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FSM notams

THE PARALLAX EFFECT

Courtesy ASRS *Callback* #246, Dec 99
NASA's Aviation Safety Reporting System

The "parallax effect" describes a type of visual illusion in which the position of an object in 3-dimensional space appears to change, due to a shift in the position of the observer. The parallax effect can make distant fixed objects, such as a planet or star, appear to be close and in motion. The twinkling planet Venus is a well-known example in aviation. Tower controllers have often cleared Venus to land, while pilots have mistaken the planet for nearby aircraft position lights.

The parallax effect is especially apt to occur during night operations when there may be few, or no, visible references to the horizon as an aircraft moves through space. Several ASRS reports illustrate, beginning with a First Officer's account of a nighttime evasive maneuver that startled crew and passengers:

I observed what I believed to be an imminent traffic conflict. I manually overrode the autopilot and started an immediate left turn. The perceived conflict was a result of slight parallax of green and red wingtip lights of another aircraft. A bright white star also appeared as one of the running lights on the perceived conflict. The maneuver was a gut reaction on my part, as I perceived the aircraft to be within a few thousand feet from us. Passengers and flight attendants who were not seated with their belts fastened were upended in the cabin. One passenger received an abrasion to a knee and one complained of a neck injury ...After landing ...[no passengers] required medical attention ...The aircraft was inspected for overstress and no discrepancies were found.

A conservative approach, followed by the Flight Officer in this instance, is to avoid the perceived hazard first, and verify the nature of the hazard afterwards. Although this report didn't mention crew fatigue as a factor, fatigue is known to be associated with susceptibility to the parallax illusion. U.S. Air Force research has shown that a few minutes of breathing 100% oxygen will help to refocus pilots' thinking—and eyesight.

NVGs
Don't Fly at Night Without Them

Searchlights required huge amounts of power to operate and, of course, gave away the user's position.

MAJ STEPHEN C. HATLEY
AFRL/HEA
Mesa AZ

Years ago, night vision goggles (NVGs) were used only by a small percentage of the military aviation community. If you mentioned the term "nogs," "NVDs" or goggles, depending upon your audience, you were sure to elicit various responses, from a wincing look of fear to a simple shrug of the shoulders and "Yeah, what about ‘em?" Well, now the "big Air Force" has finally (pardon the expression) seen the light.

What started out in the rotary wing community and a small, elite number of fixed wing units (namely special operations forces) has spread into the mainstream Air Force, to include fighters, transports and most operational MDSs (tactically speaking, of course). Just about everyone who has flown with NVGs will say, "I'd rather fly with them than without them."

Goggles have certainly evolved a long way since the early years. In this article, I hope to dispel some myths, state the facts and give you a broad overall understanding of how we got where we are today. Get ready; if you're not already flying with them, you probably soon will be.

The Early Years

The military has always made an attempt to gain the upper hand in battle, and for this the value of surprise and stealth cannot be overestimated. Historically, most major confrontations were in the daytime, when the ability to see was the greatest. Unable to live with this constraint, warfighters began to seek out ways to operate under the cover of darkness, expanding their effectiveness.

In World War I, searchlights were used to enhance night vision. They were large, cumbersome, unwieldly to transport and set up, required huge amounts of power to operate and, of course, gave away the user's position. To achieve some level of "covertness," searchlights were modified during WW II with infrared (IR) filters, which blocked the visible light and passed only the near- IR wavelengths between roughly 700-1200 nanometers (nm). The users then used a simple image converter to view what they were illuminating. This is generally referred to as "Generation 0" technology. However, this was still not a true covert method, as it still required active illumination. Both friend and foe alike could view the illuminated area if they had an image converter.

HQ AFSC Photo by TSgt Michael Featherston
Photo Illustration by Dan Harman

So, it was back to the drawing board for a truly passive system, one that would allow the user to view the night utilizing only available "light energy." Thus, the image intensifier (I^2) was born. Image intensifiers are totally passive and operate on the principle of light energy (actually electron) amplification. They intensify (amplify) reflected and/or emitted energy and display it for the human eye to view. It is important to note that I^2 devices cannot operate in total darkness, and must have *some* light energy present.

Basically, I^2 tubes work this way: The scene viewed is focused on a photosensitive material, known as a photocathode. The photocathode emits electrons proportional to the amount of light striking it. The electrons emitted from the photocathode are accelerated toward a phosphor screen by an electrical charge. When they strike the screen it fluoresces, creating an image of the scene. The observer then views the image through an eyepiece lens.

First generation (Gen I) tubes made their debut around the mid-1960s during the Vietnam conflict and were used mainly by infantrymen for night observation and reconnaissance missions. Some examples of Gen I technology were the AN/PVS-2, a six-pound starlight scope, and the AN/TVS-4, a 34-pound Night Observation Device. These devices had a resolution of approximately 20/80 Snellen visual acuity (VA). Not very good, although it really was a significant improvement when compared to unaided night vision which, under ideal conditions, only approaches 20/200.

Continuing improvements led to Generation II tubes. These tubes were smaller, lighter and allowed for the mounting of two tubes in a binocular device. Most importantly, Gen II tubes incorporated a "microchannel plate" which greatly increased the number of electrons, producing a much brighter image of the outside scene. The microchannel plate (MCP) is a thin, glass, honeycomb-like structure about the size of a penny, penetrated by approximately 10 million microscopic, hollow tubules (microchannels), all parallel to one another but canted at roughly 8°. The electrons exiting the photocathode enter the microchannels, but can't get through without hitting the wall because of the 8° cant. In doing so, an electron takes one or two more electrons with it off the wall, and so on. All this bouncing back and forth along the walls results in a tremendous multiplication of electrons. Thus, the MCP acts

continued on next page

I^2 devices cannot operate in total darkness, and must have some light energy present.

as an electron multiplier, with each microchannel providing one specific portion (pixel) of the image.

The most common fielded unit using Gen II tubes was the AN/PVS-5, which had a 40° circular field of view (FOV) and an improved visual resolution o 20/55 VA. Although not originally intended for aviation use, the PVS-5 was modified with a helmet-compatible facemask so it could be used during flight. This goggle weighed in at approximately 1.9 pounds and was mounted to the Army rotary wing helmet, the SPH-4, using Velcro straps and quick release side straps. It quickly became obvious that the aviator needed to be able to see under and around the aided 40° FOV to see such things as the flight instruments. Another faceplate modification quickly came about, known as the "cut-a-way," which allowed the aviator to look under and to the sides. This goggle was the mainstay for the U.S. Army until the mid-to-late 1980s.

Present Day

Although operational testing began as early as 1982, it wasn't until around 1989 that Generation III I^2 tubes came on the scene in full force. These tubes were incorporated into the AN/AVS-6, Aviator's Night Vision Imaging System (ANVIS). Not only was there a significant leap in technology worthy of classification to the next generation, but this system was the first designed specifically for aviation use. These goggles operated over the spectral range of approximately 625-950 nm as a result of a minus blue filter (a dielectric coating) incorporated on the objective lens assembly. This filter blocked energy shorter than 625 nm (Class A), allowing cockpit instruments and displays to be illuminated for unaided vision yet remain "invisible" to the goggle. The FOV of these goggles was still approximately 40°, but the resolution was improved to roughly 20/45, and they had added "creature comforts" (i.e., inter-pupillary distance [IPD], tilt, and fore and aft adjustments). The AVS-6 was procured in large numbers by all the services, and it was the most common NVG used by aviators. There are large numbers of these models still being utilized in the field. Compared to the older PVS-5s, the AVS-6s were a dramatic improvement. Depending upon the vintage of the actual I^2 tube in the goggle, VA ranged to something as good as 20/35 and gain to around 2000-3000.

The AVS-6 was procured in large numbers by all the services, and it was the most common NVG used by aviators.

