are smart and resilient, normally. Personal intervention / prevention, rather than treatment later, CAN make a difference. Some suggestions are:

• Address the stressors even if they're so pervasive that they've become "ops normal"
• Squadron leadership, know your local resources (psychologist, physiologist, chaplain), and involve them in the squadron (not with the individual)
• Use your flight surgeon for advice
• Trust your instincts, but never make a decision using wishful thinking

Supervisors, avoid deciding based on what YOU would do (or did, e.g., "I got divorced and ended up OK")

Intervene based on the aviator's abilities, demonstrated behaviors, Air Force needs and appropriate risk assessment. The Distressed Aviator prognosis is *good*; many outstanding aviators have "been there" and become more insightful aviators as a result. Establish the basics—good discipline cultivates good judgment—and get involved when something doesn't seem right.

In the end, you guys are not psychologists, and no one expects you to be, but you're definitely the front line for catching fellow aviators before they run into problems, both personally and professionally. Picking up on the folks that need a little break (Distressed Aviator) or genuine help (Failing Aviator, Rogue Pilot) often requires a "personal" connection (i.e., friendship). And who's better than squadron mates?

While your primary job is not "assessments," successful aviators actually do size people up and make decisions on a regular basis. We hope this gives you some vectors for your own personal "risk management."

Please give us feedback on the applicability of this article, e.g.,

a. Wrong. No way is this me!
b. Right. Wow.
c. OK, I read it; where's my certificate in psychology?
d. What?! Have you been testing the pharmacy leftovers??

At the Safety Center:

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Maj Davenport, Physiology,
DSN 246-0840
Lt Col Neubauer, Flight Surgeon,
DSN 246-0830
Lt Col D'Amore, Life Support,
DSN 246-0853 ✈

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Intervene based on the aviator's abilities, demonstrated behaviors, Air Force needs and appropriate risk assessment.

USAF Photo by SSgt Andrew N. Dunaway, II

THE "EYES" HAVE IT

USAF Photo by SSgt Andrew N. Dunaway II

LT COL JAY C. NEUBAUER, MC, SFS
HQ AFSC/SEFL

> ***Cues on altitude are largely determined by what the pilot expects to see when looking out the window.***

As most aircrew have heard at least a thousand times, in such forums as IRC and the altitude chamber, the standard-issue crewmember has three methods of establishing orientation to the surroundings.

Although the vestibular (inner ear) and proprioceptive (seat of the pants) systems are important and provide critical information, the eyes, our visual system, ride herd over them. Visual inputs are often the strongest and will override the other two orientation systems in most situations.

Unfortunately, the visual system, like the others, can play tricks and lead to misperception of location, separation, closure, altitude and attitude. This is defined as unrecognized spatial disorientation. Of course, there are certain situations that predispose the pilot to misinterpretation of the visual cues presented. The false perceptions produced are called illusions. Understanding how visual cues are used in flight and the problems associated with misinterpretation can save an aircraft, a life or just a clean pair of shorts.

Size Constancy

A pilot expects familiar things to be the same size in most situations. In fact, cues on altitude are largely determined by what the pilot expects to see when looking out the window. At the home aerodrome, the runway is a certain width which looks "right" at certain known altitudes. It's expected. At an unfamiliar airfield this same expectation can lead to big problems. If the runway is narrower than expected, the pilot will feel high and adjust the approach to get the sight picture "right." This leads to a low approach and a tendency to land short. The opposite occurs with a wider than expected runway. The pilot will feel low and adjust to a higher approach, tending to flare high and land long.

Expectation of size constancy also plays a role in flight over unfamiliar terrain. A pilot may fly in an area where trees are normally 75-100 feet tall. In an unfamiliar area where the trees are shorter or bushes have replaced the trees, the pilot will often fly lower during low-level flight or shoot a low approach, trying to keep the visual reference the same as in familiar territory. In actuality, any terrain feature can create the same illusion (you know, the big rocks / little rocks thing over desert terrain).

Size constancy can also play mind games during approaches where the terrain is sloped to the runway. If terrain is sloping up from the runway, the pilot will feel too low, because objects or features on the ground look too close, leading to a steeper approach.

Shape Constancy

Similar to size constancy, a pilot expects objects (like runways) to be a certain shape at a certain altitude. In unfamiliar surroundings a sloping runway can alter this visual cue, causing changes in approach angle to make things look right. For example, a down-sloping runway will appear shorter than expected, causing the pilot to feel low and adjust to a high approach angle.

Aerial Perspective

Clarity of detail also plays a role in determining distance and perspective. More clearly seen objects or features appear to be closer. For instance, if runway lights are partially obscured by ground fog, rain or mist, they tend to look further away. Imagine doing a night approach to an airfield partially obscured by ground fog or haze. Typically, vertical visibility is better than horizontal visibility, giving the pilot enough cues about altitude and distance. Upon descent into the fog, the peripheral cues are suddenly taken away and the distant runway lights diminish in intensity, giving the illusion that the aircraft is pitching up, generating a desire to counter with nose-down pitch. This may well have been part of the reason for a recent mishap involving a cargo aircraft, on approach to a field partially obscured by ground fog, which impacted almost 3000 feet short of the runway.

Other Focal Cues

Size and shape constancy, as well as aerial perspective, are considered focal cues because they require central, or focused, vision. Other focal cues also provide information about the relationship of objects to one another and to the viewer. An object that appears to be partially obscured or covered by another object is perceived as further away. In addition, light and shadow provide contour details that help with orientation. Flying over still water or featureless sand or snow can be very disorienting, and more than one pilot has flown into the ground or water with no idea about their loss of altitude.

Horizon

Ambient cues are those cues picked up by the ambient (peripheral) vision, often subconsciously. To maintain orientation, the brain will try to pick out a horizon on which to line up. Unfortunately, any straight line will do. So cloudbanks will work, and so will rows of streetlights on an otherwise featureless, dark night. Absence of any discernable horizon leads to potentially huge problems. Starlight can become ground lighting, and starlight reflecting off water can confuse the visual picture to the point where the pilot literally doesn't know which way is up. Common challenges are the so-called "black hole approach," a landing over relatively featureless, dark terrain to a runway with no discernible horizon in the background, or the white-out/brown-out for helicopters.

Relative Motion

Relative motion is another orienting cue picked up by ambient vision. The sense of speed and closure are heavily determined by this cue. Something that moves by quickly seems to be closer than something moving by slowly. With limited additional cues, say at night, something stationary on the windscreen appears to be at a constant distance (until size cues give it away). This becomes critical when flying formation or in pursuit of an adversary. The illusions caused by lack of relative motion have, in part, contributed to several recent midair collisions

Relative motion can also cause vection illusions, the false sense of motion due to misinterpreted motion out of the corner of the eye (ambient vision). This is the old "I feel like I'm moving forward at the stoplight when it's really the guy in the next lane rolling back" thing. Vection illusions are what make formation flying difficult. One can never be sure who is doing the moving. Another less common vection illusion, referred to as the "Star Wars" illusion, results from the motion of ground light reflections off the curved canopy and can create a disconcerting false feeling of motion.