Technological advancements continued to churn out better I^2 tubes for users in various goggle models. In the early 1990s, the F4949, or AN/AVS-9, came on the scene. There were several improvements made over the AVS-6s. The tubes themselves were better, although still classified as Gen III. The most notable physical differences were that the F4949s had a much "smoother" objective focus mechanism and a larger eyepiece lens. The older AVS-6 incorporated an 18 mm eyepiece lens whereas the newer F4949s (and AVS-6s) had a 25 mm eyepiece. What did this do for the user? It still had the same 40° FOV, but this was now achieved with greater eye relief (distance from the eyeball to the lens while still achieving full FOV). This enabled the user to have a better "look under and around" capability, because the eyepiece didn't need to be so close to the eye, giving greater eye relief. For those folks sporting the standard issue flyer's spectacles, this eliminated the annoyance of the lens bumping their glasses while attempting to get the full FOV.

Inside, the I^2 tubes were dramatically improved, yielding superior performance at lower ambient illumination levels. VA with the latest tubes fielded for this particular model approached 20/25 with a system gain on the order of 6000. Production methods continued to improve and turned out better and better tubes yielding higher performance with respect to photocathode sensitivity, signal-to-noise ratio and reliability.

With the introduction of color displays and MFDs in the cockpit, a different class of filter was also introduced with the F4949 models, the "Class B" and "Class B Leaky Green." A "Class B" filter was incorporated which blocked more of the energy from reaching the goggle—namely wavelengths shorter than 665 nm—thus allowing some reddish-orange in the cockpit for color displays. However, only the Navy and Marine Corps procured the pure Class B filter. Both the "Class A" and the "Class B" filters blocked energy needed to see the HUD, so yet another filter came on the

HQ AFSC Photo by TSgt Michael Featherston

scene, the "Class B Leaky Green" or "Class C." It basically incorporates a notch filter, which allows through to the goggle just enough of the energy needed to see the HUD (around 545 nm). The Air Force began procuring the "Class C" filter in the F4949G goggle. The model F4949 is now the most common NVG in the inventory and the mainstay for aviators. Depending upon your unit, aircraft or procurement method, you may find any of the following models of F4949s: F4949C, F4949D, F4949F, F4949G, F4949H, F4949L, F4949P, F4949R or F4949Ultra. As you can imagine, there are *some* differences among them and one particular model may or may not work for you in your specific MDS.

What's Next?

Despite the best overall performance seen yet, the aviation community still wasn't content (what a hard group to please). *"What we really want is…well, where shall we start? How about the same, if not better performance than we currently have, but at low ambient illumination conditions? Say, 20/20 VA at starlight? And, as long as you're at the drawing board, how about cutting down the halos and blooming effects due to high light conditions, without ruining my image? This would be the ideal solution for urban environments where I still need the goggle, but I don't want to lose image quality because of bright lights."* Frantically working on this concept, the manufacturers are working on the next iteration, unfilmed (filmless) technology. Without getting too deep into the techno-babble, unfilmed tubes have essentially eliminated one of the production processes (the ion barrier film), which was necessary in the current production Gen III tubes. Elimination of this "thin veil" allows for more efficient photoelectron multiplication than that found in filmed Gen III tubes. The result: an extremely high quality image that's nearly noise-free (less scintillation), even in extremely dark conditions.

In addition, the power supplies recently developed for use with the filmless

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The Panoramic Night Vision Goggle (PNVG) will increase the FOV from the current circular 40° to roughly 40° x 100°.

tubes incorporate auto-gating, or pulsing, whereby the tube voltage is rapidly pulsed on and off to prevent saturation of the MCP under high light levels. The power supply automatically varies the pulse width (duty cycle) depending upon how much current is passing through the MCP. At low light levels, the duty cycle approaches 100%, while at higher light levels it is shortened, almost shutting down for a few microseconds to allow the flux of electrons to exit the MCP before applying power once again.

Tired of looking at the night through a soda straw? The Panoramic Night Vision Goggle (PNVG) will increase the FOV from the current circular 40° to roughly 40° x 100°. The currently-fielded ANVISs all utilize two independent tubes in a binocular assembly. However, each image has a fixed number of pixels (picture elements). If the pixels are spread out over a larger FOV, the result is a loss in resolution. I don't want to trade off resolution at the expense of a larger FOV. PNVG has approached this limitation in a different way, featuring four 16 mm I^2 tubes, rather than the currently-fielded 18 mm pair. The weight with four 16 mm tubes is about the same as with two 18 mm tubes. The central portion of the FOV (30° horizontal x 40° vertical) remains binocular, while the 35° FOV outboard images (left and right) are visible only to the left and right eyes, respectively. There are dual fixed focus eyepieces, each joined with a thin demarcation line separating the binocular central image from the monocular peripheral image.

The final variants of this goggle have yet to be finalized, but one version will be similar to the ANVIS as far as mounting on the helmet. The other version under development will have an entirely different attachment for use in ejection seat-equipped aircraft. Develop-mental efforts are also underway for a 640 x 480 active matrix electroluminescent display (AMEL) for symbology overlay. Stay tuned for the latest developments.

Simulation

I would be remiss in my duty if I didn't tout some of the latest and greatest developments we are working on here at the Lab, so here's a pitch for the "Home Team." Flight simulators are getting better and better by the day; unfortunately, most simulation addresses just that, *day*. Want a night scene in your sim? That's easy enough. Decrease the light levels in the screens until it's totally dark. What more do you want? How about the ability to use your NVGs in a flight simulator? Sure, we already have that capability in some sims. However, they are all based on the old "stimulation" approach. That is, you must drive the visual displays bright enough to stimulate a scene in the actual goggle itself. By doing so, the outside scene (i.e., looking under and/or around the goggle, unaided) is so bright you don't actually need the goggles to see at all. There probably is a very fine line bordering on negative training for some folks out there learning to fly with goggles for the first time utilizing this type of simulation.

A different approach altogether, one we here at AFRL/HEA have tackled, is a true "simulation" approach. That is, instead of driving the sim to such bright levels for a response in the goggles, we have replicated a much more realistic goggle scene in a helmet mounted display (HMD) using a geo-specific, physics-based database. As the operator, you still don your helmet with the standard mount. But instead of bringing your actual NVGs to the sim, you snap on our HMD, which is in the same shell as your F4949—with some minor changes, of course. We removed the objective lens assembly, literally dumped out the I^2 tubes and replaced them with miniature cathode ray tubes (CRTs). The form, fit and function is very nearly the same as the real thing, even the CG and weight. With a headtracker, the system knows where the pilot is looking and provides the appropriate image. This approach also can be used to provide the correct eyepoint for every crewmember. We needed a database that would completely correlate the visual scene with multiple sensor simulations, to allow NVG, FLIR and radar imagery to be matched to the out-the-window scene. Unfortunately, there weren't a lot of these databases available, so we had to build one. It's as close to the real thing that I've seen yet. And it's coming: An initial system has already been delivered to the Marine Corps AV-8 Harrier training center in Yuma, AZ and considerable interest has been expressed by other aviation communities as well.

With a headtracker, the system knows where the pilot is looking and provides the appropriate image.

HQ AFSC Photo by TSgt Michael Featherston

NVG Training

Despite all the technological advances in night-fighting capabilities—aircraft modernization, sensors, tactics and experience—it still all boils down to where the rubber meets the ramp, so to speak. Like anything else, it usually comes down to a training issue. That is: How much is enough? What's it going to cost? What do we have to give up in order to get it? And, probably most importantly, who's going to do it? All of these issues have recently surfaced as the number of units embracing NVG operations has grown.

It's not that NVG flying is hard; far from it. It enhances mission capability and usually adds a comfort factor for the aircrew, as they can now see at night.

The biggest problem we see is that folks consistently "out-fly their eyeballs." As we all know, vision is our dominant sense. With NVGs, we now have the ability to maintain this dominance at night and may end up relying too heavily on them, at the expense of other sensory inputs. Aircrews tend to believe they see better than they really do. The world looks different, especially at low illumination, and goggles are subject to some significant limitations and illusions. Do yourself and the folks you're training a favor: Point these out, and be aware of them. Even if future goggles give us 20/20 resolution, the image color, contrast and texture aren't apt to be the same as that experienced with normal day vision.

There is still a little stigma out there, especially among some of the older folks who have never flown with goggles. All they remember are the older goggles, things glowing green in front of their face and quite "user-hostile." With effective training and a thorough understanding of the limitations associated with NVG operations, I think you'll agree, we're better off with them than without them. Fly Safe.

(Major Hatley was Chief, Night Vision Training Integration for the Night Vision Program in the Human Effectiveness Directorate (HEA) at the AFRL division in Mesa AZ from June 1997 to June 2001. He has flown HH-3E, UH-1N and MH-53J helicopters.)

The world looks different, especially at low illumination, and goggles are subject to some significant limitations and illusions.

USAF ACES II Ejections and You, the Aircrew

LT COL GEORGE D'AMORE, MSME
LT COL (DR) TOM LUNA, MD, MPH
HQ AFSC/SEFL

Today, the ejection seat is standard equipment in most fighter, attack, bomber and trainer aircraft.

HQ AFSC Photo by TSgt Michael Featherston

Here's a revelation for you: Ejection systems were incorporated into USAF aircraft to save the life of you, the crewmember, especially when operating in a combat environment. A 1972 Safety Center Preliminary Report on Southeast Asia escape, evasion and recovery experiences between 1963 and 1971 provides proof (as if any were needed?) that lack of time to prepare for ejection and high-speed ejections lead to more injuries. About 44 percent of combat ejections were at high speeds, with both the number and severity of injuries higher than peacetime ejections, where the speeds at time of ejection were normally lower and injuries mostly in the minor category. At issue was high-speed ejections and what changes were needed in seat design and life support equipment to further improve crewmember survival, particularly in the combat environment. Injuries had to be minimized to give the crewmember the best chance for successful evasion and recovery. During the Vietnam War, crewmembers who ejected over unfriendly territory and suffered injuries were quite often captured.

The US Air Force continues to expand its capabilities with better-equipped, faster and higher-flying aircraft. The USAF mission often puts aircrews in situations that push the envelope of survival, but great effort has been—and continues to be—exerted to reduce the chance of injuries to you and increase your odds of survival while performing the mission. Today, the ejection seat is standard equipment in most fighter, attack, bomber and trainer aircraft, and it's one of the primary means for improving aircrew survival.

The Advanced Concept Ejection Seat II (ACES II) ejection seat isn't the only system used today, but it is the primary escape system used in Air Force aircraft. Effectiveness of the ACES II seat is noteworthy and crewmembers continue, with confidence and without hesitation, to use the system in time of need.

Methods

A Safety Investigation Board (SIB), which is convened at the time of a Class A flight mishap, thoroughly researches the event. Except under unusual circumstances, the SIB is required to provide a complete report of the mishap to the MAJCOM commander within 30 days. Every mishap is researched, analyzed, studied and reported with recommendations for corrective actions to prevent similar situations from resulting in mishaps in the future. SIB-collected mishap data for all USAF Class A mishaps is stored for future reference and analytical studies in a data file library located at the AF Safety Center (AFSC), Kirtland AFB, NM.

The mishap data from August 1978 to September 2000 was queried from the AF Safety Center Life Sciences and Flight Database for Class A mishaps involving aircraft with the ACES II ejection system. *(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. Ed.)* That data was used to describe ejection attempts by aircraft type. Fatal ejection attempts were defined as those where crewmembers were fatally injured after: (1) They ejected out of the envelope of the seat; or (2) An ejection malfunction occurred. The database was also queried for the total lifetime, non-combat, fatality rates for each aircraft and whether an ejection did, or did not, take place. The data for the A-10 and F-15 aircraft include the early ESCAPAC (Escape Pack) ejection system, which was used in 6 and 14 ejections, respectively. Injury data was tabulated from the first 288 ACES II mishaps involving ejections between FY78 and FY95. (See Figure 7.) Finally, all Class A mishaps, from FY96 through FY99, were comprehensively analyzed for aircrew ejection attempt errors.

Results

During an ejection, the limits of performance of humans and their equipment can be approached; those failures are closely studied. The overall ACES II ejection survival rate from Aug 1978 to Sep 2000 was 92 percent (see Table 1).

ACES II Ejection Rates
08 August 1978 - 30 September 2000

Aircraft	Survived		Fatal	
	Number	Rate	Number	Rate
A-10	37	84%	07	16%
F-15	57	91%	05	9%
F-16	222	93%	16	7%
B-1B	15	94%	01	6%
F-117	02	100%	00	0%
Total	333	92%	29	8%

Table 1

During an ejection, the limits of performance of humans and their equipment can be approached.

During this period, a total of 362 ejections occurred in five different types of ACES II seat-equipped aircraft. Accompanying figures depict A-10 Thunderbolt II, F-15 Eagle and F-16 Fighting Falcon lifetime ejection history totals, as well as fatalities where ejections were, and were not, attempted. Success rates are different for each aircraft, primarily because of the different mission profiles flown in those aircraft. Aircraft with specific mission profiles that have them flying faster and closer to the ground will likely have more mishaps.

The A-10 has had 50 total lifetime ejections with a survival rate of 82 percent (41 crewmembers). The ESCAPAC system, an ACES II predecessor, was used in six of the total ejection attempts. Of 46 fatalities occurring in the A-10, there

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USAF A-10 Ejections
Lifetime - 30 September 2000
50 Total Ejections (44 ACES II, 6 ESCOPAC)

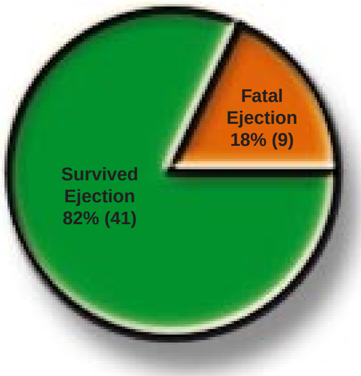

Figure 1

USAF A-10 Fatalities
Lifetime - 30 September 2000
46 Total A-10 Fatalities

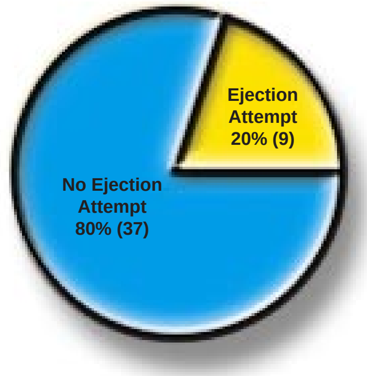

Figure 2

The F-16 has had 238 lifetime ejections in the USAF. The ejection survival rate is 93.2 percent.

were 9 ejection attempts and 37 "no attempts." See Figures 1 and 2.

The F-15 has had 76 lifetime peacetime ejections, of which 14 were with the ESCAPAC system. A total of 66 crewmembers (86.8 percent) successfully ejected. The F-15 community has experienced a total of 42 fatalities, with 32 crewmembers (76 percent) perishing with no ejection attempt. See Figures 3 and 4.

The F-16 has always used the ACES II system and has had 238 lifetime ejections in the USAF. The ejection survival rate is 93.2 percent (222 crewmembers). A total of 71 crewmembers were fatally injured in the history of USAF F-16 peacetime operations, of which 55 crewmembers (77 percent) made no attempt to eject and perished. See Figures 5 and 6.