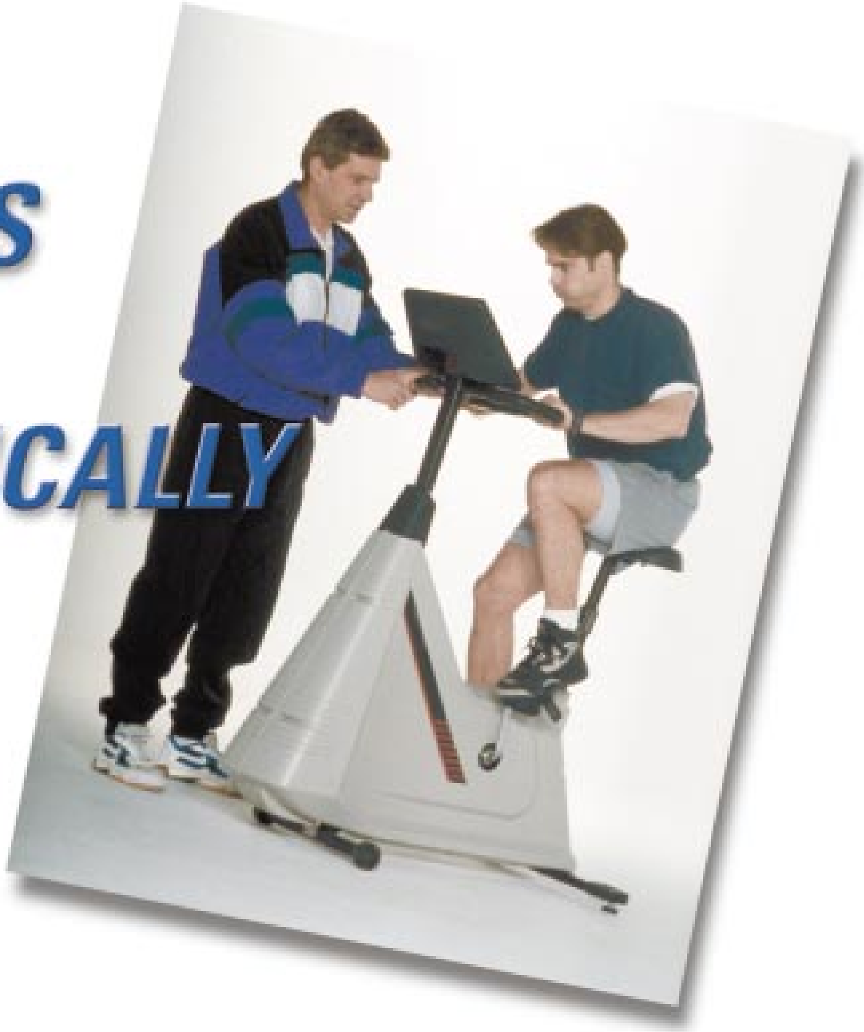
Flying over still water or featureless sand or snow can be very disorienting…

Countermeasures

Visual illusions, or misperception of visual cues, are all a form of spatial disorientation. One obvious countermeasure is education. We need to understand how visual cues provide critical information in the flying environment and when we are susceptible to the various illusions that can provide false information. The other countermeasure is the use of an effective instrument crosscheck and following the mantra "MAKE THE INSTRUMENTS READ RIGHT."

Visual illusions are every bit a form of spatial disorientation and should be treated as such. Yes, the eyes have it, but the brain needs to know what to do with it. ✈

WHO'S PHYSICALLY FIT?



> ***The topic of today's Bicycle Test is a sure-fire way to spark argu-ments.***

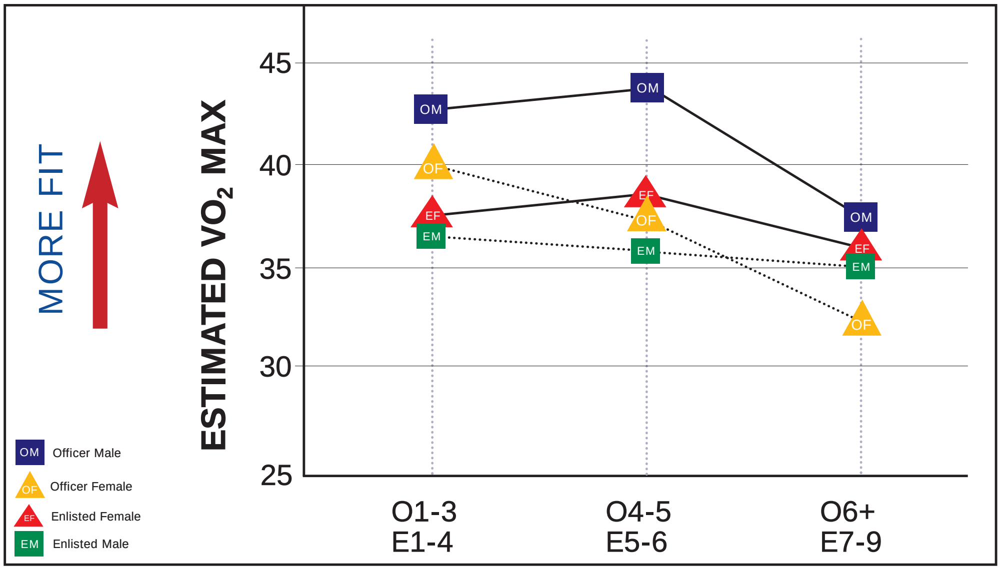
FREDERICK V. MALMSTROM, Ph.D.
USAF Academy CO
Flying Safety, July 1997

Nobody denies physical fitness is good for you. The only discussion is how we should get there. Some years ago, a reporter from the Air Force Times told me few articles generate as many letters to their editor as ones on the Air Force's physical fitness program(s). Alas, the topic of today's Air Force Bicycle Ergometer Fitness Test is a sure-fire way to spark arguments and food fights amongst otherwise genteel Air Force ladies and gentlemen.

The Air Force has been in search of the ideal physical fitness measure. During my career, I could recall the Air Force evolving through many measures, beginning with the (Army) Physical Fitness Test {1957}; (RCAF) 5BX Test {1963}; (Cooper) 1 1/2 Mile Run {1969}; 3-Mile Walk {1984}; and the Bicycle Test {1993}. Which one of these measures is best? Well, the answer is one of those "It depends" things. I do, however, have some facts which I'd like to share with you.

Aerobics Are Scientific

For centuries, athletes have known there were at least two kinds of physical fitness, power versus endurance. However, only in this century did two scientists, A.V. Hill (1922) and Sir Hans Krebs (1953), receive well-deserved Nobel Prizes for their discoveries of the body's anaerobic (power) and aerobic (endurance) energy conversion pathways. Despite the Hollywood ballyhoo



attributed to aerobics, I present these factoids to stress that aerobic fitness is not a fad. It is scientifically respectable.

For the unenlightened, aerobic fitness is measured by the maximum ability of the body to burn oxygen efficiently, expressed in milliliters of oxygen (O_2)/kilogram body weight/minute (i.e., ml/kg/min), aka VO_2 max. VO_2 max can be achieved only by pushing the body's cardiovascular system to its limit over a long period (five minutes or longer) of exercise. Long-distance running is, of course, an excellent aerobic conditioner.

So, in 1969, Maj Kenneth L. Cooper, M.D., then an Air Force physician, published a landmark research paper in the Journal of the American Medical Association on aerobic fitness among Air Force personnel. Following suit, the Air Force declared the Cooper 1 1/2-mile run as THE physical fitness standard; anaerobic fitness was declared optional. Aircrews were to maintain rigidly higher aerobic fitness standards than nonrated personnel. Air Force personnel with a VO_2 max greater than 33.7 ml/kg/min were declared "fit." That is, to pass the test, you had to run at least 1.25 miles in 12 minutes; 1.5 miles in 12 minutes was the average.

There are at least five ways to measure physical fitness, each measure with its own good news and bad news. The most accurate yardstick is a 100 percent theoretically valid concept known as Physical Work Capacity (PWC) which can, unfortunately, be known only by unethically working a person to utter physical exhaustion. The second best measure, VO_2 max (about 90 percent theoretical validity), absolute aerobic capacity, can be estimated only by hooking up subjects to an oxygen-measuring device during prolonged physical exertion. The third best measure, maximal steady state cardiac output (about 85 percent theoretical validity), requires direct measurement of heart rate. The fourth best measure, prolonged, sustained maximal running speed (about 81 percent theoretical validity) is easily measured. The fifth best measure, prolonged submaximal steady state heart rate (about 60 percent theoretical validity) is presently used by the Air Force in the modified Astrand Bicycle Ergometer Test.

There are at least five ways to measure physical fitness, each measure with its own good news and bad news.