Figure 7 quantifies the various degrees of injury resulting from the 288 peacetime ACES II ejections that occurred from FY78 through FY95. Approximately 67 percent (193 crewmembers) received either no injury or only minor injuries. About 18 percent (53 crewmembers) received moderate injuries but remained mobile. "Mobile" simply means that, in the context of a combat environment, the crewmember would be able to move and evade capture, at least to a limited extent. Approximately 15 percent (42 crewmembers) received major injuries (those

USAF F-15 Ejections
Lifetime - 30 September 2000
76 Total Ejections (62 ACES II, 14 ESCOPAC)

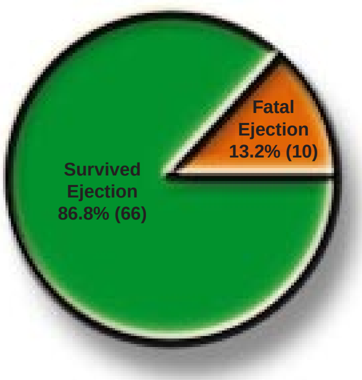

Figure 3

USAF F-15 Fatalities
Lifetime - 30 September 2000
42 Total F-15 Fatalities

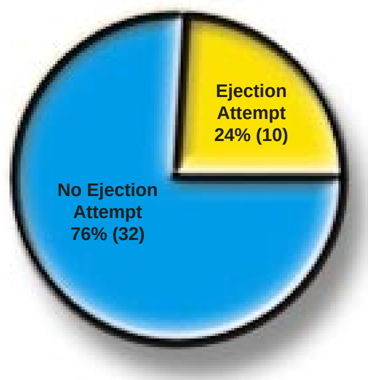

Figure 4

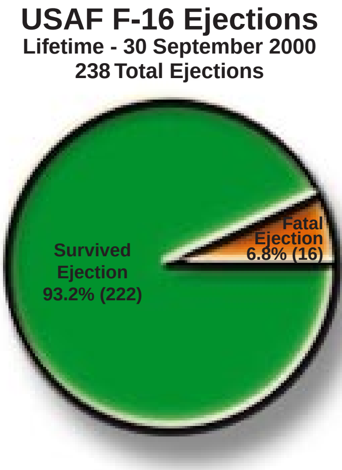

Figure 5

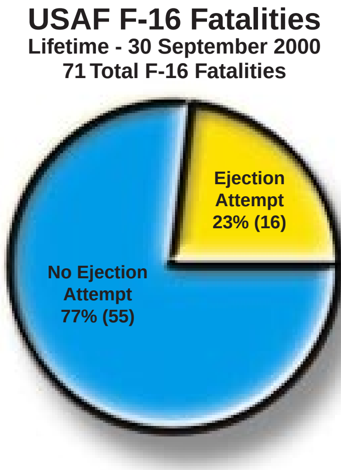

Figure 6

which were life-threatening, or loss of eyesight or a limb), were immobilized (incapable of moving from one place to another) or suffered fatal injuries.

We also took a "snapshot" of ejection errors aircrews made over a discrete period of time, FY96 through FY99. The results were telling. See Table 2. Approximately 38 percent of the aircrews didn't wear proper clothing for the mission and environment (not wearing cold weather-issue gear during a winter sortie, wearing flammable clothing, etc.). Twenty-six percent weren't prepared for the ejection (didn't attain proper body position for ejection, didn't secure loose items which could cause injury due to ejection windblast, etc.). And when the ejection decision was made, 25 percent ejected below 2000 feet, the minimum published altitude for a safe, controlled ACES II ejection altitude. Fourteen percent lost their flight helmets (helmet was secured improperly). Once aircrew members were descending to the ground under a parachute, 19 percent didn't deploy the four-line release, nine percent didn't deploy the seat kit and 15 percent didn't execute a proper PLF (parachute landing fall). Finally, take note of this one: Approximately eight percent of aircrew members forgot how to use a piece of life support equipment that was introduced in flight training.

Your ability to properly use *your* life support equipment plays a huge part in the degree of ejection success. Ejection-related injuries most often result from not following ejection procedures or improperly using life support equipment. Wearing the parachute harness improperly, not securing loose-fitting equipment to survive the windblast that accompanies all ejections, not detaching a night vision device from the helmet or not deploying the parachute four-line control to minimize parachute landing injuries all have an impact on whether you do—or don't—suffer an injury during ejection.

Discussion

Aircrew members train for all possible scenarios, and emergency procedures are an integral part of that training.

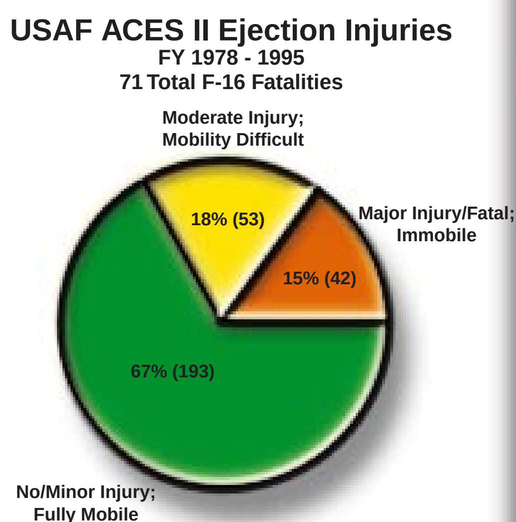

Figure 7

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Approximately 8% of aircrew members forgot how to use a piece of life support equipment that was introduced in flight training.

Aircrew Ejection Errors FY 1996 - 1999		
Number	Rate	Error
29	38%	Not wear proper clothing
20	26%	Not prepare for ejection
19	25%	Ejected below safe altitude
11	14%	Lost helmets
22	19%	Not perform 4-line release
07	9%	Not deploy seat kit
15	19%	Not perform proper PLF
06	8%	Not know piece of equipment

Total is > 100% because some crew-members commited more than a single error.

Table 2

The data reflects that check-lists aren't completed and impor-tant items aren't done.

When an emergency situation occurs, if you react as you've been trained, the result should be reduced injuries. Interestingly enough however, the data shows errors committed by aircrew are typically similar from year to year. It is not presumptuous to expect these errors to lead to injuries.

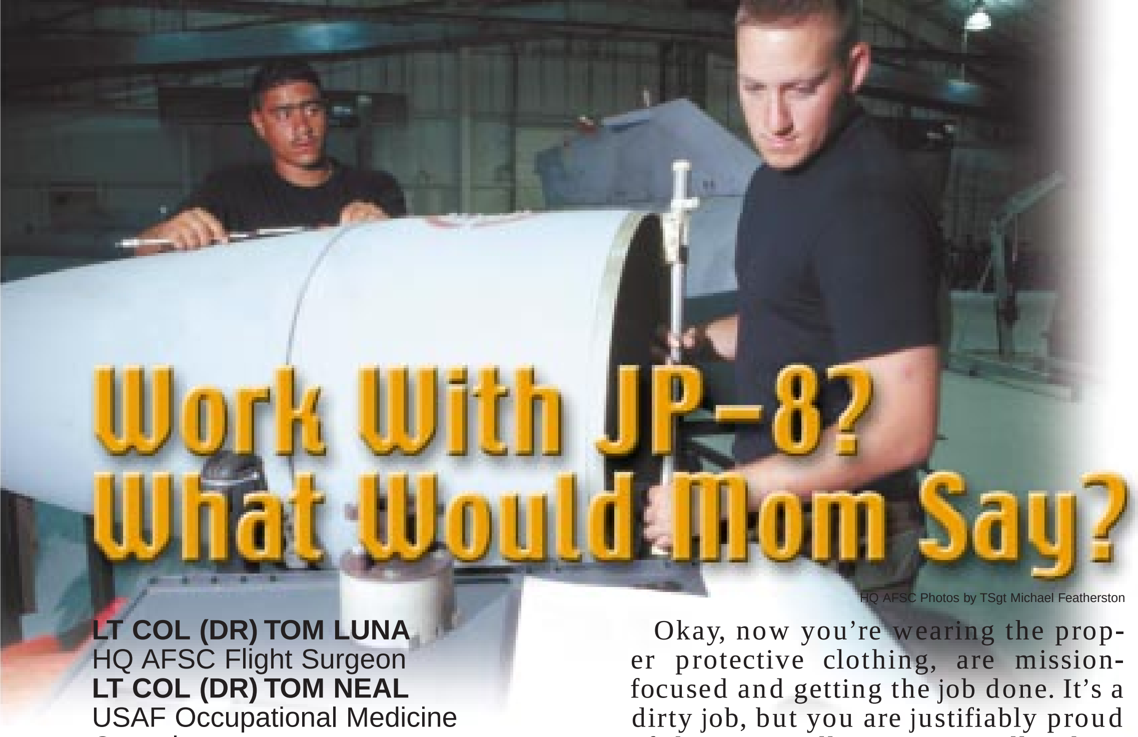
One common error is not fully preparing for ejection. Crewmembers generally try to complete the pre-ejection checklist but, invariably, the data reflects that checklists *aren't* completed and important items—storing loose equipment, tightening personal equipment, and the like—aren't done. Initial windblast can easily lead to serious injuries of the arms and legs (due to flailing), as well as head and face (as when the oxygen mask isn't attached). Leg and arm restraints weren't incorporated into the ACES II system for the A-10, F-15 and F-16, so it does pose a flail problem in those airframes. But both the B-1 and the F-22 Raptor have arm and leg restraints.

Once the actual ejection phase is complete and you are safely hanging in the chute, you still have to prepare for the parachute landing. Again, data indicates crewmembers don't always complete the preparation-for-landing checklist. Forgetting to deploy the four-line release is especially significant. Omitting this step means you won't be able to adjust for wind and control the parachute descent into a safe area. Based on an unofficial records review in 1989, for mishaps occurring from FY76 to FY89, the AF Safety Center calculated the injury rate was about 21 percent *higher* for aircrew members who didn't deploy the parachute four-line release. Also, some aircrew members have omitted releasing the extra survival baggage that accompanies them in the seat kit. This extra weight, if not released, can cause severe back injuries. Consequently, it's not uncommon for injuries to occur upon landing when the PLF is less than ideal due to preparation omissions.

Conclusion

The USAF's ACES II ejection seat has repeatedly proven itself to be very effective in over 20 years of operational use. Still, the Air Force isn't resting on its laurels. It is constantly improving life support equipment to endure the harsh environment of the mission so it will perform as advertised 100 percent of the time and minimize injury to you, the aircrew. Injuries are quite costly, particularly in a combat environment where evasion is a priority.

Want to significantly improve the odds you'll return uninjured from your next mission? Know when it's time to get out. Wear your gear securely and properly. Follow the pre-ejection and parachute landing checklists. Understand and practice what you've been trained. You do your part and the ACES II will do its part. Fly Safe!



Work With JP-8? What Would Mom Say?

HQ AFSC Photos by TSgt Michael Featherston

LT COL (DR) TOM LUNA
HQ AFSC Flight Surgeon
LT COL (DR) TOM NEAL
USAF Occupational Medicine Consultant

So you work with JP-8? Do you ever get soaked and dirty from it? If you do, what do you do about it? What would Mom say?

The USAF switched from JP-4 to JP-8 several years ago, in large part because JP-8 is safer for people who work with it. It has a lot less of the potent, nasty chemicals like benzene and n-hexane which can make people very ill. Although JP-8 is safer, you wouldn't want to take a bath in it; it still carries the hazards of all hydrocarbon fuels. If you wear clothing soiled with fuel you are essentially bathing in it. What would Mom say?

Fuels like JP-8 are easily absorbed into and through your skin. Routine exposure can cause drying, cracking and irritation of your skin, so it's important to limit its contact with your skin. How do you do that? Actually, it's all basic, common sense personal hygiene.

Imagine your Mom goes to work with you. You notice that the cotton coveralls you planned to wear are soiled from a previous exposure to fuel. Do you put them on? Are you crazy? What would Mom say? So, you find a clean pair to wear, air dry the soiled coveralls and put them with the other soiled coveralls to be appropriately laundered. Mom would definitely approve!

Okay, now you're wearing the proper protective clothing, are mission-focused and getting the job done. It's a dirty job, but you are justifiably proud of doing it well. Your coveralls, clean when you began, are now wet with jet fuel. They've been in contact with your skin. What do you do? You strip off your clothing, shower with soap and water to remove all traces of the fuel, and change into clean clothing. Once again, you air dry the soiled coveralls then ensure they are appropriately laundered. Mom would be proud.

As always, if you have a severe exposure and get weak, dizzy, confused or vomit, go to the doctor immediately.

Supervisors and commanders play an important role in ensuring the safety of personnel working with fuels. In the context of the potential hazard of contact with fuels, supervisors and commanders need to ensure that shower facilities are easily accessible to personnel, appropriate laundry procedures/contracts are in place, and adequate stocks of clean coveralls are kept readily available. They also need to play "Mom" and ensure that all personnel follow appropriate personal hygiene in relation to fuels.

JP-8 is a big step forward for the safety of those who work with fuels. But, it's not water either, so be careful! If you follow the personal hygiene practices your Mom taught you by wearing clean clothes, replacing soiled clothing, minimizing contact and showering appropriately, you will accomplish the mission safely and minimize the hazard to your good health. ➤

Routine exposure can cause drying, cracking and irritation of your skin, so it's important to limit its contact with your skin.

Technology Replaces Weather Counters

SMSGT SALINDA LARABEE
AF/XOWP

Aircrews transiting Air Force bases and Army posts may have noticed a recent change—the significant expansion of weather technology. You no longer have to stand in line at a traditional weather station counter to receive your weather briefing.

Each Air Force base or Army post has a transient aircrew work area located near the weather station, usually in the post/base operations area or flight planning room. Each work area has a computer terminal capable of electronically filing a flight weather briefing request with the appropriate Operational Weather Squadron (OWS). The latest in Web technology, Program Generation Scheduler/Server (PGS/S), facilitates the transaction. The information is transmitted directly to the briefing cell at the OWS. The completed briefing is returned, either via the computer or a designated fax machine.

In the Continental US, there are four OWSs which are staffed and organized to provide 24-hour transient aircrew support. The map shows the geographic responsibility of each respective OWS and lists the appropriate contact information. Overseas OWSs are located at Sembach AB, Germany, Yokota AB, Japan, Elmendorf AFB, Alaska, and Hickam AFB, Hawaii. The local weather flight or OWS can help you contact the appropriate overseas OWS for your destination. In addition, OWS contact information can be located in the Flight Information Handbook and FLIP.

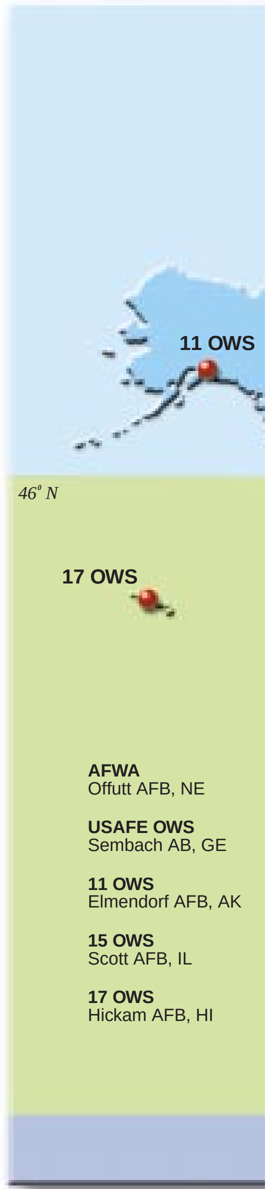
OWSs usually need two hours notification to schedule and prepare a weather briefing, but if an aircrew has an emergency or a high priority request, the OWS can process the briefing ahead of others. Requests should be submitted as soon as possible to speed services for everyone. Ideally, file your request the evening prior to the next morning's takeoff, and your briefing will be ready when you start your day. Some OWSs are already logging nearly 3000 weather briefs per month, with most requests filled during peak flying hours.