What the Air Force is Doing

Why has the Air Force switched to a different type of fitness test? The short answer is that Air Force physical fitness programs are largely individual. Whereas other services typically schedule daily and weekly mass physical fitness training for all personnel, the individual aircrew is usually expected to provide his or her own exercise program, and, therefore, the motivation. *Motivation, or the lack of it, is the key.* If Joe Flyer remains an unmotivated sofa slug all year and suddenly runs a 1 1/2-mile sprint, he has an invitation to a heart attack. So, in 1993, the Air Force adopted the submaximal bicycle test. Definitely less accurate but definitely safer and still a decent test.

I routinely hear complaints from aircrews who say they jog regularly and then flunk their annual bicycle test. Likewise, they tell me of Maj Overweight Smoker who breezes

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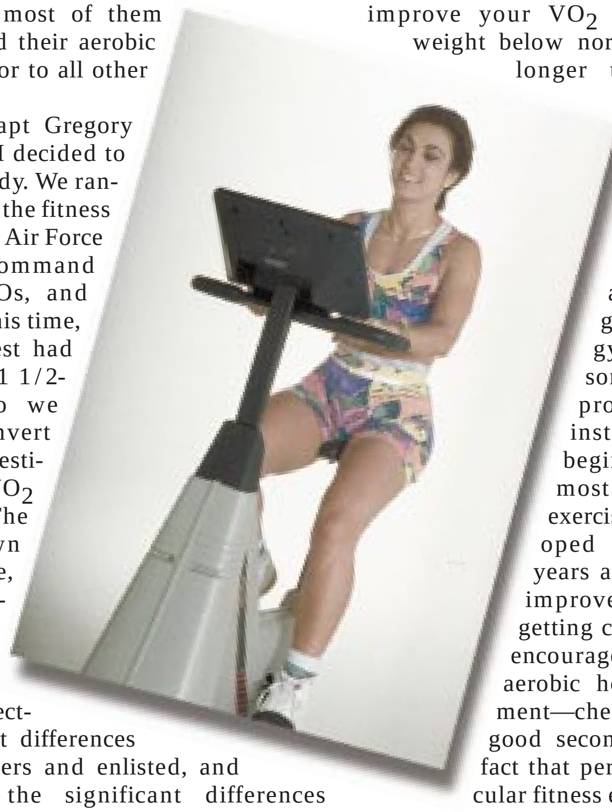
through the bicycle test every year. The answer to their righteous complaint is that no test is perfect. Science is riddled with false alarms and misses. Medics call them false positives and false negatives. Furthermore, if you want to perform well on a running test, practice running. If you want to perform well on a bicycle test, practice bicycling.

There were significant differences between fitness levels of males and females. However, the differences applied only for officers.

In 1991, one of my Air Force graduate students pulled the physical fitness records of 100 randomly selected 18- to 50-year-old Wright-Patterson AFB officers and NCOs, both male and female. We compared their times to complete the 1 1/2-mile run. The results showed officers were more physically fit than NCOs, and males had better aerobic fitness than females. (Because VO$_2$ max is a measure of total body mass, not just lean muscle mass, females always, by definition, pay a penalty in measures of aerobic fitness. Likewise, 18-year-olds normally have a natural aerobic advantage over 50-year-olds.) However, against all expectations, the sample of eighteen 30- to 40-year old officers, most of them rated, showed their aerobic fitness superior to all other groups!



In 1995, Capt Gregory A. Esses and I decided to repeat the study. We randomly pulled the fitness records of 225 Air Force Materiel Command officers, NCOs, and airmen. (By this time, the bicycle test had replaced the 1 1/2-mile run, so we had to convert heart rate to estimated VO$_2$ max.) The results, shown in the figure, were consistent with our 1991 study.

There were, as expected, significant differences between officers and enlisted, and there were the significant differences between fitness levels of males and females. However, the differences applied only for officers. Enlisted males and females scored about the same levels of fitness.

It was truly mind-blowing, however, to consider our male O-4s and O-5s (the majority of them rated) actually consistently score higher on physical fitness than their O-1, O-2 and O-3 contemporaries. It's as if we have a group of 35-year-old men in 25-year-old bodies. It is obvious most field grade aircrew take their physical fitness quite seriously. Here is a group of middle-aged men worthy of further study.

Some Valuable Fitness Tips

Here are some valuable lessons learned from rated majors and lieutenant colonels. I'll give you three guaranteed tips, putting the most important one first.

1. Quit smoking. You will live longer. The average non-smoker lives about seven years longer than the smoker. Rated personnel smoke less than nonrated. My latest statistics also showed fewer than two percent of Air Force Academy cadets now smoke cigarettes.

2. Lose weight. Being overweight puts unnecessary strain on your cardiovascular system. Shed fat and, by definition, you'll improve your VO$_2$ max. Persons with weight below norms live many years longer than persons with weight above norms.

3. Start an aerobic fitness program. Check with your flight surgeon first, and then begin an aerobic fitness program. Any Air Force gymnasium has personnel who will offer professional tips and instruction on how to begin a program. Also, most commercial home exercise equipment developed during the past 15 years are fine, technological improvements, and they're getting cheaper all the time. I encourage anyone to invest in aerobic home exercise equipment—check the classifieds for good second-hand deals. It's a fact that persons with cardiovascular fitness enjoy a higher quality of life and have greater resistance against stress, fatigue and disease.

Follow these tips for a better chance at staying fit! ✈

HACKING IT

USAF Photo by SSgt Jeffrey Allen

LT JOE NOWICKI, USN
VAQ-131

Being members of the EA-6B Prowler community, we have considerable exposure to the USAF "crew rest" mentality, primarily due to the myriad Air Force personnel in our community and because of the expeditionary deployments our squadrons make in support of USAF operations. Counter to the USAF mentality lies the Navy TacAir "hack-it" mentality (e.g., "We can do more with less; crew rest is a luxury that we often can't afford").

As we all know, the Air Force takes crew rest to what some consider an extreme. TransPacs of entire squadrons get slid a day if the boom operator of the KC-10 tanker didn't get his twelve hours of sleep prior to the brief. (As if he's not sleeping between ARs anyway...)

Many of us Naval aviators, myself included, take a subtle pride in our "hacker attitude." Perhaps it's a product of the carrier aviation identity that we take pride in. It may also exist because we don't want to take the ready room ribbing that would come after bagging out of a hop for being tired. Or could it be a subconscious resistance to our brethren in the blue bus driver uniforms, whom we might consider inferior or "weak"?

Nonetheless, Naval aviators become accustomed to long days and short nights during work-up cycles and six-month cruises. Even while shore-based, the demands on crew rest are tested by the occasional push to burn up OPTAR, late-night FCLPs, frequent weekend coast-to-coast "extended training flights," and long duty officer watches.

On one such occasion ashore I found out the hard way that I didn't quite hack it. After standing the day portion of an uneventful SDO watch, the following day's flight schedule, IAW NATOPS, allotted me "at least eight hours of uninterrupted rest." The problem arose with an abnormally busy Friday night as SDO. Multiple incidents requiring my attention were capped off by bailing out a belligerent drunk at 0330. After a full three and a half hours of sleep, I was up again, dragging myself into the ready room for an 0730 functional check flight brief. I thought to myself, "I was only the backseater, so I didn't really need a full night's sleep, right? The eight hours of uninterrupted rest is a should, not a shall, right?" I also had confidence in my ability to hack it, just like many times before. As fate would have it, the two cups of coffee I chugged at the beginning of the brief kept me from napping when we slid the takeoff for three hours for weather. So, I decided to bury myself in mind-numbing paperwork.

Finally, the weather broke and we walked to the jet at around 1200. I hadn't even realized that I had skipped breakfast and never considered lunch or a snack. I quickly preflighted and strapped in for another routine flight, deprived of sleep and malnourished (even by Navy standards).

After starting engines and just prior to taxi, I noticed our most junior airman maintainer beside the aircraft observing his first launch. His seemingly random motions at me didn't resemble any hand signal I recognized. "What on earth is *his* problem?" I thought to myself. Finally, the light bulb, although dim, came on. In my groggy state, I had strapped in *without unpinning the ejection seat*.