While waiting on your briefing request to process, you should access other products posted on the OWS Web page. You'll find the current radar composites, satellite imagery, severe weather information, flight hazard graphics, etc. One unique feature all OWS Web sites have is the ability to link to other OWSs directly. If your flight will be crossing OWS boundaries, you can access the region-specific products with just a few simple clicks of the mouse.

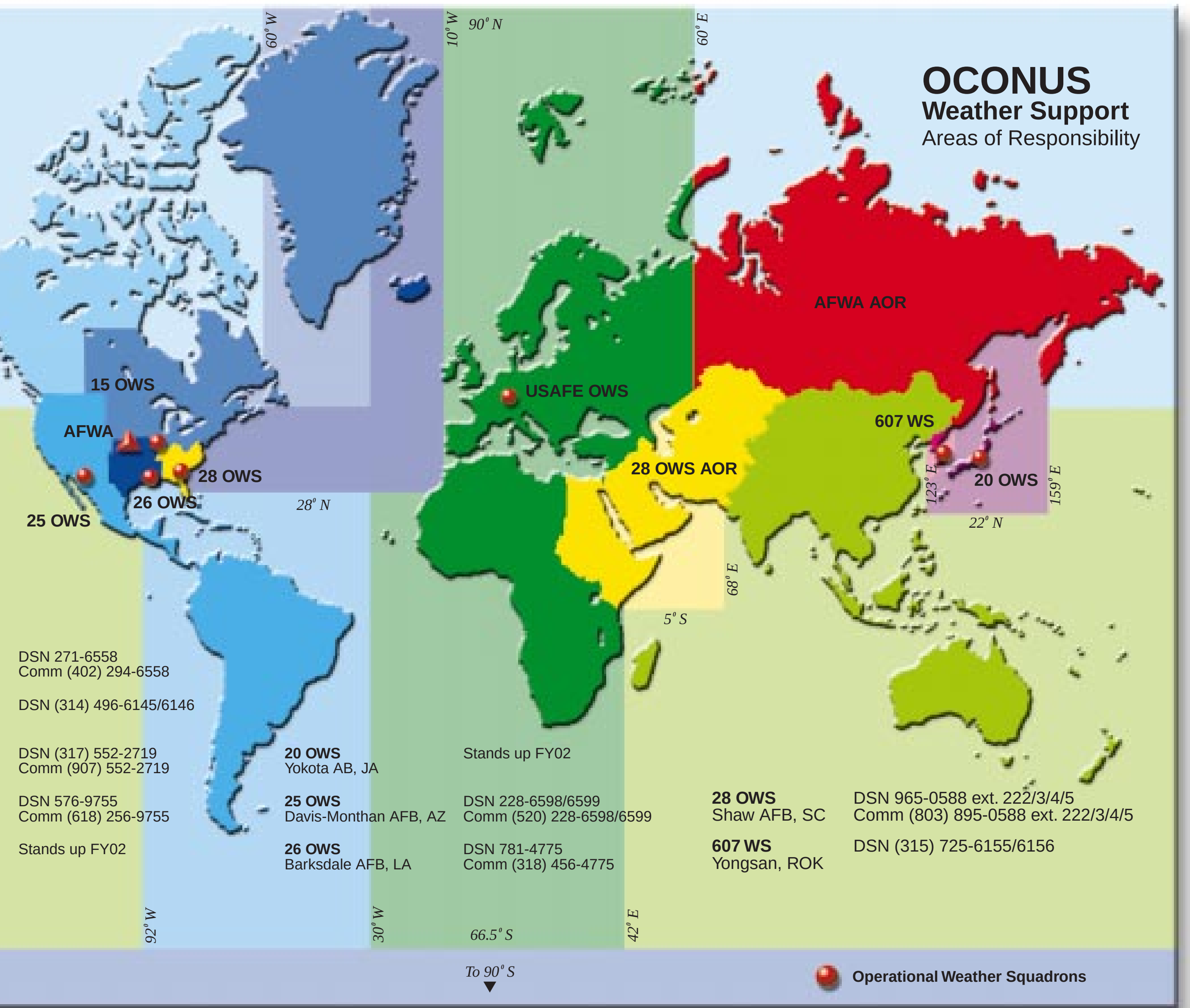
Technology has not replaced the weather forecaster, however. You can still hear a human voice, and you always should. OWS forecasters can answer any questions you have, clarify information, elaborate on expected weather conditions and provide the official "brief time" and "initials" for the DD 175-1, Flight Weather Briefing.

The process is as simple as can be. The primary difference is the appearance of the weather counter—in virtual reality instead of wood or cement.

(You may e-mail questions to AF/ XOWP at AFXOWP@pentagon.af.mil)



CONUS
Weather Support
Areas of Responsibility



Why?

The Definition of Cause in Air Force Mishap Investigations

COL ROBERT RENEAU
HQ AFSC/SEF

There was no end to cause. Everywhere I looked, I found cause.

A recent tour as the Branch Chief for Final Evaluations at the Air Force Safety Center tested my sanity when I accepted responsibility for issuing Memoran-dums of Final Evaluation (MOFE). The problem came about when I was introduced to the mishap investigation concept of "Cause" or, in layman terms, the answer to "why" a mishap occurred.

In writing mishap reports you produce findings that explain *what* happened and also findings as to *why* it happened. When you get into the questions of "why," you're beginning to earn your money. First you begin with the "Findings," which provide significant conditions and events of the mishap. Next you must determine if these findings are causal.

When I began writing MOFEs it became apparent almost everything could be considered causal. Where does cause begin and where does it end? There seemed to be no right answer. Everybody had a different opinion on cause, and thus I began my quest for the true determination of "Cause." Many months later, the seemingly vague concept of cause began to take shape in my brain. This article focuses on the causes of mishaps, and here I will assume *what* happened is easily identifiable but the quest for *why* is elusive.

Once I answered the *why* question (cause), I was able to perform my most important task: issue corrective actions.

My venture took me first to the dictionary. "Cause" was defined as "The agent or force producing an effect; a person, occasion, condition, etc., giving rise to a result or action." This was a start, but by no means did it provide the complete answer. Nor did it sound like the definition provided in AFI 91-204, *Safety Investigations and Reports*, which states, "A cause is a deficiency the correction, elimination, or avoidance of which would likely have prevented or mitigated the mishap damage or significant injury." The more MOFEs I wrote, the more causes I found. There was no end to cause. Everywhere I looked, I found cause.

When faced with my frustration to understand the concept of cause, a wise man gave me the answer: "There is no beginning and there is no ending to cause. Cause is subjective, and one can only use the concept of 'reasonable person' to stop searching for cause." The reasonable person concept is based on logic and is applied to findings to determine if an action / event is causal. It is totally subjective, dependent on a person's judgment, experience and common sense, and it entails no scientific formula. It comes down to a judgment call which you have to make. Were a person's actions reasonable? Was the performance of the part reasonable? If the answer to these questions is "yes," cause is not assigned. If the actions / performance were unrea-

USAF Photo

sonable, then we have found the "potential for cause." I say "potential for cause" because you need to dig deeper until you find the "root cause."

A root cause explains why an action/event occurred and includes a correctable issue. In order to get to the root cause, many investigators rely on a tried and tested "Five Whys Deep" approach in analyzing mishaps. For example, could one assign cause in the following scenario?

An engine fails 10 minutes into the mission. The pilot explains he heard a loud bang, experienced a loss of thrust, and shut down the engine.