I learned two very important lessons from this potentially hazardous incident. First, no matter who you are, you can't always hack as much as you think. Rules on crew rest are there for a reason. We perform a very unforgiving job, and can't afford to be at our worst when we climb into the jet. Second, I'll never again be so quick to discount the input of even the most junior maintainer. That young airman quite possibly saved my tail that day.

Oh, there's one other lesson I learned: Maybe those guys in blue are onto something. ✈

As we all know, the Air Force takes crew rest to what some consider an extreme.

I think to myself, "You'll wake up for the approach and landing."

CAPT TYSON HUMMEL
McGuire AFB NJ

I'm so tired right now I can't stay awake. I'm trying, really trying, but my eyes just seem to be closing on me. Okay, let's run the descent check and get ready for our approach and landing. "Don't worry about it," I think to myself. "You'll wake up for the approach and landing." Sound familiar?

After returning from the Kosovar Conflict, where a lot of us flew day-in and day-out for almost three months, I can remember flights where the above scenario was more fact than fiction. We were always professional and leaning forward to get the mission done, while also making sure we did it safely. We never knowingly compromised safety, especially in my squadron. Safety is simply a huge priority at all times. War or no war, safety is big!

However, at times, the effects of the sleep/wake cycle were almost unbearable for me. Our flights were often over ten hours in duration, with irregular show times and work schedules. Sometimes you would show in the morning and fly all day, landing at night. Other times you'd show late in the evening, fly all night and land in the morning. Just about any combination you could think of happened. Sometimes you would fly three days in a row, and sometimes you would sit for three days. You never had a regular sleep/wake cycle, and just when you got somewhat adjusted to something, you would be put on a flight that disrupted that.

LONG HAUL

USAF Photo by SSgt Andrew N. Dunaway, II

To me, that's fine. It was war and we were all leaning forward. As I said, we did it all safely. Besides, I'm not so sure that we can change how we do business in wartime anyway. The way we worked the schedule, the way everyone thought was fair, was to fly, then move back to the bottom of the list to fly again. When your time came up, you had the opportunity to fly unless you passed. Sometimes crews did pass on a rotation, but it was rare. The bottom line was, we were all fatigued.

I often found myself falling asleep—what I now know were "microsleeps"—during cruise and sometimes even during our descents and approaches. It was a battle, if not impossible, to stay awake at times. Our current regulations in the KC-10 require that both pilots be up front occupying their duty stations at all times, except for short periods to attend to physiological needs. Therefore, we were in our seats for the entire flight, even during non-critical phases of flight.

Our current regulations don't mention sleeping while at your duty station, but I've received different feedback on this philosophy. Some folks believe you should be awake while in the seat. Others feel it's acceptable to sleep in the seat, because current C-5 / C-141 regulations only require one vigilant pilot during non-critical / cruise flight, while the other one can hit the bunk.

(Editor's note: AMC/DOV informs us that the KC-10 and C-5/C-141 regulations are worded identically but interpreted differently because of cultural differences and the locations of crew

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Is there anything we could do...to help with fatigue and sleepiness?


USAF Photo

"A planned cockpit rest period could provide a 'safety valve' for the fatigue and sleepiness experienced in long-haul flying."

bunks. To clarify, C-5/C-141 leaders interpret "physiological needs" to include sleep. KC-10 leaders don't.)

I couldn't help it; I had to catch a nap (if not a couple) to feel awake and alert during other portions of the flight. I almost felt guilty. So it started to make me wonder. Is there anything we could do on an individual or crew level to help with fatigue and sleepiness? The question was lingering in the back of my mind.

Then one day, while at Langley AFB for my altitude chamber recurrency training, I discovered that the aerospace physiology instructor conducting my training, Maj James Carroll, was also interested in fatigue. It was through him that I became familiar with the organization and information below.

Maj Carroll introduced me to the NASA Ames Fatigue Countermeasures Program. After spending some time at their website, I came across a variety of useful information that has reinforced my intuitions about fatigue and what we can all do on our long flights to make us safer. If you'd like to read some of these articles for yourself, go to http://olias.arc.nasa.gov/zteam. The "Publications" link will take you to some very useful and informative papers about long-haul flight operations, as well as many other areas. I received my information from the research subsection.

A study conducted by the NASA Ames Research Center[1] concluded, "operational effectiveness and safety may be compromised because of pilot fatigue. One natural way of responding to sleepiness and fatigue experienced in long-haul operations is unplanned, spontaneous napping and non-sanctioned rest periods." It went on to state, "a planned cockpit rest period could provide a 'safety valve' for the fatigue and sleepiness experienced in long-haul flying. The cockpit rest period would allow a planned opportunity to sleep, with the primary goal being to improve subsequent levels of performance and alertness, especially during critical phases of operation such as descent and landing." How did they come to this conclusion?

The NASA Ames Fatigue

Countermeasures Program conducted the study with two commercial airlines. The crewmembers were flying the B-747, non-augmented (i.e., basic crew), on trans-Pacific flights. The four consecutive middle legs of a 12-day trip were studied, using various scientific and observational methods of collecting the data. Twenty-one pilots volunteered for the study; 12 were assigned to the rest group (RG) and nine were assigned to the no-rest group (NRG).

The 12 RG pilots were given the opportunity to sleep in their seats, one at a time, while the two other crewmembers (i.e., other pilot and flight engineer) stayed awake and continued their normal flight duties. (It should be noted that the 12 RG pilots' sleep opportunities had many safety guidelines built in, one being that the rest was scheduled during a low-workload phase of flight and ended one hour before descent.) The nine NRG pilots were told to continue their normal flight duties and were not given the opportunity for a sanctioned sleep period during the flights.

Several measures were used to evaluate just how well this nap period helped the pilots out. What they learned is amazing!

On average, they found the RG pilots were able to sleep on 93% of the rest opportunities, and it only took them 5.6 minutes to fall asleep with an average sleep period of 26 minutes.

Interestingly enough, four NRG pilots fell asleep (a total of five episodes) although they were instructed to continue their normal flight activities. This is even more alarming considering the NASA researchers were onboard during the study, actively monitoring the crew.

Generally speaking, the NRG pilots showed a steady increase in their reaction times to various tasks and a corresponding decrease in vigilance as the trip progressed; this can be viewed as negative. The RG pilots maintained a fairly consistent level of performance and vigilance, and did not degrade as much as the pilots who didn't have the chance to sleep; this can be viewed as positive.

Now the good stuff: The period from one hour before descent through descent and landing was analyzed for the occurrence of brain and eye movement microevents indicative of reduced physiological alertness; basically we know these as microsleeps. The NASA scientists recorded every event longer than five seconds for both groups. Of the NRG pilots, 78% had at least one event, compared to 50% of the RG pilots. The NRG had a total of 120 microevents, and remember that their entire group only had nine pilots. The RG had 34 microevents, and they had 12 pilots. This supports the conclusion that sleep obtained during the rest period was followed by increased physiological alertness in the RG versus the NRG.

Okay, no big surprise here, right? It makes sense; you get some sleep when it's safe to do so and you're less likely to fall asleep later. In my book, it definitely supports the argument for planned cockpit naps.

Now for the amazing part: The NRG crewmembers had 22 microevents *during descent and landing*. How many microevents did the RG pilots have during descent and landing? None...as in zero! All of their microevents occurred before the descent ever began. They were awake and vigilant when their skills were needed most—during the descent and landing.

It should also be noted that the naps didn't affect layover sleep or cumulative sleep loss. They did not disrupt flight operations, and there were no reported or identified concerns regarding safety.

All in all, a short nap during a non-critical phase of flight increases safety by improving vigilance during more critical phases of flight.

Making us all safer pilots isn't the only intent of this article. It was also to introduce some of the resources at the NASA Ames Fatigue Countermeasures Program website. Whether you are interested in short-haul, long-haul, or helicopter ops, it has useful information to add to your reservoir of knowledge. If you want to know how to get more effective sleep while in the aircraft bunk, that's there also. Want to know why it's easier to travel west than east on long oceanic flights? You got it; that's there too. Take a look and add some good info to make yourself a little more vigilant when you'll need it most. ✈

[1]Rosekind, M.R., et. al., *Crew Factors in Flight Operations IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations* (NASA Technical Memorandum 108839), 1994. Moffett Field, California: NASA Ames Research Center.

(Capt Hummel is a KC-10 aircraft commander with the 2nd Air Refueling Squadron, 305th Air Mobility Wing, McGuire AFB NJ.)

All in all, a short nap during a non-critical phase of flight increases safety by improving vigilance during more critical phases of flight.

USAF Photo by SSgt Andrew N. Dunaway II

MAJ KIRK MAYS
52 FW/SE
Spangdahlem AB

We clearly had become compla-cent...over-confident in our threat awareness.

THERE I WAS: It was my 25th mission into Kosovo as an Airborne Forward Air Controller flying the Warthog. I was the flight lead of a 2-ship with number two in a 1.5-mile wedge position. Our vulnerability time expired and we were flying south out of our area of operations. We were still 20 miles inside Kosovo just south of Pristina at 19,000 feet when I heard "Missile launch" on the radio. I didn't know who called it, or where the missile was coming from, but I immediately performed my defensive maneuvers. I evaded the manpad but only at the very last second.

Our threat awareness on this mission was much different than on the first few missions. We were no longer honoring threats the closer we came to the border. I didn't realize this until we debriefed the mission. My number two informed me he spotted the missile when he was looking through me trying to stay in position. I queried him on his clearing technique and determined he wasn't clearing as thoroughly as we both were on the first few missions of the war. We clearly had become complacent...overconfident in our threat awareness.

In my attempt to determine the root cause, I realized I didn't address complacency correctly during the brief. When I addressed Human Factors, item number 8 (listed below) in the briefing guide, I stated the same old thing I always state, "If you experience any of these factors during flight, speak up or call a 'knock it off'."

8. Hazards associated with Human Factors
a) Channelized attention
b) Task saturation
c) Prioritization
d) Complacency

We all have been there, deciding what pertinent information to brief concerning human factors. It is an extremely nebulous subject. The MAJCOM Standardization and Evaluation branch made this a mandatory briefing item, but how do you correctly brief this topic, and is it important?

Human factors are a major cause in a majority of accidents and mishaps. Historically, 70% of all aircraft accidents are operator error. Between Oct 97 and Sept 99 (FY98-FY99), 43 USAF fighters crashed and 20 were "Ops" mishaps, where the operator's action initiated the mishap sequence. Roughly 80% of the pilots were experienced, and two accidents were G-induced Loss of Consciousness (GLOC). Judgment, physiological or complacency were some of the main reasons behind all of the accidents. These shocking statistics demand respect.

When we examine the accident reports, there are startling similarities between the judgment, physiological and complacency mishaps. All the mishaps occurred during normal, everyday, non-complex missions, and the pilot was very familiar with the maneuvers being flown, yet the pilot exercised poor judgment, or became spatially disoriented or complacent. Why?

Looking at definitions of each reason reveals distinct similarities. According to the "Safety Investigation Workbook 1987," complacency is "a state of reduced conscious attention due to an attitude of overconfidence or under-motivation." This is a result of highly repetitive tasks. The current AFI 91-204 (A4.5.1.3.3) includes complacency in the broader category of "emotional state" under the psychological reasons.

The physiological mishaps were associated with spatial disorientation type I, which AFP 127-1, *Safety Investigations and Reports*, defines as unrecognized incorrect orientation in space. This occurs when, at some point in the flight, the environment changes and goes undetected by the pilot.

Poor judgment, according AFP 127-1, is inappropriate assessment of information vital to decision making.

There is a common thread here. If we become complacent, we fail to adequately crosscheck our aircraft's linear and angular position and motion relative to earth and / or other aircraft. In other words, we have a reduced situational awareness (SA) crosscheck. This is the first important point—*complacency results in a reduced SA crosscheck.* This is natural and will occur during every sortie.

During a mission, a pilot will cycle through various levels of attentiveness. When the task level is high, attentiveness increases. To a point, however, a further increase in tasks may lead to a task saturation state, while a decrease in tasks may lead to a state of complacency. Having described this continuum, let me emphasize that *more accidents can be attributed to attention management than any other factor, and it is the main link between all human factors.* It is the catalyst behind our precarious positioning of aircraft during flight.

As a result, we want to minimize the state of complacency and maximize our attentiveness. Unfortunately, during a one to two hour flight, it is impossible to maintain peak attentiveness and completely eliminate complacency. Since we will experience some degree of complacency during each flight, identifying factors that cause it will enable us to anticipate when complacency will occur.

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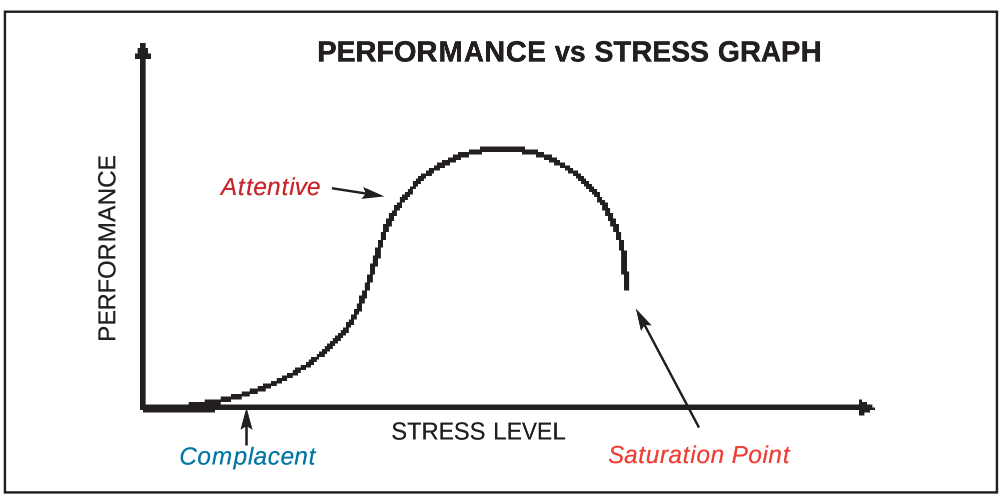
During a one to two hour flight, it is impossible to maintain peak attentive-ness and complete-ly eliminate compla-cency.



Thousands of tasks are processed and prioritized each flight, and failure to properly prioritize critical tasks can be deadly.

A person's attention span will fluctuate during a mission. These fluctuations depend on many factors, the most important being stress. Stress levels increase when pilots are exposed to an unfamiliar flight environment, and decrease when acclimated to a familiar flight environment. As shown in the stress vs. performance graph, our performance level will increase with a rise in stress; however, too much stress leads to a saturation state and too little stress leads to a complacency state.

Unfortunately, low-stress complacency is difficult to detect. It can lull one into a false sense of security, impair judgment, contribute to spatial disorientation and, most importantly, allow a pilot to improperly prioritize tasks. As a result, a pilot will fail to "fly the jet first."

This leads me to the second main point: *A reduced SA crosscheck or complacency leads to an improper prioritization of tasks and inflight duties.*

Thousands of tasks are processed and prioritized each flight, and failure to properly prioritize critical tasks can be deadly. For example, accident statistics over the past two years show operators failed to properly prioritize the following tasks during flight with fatal consequences:

1. Monitor aircraft parameters during low-altitude maneuvering and night threat reactions.
2. Perform proper G-straining maneuver prior to an air-to-air / air-to-ground threat reaction.
3. Maintain positional awareness of other aircraft in your flight.
4. Complete proper rejoin procedures.
5. Monitor takeoff and landing parameters.

Finally we arrive at the most important conclusion: *Pilots have the ability to operate aircraft and prioritize tasks safely, but some pilots fail to do so at critical phases during flight. This is a direct result of complacency.*

For example, one year ago, an F-16 crashed after the pilot lost his SA crosscheck during a first run attack on a controlled range. I believe his familiarity with range procedures and the "pop pattern" resulted in a low-stress state of complacency. During pattern operations, he improperly prioritized the monitoring of his excessive closure on the preceding aircraft. As a result, as he started to egress from the target area he became excessively close to the aircraft in front of him. He performed an evasive maneuver to prevent a midair collision, and a last ditch effort to avoid the ground. He initiated ejection, but the sequence was interrupted by ground impact. This is an extreme example of overconfidence, but hopefully we can learn from this example.