In your analysis, you find the pilot's actions were correct and not a factor. You look into maintenance records and find them in perfect order. So far everything seems reasonable. A teardown of the engine finds a bearing that failed and caused the engine to shell. Why? You go back to the depot and find out that it appears the bearing was installed incorrectly. Why? The technician placed it in backwards. Why? The bearing design allowed for a directional specific bearing to be installed backwards. Why? The part design did not take into consideration the possibility that anyone would do this. Why? As you can see, you can chase cause beyond the point of usefulness.

Using the concept of "reasonable person," and supporting my analysis of each of the "why" questions above, I stopped the chase at the bearing design since, at this point, I can recommend a corrective action to eliminate this problem in the future. When arriving at this decision, I must support it with a thorough explanation as to why I stopped at "design" as causal. Conversely, you must also be prepared to explain why all findings after this are not causal. Why didn't I find the technician causal? Let's say the design of the bearing did not make it obvious that it required specific fitting. Now the finding would read, "Cause. Manufacturer designed bearing that made it possible for technicians to install it incorrectly."

When determining cause, it is imperative that you provide a concise explanation. Without a complete explanation, your report will suffer the scrutiny of many experienced people. In your report, explain why your findings were causal and explain why the other findings were not. A thorough explanation will do wonders for others trying to understand why a *person* could be causal when it was the *part* on the aircraft that malfunctioned.

Also, realize cause is not synonymous with fault. Safety investigation objectives are to identify issues that cause mishaps and prevent them. All safety investigation causal findings are protected by privileged status and cannot be used in a court of law. An Accident Investigation Board also determines causes, but they do so independently, and these causes are *not* protected by privilege status and can be used to take appropriate action against individuals found causal.

In summary, determining cause is not always easy. Answering the final "why" question requires extensive analysis and determination. One must go beyond the obvious and delve deep into the less apparent. Once you get into the question(s) of "why," you have to decide where to stop; using the reasonable person concept provides an important limiter.

I hope I've helped to answer some questions. I also hope I've brought up questions which will encourage you to look closer at the subject of "Cause." There are many mishap investigators here at the Air Force Safety Center who can help you in writing your reports. Please feel to contact any of us in aviation safety at HQ AFSC/SEFF, http://safety.kirtland.af.mil.

A root cause explains why an action/event occurred and includes a correctable issue.

SSgt Lance E. Davis
Tower, Local Controller,
14th Operations Support Squadron,
Columbus AFB, Mississippi

While working local control during routine wing flying operations, SSgt Davis noticed the solo pilot of Gundog 62, a T-38, initiating a non-standard go-around. SSgt Davis quickly identified the problem and directed the solo pilot back to the base using suggested headings. After determining that the solo pilot was at emergency fuel status, SSgt Davis declared an emergency and expeditiously recovered the solo pilot. His alertness and calm control instructions prevented a potentially hazardous situation. SSgt Davis' attention to detail avoided a potentially hazardous situation for a student pilot and prevented the loss of a $1.75 million trainer aircraft.

Privilege:
The Cornerstone of Flight Safety

CAPT CHRISTOPHER J. WILL
366 AEW/SEF

You, the hottest pilot since Steve Canyon, screwed up. Royally.

This was no ordinary mistake. In typical fighter-pilot fashion, you've managed to make the world stop and take a look at the mess you've made. So there you sit, in your hospital bed, leg in a sling, still smarting from that "feet-knees-face" PLF you performed to cap what was an otherwise perfect nylon let-down. You can still count the hours since your gazillion-dollar jet left a smoking hole in some rancher's favorite patch of land, and that pesky news helicopter caught you on camera making an "inappropriate gesture" in its general direction. It's been a bad day.

As you sip your dinner through a straw, visions of horror run through your mind: court-martial, lawsuits, and worst of all (sound of fingernails on a chalkboard), the sobering prospect of being on the "wrong end" of a Flight Evaluation Board (FEB).

Who do you trust? What do you do?

Hopefully, none of us will come close to living out this pilot's nightmare. Yet the fact remains that each of us as military aircrew run pretty close to the ragged edge of mayhem on a daily basis. It's important that we know our options if we're involved in a mishap investigation, regardless of whether we're asking the questions or giving the answers. As a player in a Safety Investigation Board (SIB) (covered in AFI 91-204, *Safety Investigations and Reports.* Ed.), you have an invaluable tool at your disposal in determining the cause of a mishap—the safety privilege.

In just a few short minutes you should have a better idea of how the safety privilege works within the context of a SIB, how it protects you from potential criminal liability down the road and, perhaps more importantly, how to protect information from becoming "unprivileged" after the SIB has closed shop.

What is the "Safety Privilege?"

The safety privilege is not defined by any law on the books. In fact, it's the result of a string of court cases that began in 1963, which recognize that aviation safety is a matter of national security, and that the disclosure of protected information can hamper the military's ability to accomplish the mission.

Simply put, the goal of any safety investigation is to determine two things:

continued on next page

The disclosure of protected information can hamper the military's ability to accomplish the mission.

Why the mishap occurred; and *How* we can prevent the mishap from happening again. Obviously, the only way to determine the cause is to uncover what really happened in the "chain of events" that led to the mishap. The resulting wreckage from an aircraft mishap doesn't always tell us why a mishap occurred, even if the "black box" (which, of course, the government has painted orange) has survived the impact. In these cases, statements from the aircrew, maintenance personnel and any other witnesses may become extremely important in finding the true cause.

But there's a fundamental problem with witness statements. You never know who's "holding the football." As an investigator, it's impossible to tell who's got the "nugget 'o truth" that may lead you to discover the mishap cause. To complicate matters, if someone thinks he (or she) may get in serious trouble for the part he played in the accident, he may be less likely to spill all the beans to the investigator.

If a witness is promised confidentiality, he can be assured that his statement to the SIB will not be used against him.

The safety privilege is partly the product of the military's attempt to remove this dilemma for the witness. If a witness is promised confidentiality, he can be assured that his statement to the SIB will not be used against him. In fact, the Air Force *expressly forbids* the use of privileged information contained in a safety report for disciplinary purposes or adverse administrative actions, or to assess financial liability.

What's more, the privilege is more than just a promise. There are serious consequences for anyone who knowingly releases privileged information to those without the "need to know." In essence, the safety privilege is premised upon the notion that, if a witness is sure he won't get in trouble for his statement, he's more likely to tell the truth.

Privilege extends to more than just witnesses or manufacturers who are promised confidentiality. It is a legal privilege and rule of evidence, which extends to all SIB deliberations, conclusions and recommendations. Air Force regulations allow release of the information on a strict "need to know" basis. The military can resist attempts by outside parties to gain access to privileged information in many ways, from denying Freedom of Information Act (FOIA) requests, to going to court to protect it.

As great as the safety privilege sounds, there are certain things it doesn't protect. Generally, anything "factual"may be considered fair game for release. For example, the information in flight data recordings, CVR tapes and ATC tapes is all considered factual, and is not protected. Likewise, medical records, toxicology reports and autopsy results are also considered factual, but any conclusion made by the SIB as a result of these medical reports is privileged. The SIB will release these records to any follow-on investigations. However, the Air Force reviews all records before they are released to the public, in order to protect the privacy interests of crewmembers or grieving family members. For example, following a fatal accident, the Air Force won't release an actual cockpit recording or graphic information from medical records and reports, except to family members upon their request.

How Does Safety Privilege Protect "Joe Aircrew"?