With a better understanding of complacency and other human factors, we can now concentrate on properly briefing this topic. *First, identify situations where complacency can be fatal; second, emphasize attentive SA crosschecks in each situation; and finally, thoroughly discuss situations.*

1) Identify locations of hazardous situations during the sortie. These are areas when the aircraft is close to the ground or close to another flight member. Each mission has about five critical areas. Examples include:

a) Pops
b) Coffin corner
c) Air-to-ground or air-to-air threat reactions
d) Post air-to-air engagement maneuvering
e) G-straining maneuver

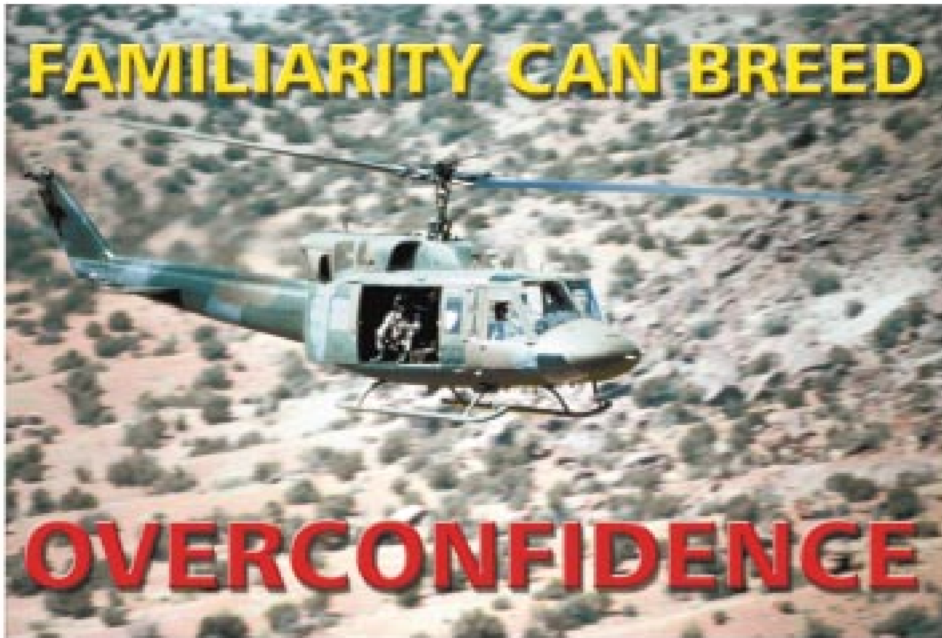
2) Emphasize the pilot's correct prioritization and SA crosscheck during these phases of flight. Here are examples of responses to the above.

a) Ensure all aircraft parameters are correct, in addition to clearance between aircraft.
b) Positive deconfliction between crosswind and downwind aircraft.
c) Never perform a defensive high G maneuver unless you know your aircraft's attitude.
d) Maintain positive aircraft deconfliction until safe separation is ensured.
e) Always think about performing your anti-G straining maneuver prior to pulling the stick.

If unable to maintain SA, a "knock it off" is a must!

3) Thoroughly discuss these situations during the meat of the mission briefing; this will reinforce proper prioritization of tasks and prevent accidents.

The problem and solution are clear... *During critical phases of flight, complacency will kill!* Preventing complacency during critical phases of flight is essential to flight safety. Complacency warrants our utmost respect and must be accurately addressed during each flight briefing. Inadequate knowledge of complacency and improperly briefed human factors will continue to plague pilots unless these important aspects of flight are properly addressed. ✈



USAF Photo by SSgt Andrew N. Dunaway, II

Familiarity Can Breed Overconfidence

Courtesy, Directorate of Flying Safety
Australian Defence Force

Moments before a UH-1 crashed in mountainous terrain, it was being flown about 50 ft above the ground at an indicated airspeed of 60 kts. After flying over basically flat terrain, the pilot of the Huey had initiated a right descending turn into a valley. Surface winds, as reported by the tower, were 150° at 30 kts, which created a right quartering tail wind condition for the aircraft just before the descent into the valley.

When the pilot cleared the leeward side of the valley, he encountered a downdraft condition. He had noticed just before he crested the valley wall that the air was becoming a little bit bumpy and the winds were beginning to pick up, indicators that excessive turbulence and downdraft conditions existed in the vicinity of the southwesterly wall of the valley. With the combination of at least a 30 kt quartering tailwind, a planned descent, entering a downdraft condition, and an initiated right turn, the rate of descent increased so rapidly the pilot was unable to keep the aircraft from crashing.

Having flown in the mountain environment for two years without difficulty, the pilot believed he was fully capable of coping with the environment. But he was unprepared for the effect of turbulent wind conditions when he began his descent into the valley.

Another pilot experienced in mountain flying placed his UH-1 in a position where power required exceeded power available because he incorrectly computed his performance planning card data, computing a higher available torque for out-of-ground-effect (OGE) hover than the engine was capable of producing. As this pilot was making an approach to land downwind along the right side of a steep valley, the low rpm audio sounded and the light came on. Sensing he wasn't going to make the selected landing area, the pilot, at an altitude of about 100 ft, began a left 180° turn with the airspeed below effective translational lift. The helicopter crashed and came to rest at the bottom of the ravine.

Take Nothing for Granted!

Aviators cannot take for granted the capability of their aircraft to perform, even when flying missions that have been routinely accomplished in the past.

If pilots who are trained and experienced in mountain flying can have accidents like these, anyone can.

Where performance planning is concerned, "close" isn't good enough. It must be done carefully and accurately, and it must take into consideration any changes that might be encountered from initial takeoff to final landing. ✈

He was unprepared for the effect of turbulent wind conditions when he began his descent into the valley.

OPS TOPICS PRESENTS...

Brazen Acts of Bodacious Buffoonery

Buf-*foon*'-ery: Clownish behavior

The mishaps related here could have been prevented had the persons involved used common sense, thought things through more carefully before acting, or—dare we say?—applied a little risk management first. Taking one of the aforementioned steps would have precluded the "What was I thinking?" question that inevitably followed their encounter with Class C mishap statistical immortality.

As someone once commented less than gently, "It could be that the purpose of your life is only to serve as a warning to others." Don't let that be your hallmark. Don't be guilty of buffoonery. Think before you act. Use risk management.

Then, There Were Three...Then Two...Uh, Make That One

If you saw the Nov 99 issue of this magazine, then you should be familiar with Major Kurt Saladana's "You Lost An Aircraft How?" article on page 9. While not directly related to the following Search-and-Rescue (SAR) saga, some of the points Major Saladana made about keeping your perspective and "flying the aircraft" find easy application here. From the files of the NTSB...

The mishap helicopter (MH1) was being operated as a VFR on-demand sightseeing flight. Conditions were VMC when the pilot and four passengers departed base in the late morning, bound for a sightseeing trip of an Alaskan ice field.

On the return trip to base, a light snow shower momentarily reduced the mishap pilot's (MP) forward visibility as he was descending gradually over a large, featureless, snow-covered ice field. The MP slowed to 70 kts and tried to use a mountain range on the left side of his aircraft for visual reference, but was unable to distinguish any terrain features due to "flat light conditions." The MP continued to descend and MH1 struck the snow-covered ice field 16 miles from base.

Once MH1 was declared overdue, the company dispatched three helicopters to conduct SAR operations for the missing craft.

Mishap helicopter 2 (MH2) launched in VMC in the early afternoon with a pilot and pilot-rated passenger aboard. After an hour of flight, deteriorating weather conditions forced them to proceed south, over an ice field. The mishap pilot (MP2) slowed to 15 kts and was attempting to use a mountain range on the right side of his aircraft for visual reference, since flat light conditions hampered his ability to see topographical features in the ice field below...when *he* impacted the terrain. MP2 stated later that he was sure his helicopter had been at least 500 ft AGL when it hit the ice field.

Mishap helicopter 3 (MH3) responded to MH2's mayday, located the crash site and picked up an uninjured MP2 and his pilot-rated passenger. The company then asked the mishap pilot (MP3) if he and his (now) three pilot-rated passengers could continue the SAR for MH1, and MP3 replied in the affirmative.

After being airborne for more than two hours, MP3 and his three pilot-rated passengers spotted the wreckage of MH1 two miles in the distance and proceeded directly for it.

Because of flat light conditions and difficulty perceiving depth, MP3 slowed to 30 kts and decided to use a mountain range to his right and the MH1 accident site ahead as reference points for navigation. (Does any of this sound eerily familiar?)

Afterwards, MP3 told investigators that visibility had been six miles with a 1000 ft ceiling and that he had been sure he was at least 500 ft AGL...just before impact.

The good news? All souls from the MH1, MH2, and MH3 crashes were recovered in relatively good condition, with only one serious injury.

The bad news? All three helicopters suffered major damage as a result of their controlled-flight-into-terrain, with varying degrees of fuselage, tail boom and rotor system damage. We also suspect the sightseers from MH1 had a thing or two to tell any friends considering sightseeing tours about the airmanship of this company's pilots. It probably wasn't much more favorable than, "At least they didn't kill us."

If you were the director of flight operations for this company today, can you think of any steps you'd take to prevent this serio-comic series of events from ever happening again? Sure you can! Apply risk management? Check! When in doubt, fly your instruments? Check! Etc., etc., etc.

Oh yeah. One more piece of good news. The third helicopter we mentioned earlier that was participating in the SAR with MH2 and MH3? It evidently made it back to base okay, 'cause we didn't find a mishap report on it.

USAF Photo by SSgt Andrew N. Dunaway, II

And the Odds Are 7-to-1

"RTFI." If these letters sound familiar, then your instructors (or trainers) obviously impressed upon you how important it is to "Read (or Remember) The Formal Instructions." On the other hand, those who are in training can occasionally be excused for forgetting instructions from time to time. Like this eager, young student aviator...

The mission was an Initial Progress Check sortie in a Talon. It had rained the night before, and while mission prep and briefing were normal, rain and thunderstorms in the area posed a threat.

The instructor pilot reviewed the forms while the mishap student pilot (MSP) performed the walk-around.

During the walk-around, the MSP depressed cabin drain valves to release any water that might have accumulated in the cockpit from the rain. After holding one drain valve open for more than a few seconds, water was still flowing out at a pretty constant rate.

Why? Turns out the MSP had been depressing a fuel drain button. That "water" was actually jet fuel. Fortunately, the MSP's gloves, jacket, G-suit, flight suit, parachute and pride were the only casualties.

The T-38 has seven water drains and one fuel drain in the cockpit area. Students are taught which drains do what via classroom and hands-on instruction, and told to not touch any drains aft of the intakes. Like this one. RTFI. Has a nice ring, doesn't it?

No, No, No, Gridley, That's 'Throttles Up,' Not 'Gear Up'

The transition sortie was uneventful and routine throughout activity in a MOA, a practice single-engine approach and several touch-and-goes.

During the final landing attempt, a no-flap touch-and-go was planned. Ahem...*planned*. The aircraft touched down 2000 ft from the approach end on its main landing gear doors and came to a stop 4000 ft later.

The crew egressed the aircraft immediately and after the Fire Department extinguished a small fire, the emergency was terminated.

We're pleased to report that there were no injuries to the aircrew or anyone else. Unfortunately, this gear-up landing did result in more than $400,000 damage to the aircraft.

Bombs Away?!?!?

The mission was a syllabus-directed conventional attack sortie. Following a safe escape on the first pass, the mishap pilot (MP)—contrary to squadron directives—executed a turn to crosswind before putting the Master Arm switch in "Safe." While rolling out of the turn, a single BDU-33 departed the aircraft.

Unaware of the release, the MP continued the mission. It wasn't until after landing, debrief and film review that it was noticed there was no bomb dropped on the sixth (and final) pass. You'd probably be correct in guessing that more than a few eyebrows went up in concern.

It was determined later that the errant BDU-33 missed populated areas. Just as fortunately, even though the bomb did land in dense forest, it didn't start a fire. ✈

Maintenan

Maintenance Matters Presents...

Some Golden Oldies

Long-time followers of Maintenance Matters may recognize some of these “Golden Oldies” from past editions of *Flying Safety*. The messages are timeless and worth recycling...

Vapor Hazards

The preflight was uneventful except for a slight odor of what the tanker crew thought was glue or solvent commonly used to make cosmetic repairs in the cockpit. Takeoff and departure were also uneventful. But as the aircraft climbed to altitude, the odor became increasingly stronger.

About three hours into the mission, the vapors became so strong the cockpit crew began to experience nausea and headaches. The navigator went on 100 percent oxygen, and after about ten minutes, the symptoms began to subside. The crew determined the source of the fumes was a semi-dry liquid on the navigator’s panel and on the back of the copilot’s seat. After landing, the crew was taken to the hospital for observation and toxicological testing. Bioenvironmental engineering specialists determined the liquid to be common hydraulic fluid.

After a review of the aircraft forms, it was determined that the hydraulic fluid was spilled during maintenance several days prior to the mishap flight. Although the specialist thought he did a thorough cleanup, residual fluid remained in the copilot’s seat and behind the navigator’s panel. Those of you that work with with hydraulic fluid every day are probably wondering “What’s the big deal over a little spilled hydraulic fluid?” Here’s why.

With the exception of some fuels and a few exotic solvents, hydrocarbons used on aircraft don’t usually generate much vapor in the maintenance environment. In fact, a vat of solvent or a rag soaked with hydraulic fluid may produce only a faint odor, barely perceptible in the shop environment. But in an aircraft, even the most seemingly innocuous hydrocarbons can produce incapacitating, even life-threatening symptoms. This is basically because a rise in temperature and drop in ambient pressure dramatically increase the evaporation rate of a fluid, generating a high concentration of vapors.

Therefore, while there was only a hint of fumes during preflight, the lowered ambient pressure at altitude, combined with the increase in cockpit temperature, caused the residual fluid to propagate a high concentration of hazardous vapor.

For this reason, it is important for maintainers to understand even a small amount of fluid residue in an aircrew’s environment can cause the crew serious inflight physiological problems.

Plan Ahead

The KC-135 was parked in the hangar for extensive fuel system maintenance. A number of system components were removed, and the appropriate entries were documented in the forms. The assistant crew chief ensured AFTO Forms 1492, “Danger Tags” were attached to the single-point refueling control box, fuel management panel and the circuit breaker panel.

In the process of performing maintenance, it was necessary to apply power to the aircraft. First, the maintenance folks reviewed the forms and found no restrictions for applying external power to the aircraft.

Shortly after power was applied, a massive fuel leak occurred from the forward fuselage area. One technician immediately shut off the power and unplugged the power cart. Another summoned the fire department. At the same time, workers opened the hangar doors and placed containers under the aircraft to capture the leaking fuel. A tow vehicle was attached to the emergency snatch cables, and the aircraft was removed from the hangar. More maintenance personnel arrived with a tug and a tow bar and moved the aircraft to a safe area. Investigation revealed one or more of the fuel valve control switches wasn’t fully in the “Off” position.

This mishap is a perfect example

ce Matters

of how a hazardous situation can develop in spite of a conscientious effort to follow established procedures. In this case, a disaster was prevented only because personnel responded to a previously established plan.

Many of us work in a potentially hazardous environment. We follow established procedures to prevent the potential mishap from becoming an actual mishap. Yet, Murphy is alive and well, and mishaps do happen—usually when we least expect them!

Take some time to look around your work area. Is there potential for a mishap? Have emergency procedures been established to handle the mishap? If the answer to both of these questions is "Yes," you're on the right track. But, for a plan to be effective, people must be aware of it. They must know what they're expected to do should a mishap occur.

Periodic briefings and practice exercises will not only provide people with training. They may also reveal any glitches in the plan. The old Boy Scout motto still holds true: "Be prepared!"

Off The Shelf

Returning from an air combat mission, the Eagle was marshalled into the combat turn area to get loaded and fueled for the next mission. The operation was uneventful until the APG member climbed out of the No. 2 intake with two flashlights. The problem was, he had only one light when he entered. He found the other flashlight jammed against the inlet guide vanes. The light was almost intact, except for the plastic lens, reflector and bulb. Not too bad, considering the light had just flown a 1.1 hour mission.

The flashlight was left on the intake by a crew chief who forgot it after he was distracted by the pilot during the walkaround. Miraculously, the Eagle's engine received only minor damage and required only a few hours of maintenance.

Another crew chief and a Falcon pilot weren't as lucky. During his walkaround, the pilot placed his VTR tape on the lip of the F-16's intake. Because of the noise from a nearby aircraft, the crew chief didn't hear the pilot when he said, "Here's my VTR tape." The pilot "assumed" (a nasty word in aviation safety) the crew chief had installed the tape, and the crew chief "assumed" (see what I mean!) the pilot had installed it.

Shortly after the pilot fired up the motor, the crew chief in the next parking spot saw sparks coming from the mishap F-16's exhaust. He alerted the mishap aircraft's crew chief, who told the pilot to shut down.

How many maintainers and pilots can say they haven't used an aircraft intake as a shelf for a part, tool or a checklist? And yet few of us would argue it's a very foolish thing to do. The cost to fix the F-16 motor—nearly $150,000!

In-Flight Fuel Leak

The F-15 took off on a routine ferry flight with 10,000 pounds of fuel. At 18,000 feet, the pilot noticed an abnormally high fuel flow reading of 25,000 pounds per hour on the No. 1 engine while fuel flow to the right engine seemed to be normal. About thirty miles from the departure base, the fuel quantity read 9,000 pounds. Suspecting a severe fuel leak, the pilot turned the Eagle back to the base and declared an emergency. During the turn, the pilot noticed fuel trailing the aircraft, confirming a major fuel leak.

Suspecting the leak was coming from the No. 1 engine, he retarded the throttle and the fuel flow indication dropped to 12,000 pounds per hour. By the time the aircraft was on final, fuel quantity was down to 6,000 pounds. The pilot made an uneventful landing and shut down the left engine during rollout.

Apparently, the aircraft leaked about 3400 pounds of fuel during the short flight. Cause of the leak was a fuel line elbow which connects the main fuel pump to the No. 1 engine augmentor fuel pump. Furthermore, three 1/4-inch bolts which connect the line to the fuel pump were not reinstalled after the main fuel pump was replaced. A check of the aircraft records revealed the removal and replacement of the fuel pump was never documented and, therefore, a seven-level inspection wasn't performed to ensure proper installation.

Three factors contributed to this mishap:

- Failure to use and follow tech data. If the book had been followed, the bolts would have been properly installed.
- Lack of documentation. Had the maintenance been properly documented in the aircraft forms, a seven-level inspection would have caught the missing bolts.
- Poor supervision. Had the maintenance been properly supervised, the entire mishap could have been prevented. ✈

USAF Class A Mishaps

FY00 Flight Mishaps (Oct 99 - Apr 00)

9 Class A Mishaps
5 Fatalities
6 Aircraft Destroyed

FY99 Flight Mishaps (Oct 98 - Apr 99)

21 Class A Mishaps
7 Fatalities
16 Aircraft Destroyed

3 Oct	♣	**While conducting a SAR mission, a UH-1N went down.**
17 Nov	♣	**Two F-16Cs flying a night vision goggle upgrade sortie collided during a VID intercept. One pilot ejected and was recovered uninjured. The other pilot returned safely to base.**
22 Nov		**An OA-10A departed the departure end of the runway. The pilot ejected successfully.**
6 Dec	✶	**An RQ-4A Global Hawk UAV was extensively damaged while taxiing after landing.**
10 Dec		**A C-130E touched down short of the active runway, then diverted to another airfield and belly-landed. Three personnel were fatally injured.**
15 Dec		**An HH-60G rolled over at an LZ following a hard landing.**
20 Jan	♣	**An A-10 crashed during RTB. The pilot was fatally injured.**
16 Feb	♣	**An F-16CG on a routine training mission experienced an engine malfunction. The pilot ejected.**
16 Feb	♣	**An F-16DG flying a night vision goggle upgrade sortie crashed. Both crewmembers ejected**
28 Feb	✶	**A maintainer sustained fatal injuries after falling from the lower crew entry ladder on a C-5.**
15 Mar		**The KC-10 tow mishap reported here last month has been downgraded to a Class B mishap.**
19 Mar	♣	**An F-16C crashed while performing at an airshow. The pilot was fatally injured.**

- ❏ A Class A mishap is defined as one where there is loss of life, injury resulting in permanent total disability, destruction of an AF aircraft, and/or property damage/loss exceeding $1 million.
- ❏ These Class A mishap descriptions have been sanitized to protect privilege.
- ❏ Unless otherwise stated, all crewmembers successfully ejected/egressed from their aircraft.
- ❏ "♣" denotes a destroyed aircraft.
- ❏ "✶" denotes a Class A mishap that is of the "non-rate producer" variety. Per AFI 91-204 criteria, only those mishaps categorized as "Flight Mishaps" are used in determining overall Flight Mishap Rates. Non-rate producers include the Class A "Flight-Related," "Flight-Unmanned Vehicle," and "Ground" mishaps that are shown here for information purposes.
- ❏ Flight, ground, and weapons safety statistics are updated daily and may be viewed at the following web address by ".gov" and ".mil" users: http://www-afsc.saia.af.mil/AFSC/RDBMS/Flight/stats/index.html
- ❏ Current as of 25 Apr 00. ✈

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FSM notams

COD—CATERER OBJECT DAMAGE

Courtesy ASRS *Callback* #242, Aug 99
NASA's Aviation Safety Reporting System

The Captain of a Boeing 727-200 describes a harrowing incident that has led his company to revise its ramp procedures. The incident underscores the importance of ensuring that contract, as well as company ground personnel, undergo training in ramp safety procedures. In particular, all ground personnel need to understand that flashing aircraft beacons mean extreme caution: Engines are running or engine start is imminent.

Arriving at gate, could not get aircraft to accept external power (APU inoperative). Left the No. 1 engine running while off-loading passengers, while still trying to get aircraft to accept external power (beacon on). Lead Flight Attendant came running up aisle saying to shut down the engine, that somebody had been sucked inside. Shut down engine. Went to back of aircraft and talked to caterer after he had been removed from intake. He said he did not know the engine was running. The No. 1 engine received Foreign Object Damage.

The Captain provided additional details about this incident to ASRS analysts during a callback. The B-727's No. 1 engine had been left on idle power while maintenance attempted to get ground power on the aircraft. The aircraft's upper and lower beacons were on, and flashing, to alert all ramp personnel that one or more engines were operating. The station procedures required that the aft galley be serviced through the left aft exit. The catering truck parked next to this exit. As the catering supervisor approached the aircraft door from the walkway of the elevated catering truck, he was immediately sucked into the turning engine. After he was removed and checked for injuries, he was asked whether he had heard the engine running. He replied "No."

The caterer suffered a number of broken ribs but, amazingly, avoided more serious injury, thanks to quick intervention by the cabin and flight crew. A preventative for this type of event is procedures that prohibit service vehicles from approaching parked aircraft until all aircraft beacons have been turned off. ✈

(We couldn't help but wonder: If the flight crew had advised the airline dispatch center of APU problems and the aircraft power situation, and told dispatch to delay aircraft servicing pending further instructions, would this mishap still have occurred? Ed.)

SURGEON GENERAL'S WARNING: Smokin' Holes can be hazardous to your health. Avoid being attached to your jet when a hole is about to be created.