The safety privilege can be confusing. Because regulations forbid the military from using a witness's confidential statements against him in a judicial or adverse administrative action, the witness has no right against self-incrimination in SIB proceedings. Put another way, a witness can't "take the Fifth" to keep from saying something that might otherwise be considered incriminating. In fact, it's perfectly lawful for the military to order a full and truthful statement about a person's involvement in the mishap. And, the witness may be found "causal" (at fault) in the accident as a direct result, which could lead to non-adverse administrative action (e.g., re-training, etc.). But, again, the military *cannot* use any of the SIB's findings or privileged witness statements in a court of law or for adverse administrative action. Other investigators must find this stuff out on their own in a separate investigation. In any Class A aircraft mishap or where there's probable high public interest, the military will convene an Accident Investigation Board (AIB) (covered in AFI 51-503, *Aircraft, Missile, Nuclear and Space Accident Investigations.* Ed.). Sometimes, the AIB will investigate a mishap at the same time as the SIB. And the SIB will try to preserve factual evidence for the AIB's use. However, an AIB is very different from an SIB.

The purpose of the AIB is to develop a public record for release and collect evidence, which may then be used to support disciplinary or adverse administrative action, if necessary. The regulations make it clear that, in the case of evidence and statements, the SIB takes priority over the AIB. The causal findings of the SIB are protected from use by the AIB, as is any confidential witness testimony used by the SIB, and anything else that could potentially compromise the safety privilege. The SIB usually provides the AIB with a list of witnesses, but can't identify what was said, or how the statement pertains to the mishap. In fact, the witnesses themselves can't identify for the AIB investigators what they told the SIB. The AIB must ask their own questions and make their own findings.

Most importantly, if you feel like you're on the "hot seat," you have the right to counsel and the right not to incriminate yourself to the AIB. Good to know when things get a bit dicey!

When is Privilege Lost?

Because the safety privilege was never put in a statute, it is still subject to change by the courts. Although it's not likely that the US Supreme Court will reverse itself on the subject anytime soon, who wants to be the one to mess up so badly that it does?

Without getting too far into the weeds on the legalities, if the military knowingly releases privileged information to anyone not authorized to receive it, the privilege may be considered "waived." For example, if the Air Force fails to follow its own regulations, and releases all or some of the final SIB report to Lockheed Martin's attorney on purpose, it opens the door for anyone to claim that "privilege" is lost for the entire report. If enough of this were to happen, it's possible that the courts wouldn't be so willing to support the privilege. However, if confidential information is released through an honest mistake, privilege is generally *not* waived, and the courts will typically deny requests for the information from other parties.

The military has put teeth into the regs for anyone who releases privileged information to those not authorized to receive it. Penalties for knowingly releasing privileged information include up to two years jail time, dismissal or dishonorable discharge, reduction in rank, and/or forfeiture of future paychecks. This should be further proof for any "harrumph-ers" out there that the military means business when it talks safety privilege!

A Couple More Things To Remember…

Here's the best way for you, Joe Aircrew, to lose the privilege and have your statement made public for the military and all the world to see: Lie. If the military can show that your statement to the SIB was a lie, the military will throttle you with it. They can use your statement to the SIB in court as evidence of criminal conduct in the mishap as well as hit you with making a *false official statement*. Ouch.

Finally, if you find yourself an accused in a criminal trial, you may request the court to order the military to release privileged information from an SIB investigation. If the judge determines that the information is relevant to your trial and necessary for your defense, the judge can order the military to release it
(the judge can order members of the court not to release it to the public, close court hearings to the public and seal privileged information in the record preventing its release to the public). However, the military may still refuse to produce the evidence. If they do, the judge has the option of dismissing the charges against you. Either way, you, the accused, are protected.

So there it is, in black and white. All you ever wanted to know (and more) about the safety privilege. And, although it may not seem all that critical now, it's great information to have in your back pocket if you ever end up on the hot seat. That's not to say that it should become part of your post-ejection checklist. It's just food for thought from your friendly neighborhood safety dude.

(Capt C.J. Will is an F-16CJ pilot and Flight Safety Officer for the 366th Air Expeditionary Wing, Mountain Home AFB, Idaho. Capt Will was commissioned in 1993, and served as a JAG at Fairchild AFB before earning his wings. Ed.)

If the military can show that your statement to the SIB was a lie, the military will throttle you with it.

The Quote

What is the deal with my vertical velocity indicator? It's pegged!

J.S.T. RAGMAN

Perhaps nothing would have helped. As I read the initial reports, I tried to imagine the thoughts and feelings running through the pilot's mind in those last few moments.

Night, over water, haze. Ease the power back, nose down, begin the descent. Three miles a minute, 5000 feet to lose, 35 miles to go—I need 500 feet per minute. Everything is looking fine. The engine sounds right. The slip stream sounds right. Perhaps my scan fell apart in conversation with the passengers. I bring my eyes forward once again. I note that the compass is spinning; I am in a right turn. The altimeter is showing a climb. I do not want to be turning, I do not want to be climbing. What is going on? Yoke forward and roll it left to level. Check the compass. Check the altimeter. I am straight and level. I think for a moment. Not much to see out front or to the sides. I am in what they call "the soup." I roll the yoke to the left and give it a slight push. Returning to course and resuming my descent. A few words with the passengers. All is fine. Back to the instruments. The altimeter is unwinding big-time. I don't need this rapid a descent. I pull back on the yoke. Feels strange, sideways forces on my body, head feels weird. Why is the compass spinning? What is the deal with my vertical velocity indicator? It's pegged! I have never seen it pegged. I have never seen a compass spin like that. Check out the airspeed, it's in the amber, approaching the redline. The slip stream sure is loud. I still can't see anything outside. What do I do now? Do I roll left, roll right, push, pull, power up, power down? What is going on?

Spatial disorientation. Three fatalities. Those last moments were no doubt confusing, frustrating and incredibly lonely. One moment, in control. The

USAF Photo

next moment, out of control. Not knowing why. Not knowing what. Not knowing how to recover. Sad.

I was reminded of a quote I had read as a second lieutenant, Vance Air Force Base, Enid, Oklahoma, in the summer of 1980. I was new to the flying business. I was new to the business of life. I had just spent the last four years in a Colorado "lock down." Yet, as I read this quote it had impact on me. Big time. My class had already lost one T-37 on the turn to final. The previous class had lost one as well—T-38 crosswind in the flare.

Try as I might, I could not find the quote. I searched high and low in my memorabilia stash. I called the folks at Vance. No luck. Until this morning. My wife and I had just moved. I had been sorting through "stuff" in the basement and there it was. It hit me even more deeply today.

An Air Force Quote About Pilots Who Don't Come Back

"We should all bear one thing in mind when we talk about a troop who rode one in. He called upon the sum of all his knowledge and made a judgment. He believed in it so strongly that he knowingly bet his life on it. That he was mistaken in his judgment is a tragedy, not stupidity. Every supervisor and contemporary whoever spoke to him had an opportunity to influence his judgment. So a little bit of all of us goes in with every troop we lose."

Ladies and gentlemen, fellow aviators, we must speak with each other. We must share our experiences, our insights, our suggestions. Most importantly, we must be willing to share our close-calls, our errors, our screw-ups. Commanders, evaluators, instructors: You more than any other have an obligation, a duty, to speak up, to share, to admit errors and close calls. Do so at every possible opportunity: Crew debrief, formation debrief, flight safety meetings, bar-talk. Set the example and encourage others to speak and share.

Flight safety officers: Consider your next flight safety meeting. Dispense with your well-written and well-researched higher headquarters briefing. Draw upon the experiences of the hundred-plus aviators in your audience. What can they share? Let them speak.

The next time someone makes a judgment and bets his/her life on that judgment, never let it be said that you had the answer but your answer had remained unspoken. That would indeed be a tragedy.

Night, over water, haze. What was going on? What do I do now?

Take it slow and steady. Establish the scan. Trust your instruments.

Live to fly another day. And be sure to tell someone your spatial disorientation story. It just might save some lives one day.

("J.S.T. Ragman" is the pen name of a C-130 pilot and unit commander in the Air Force Reserve. He is also a Boeing 777 pilot for a major airline.)

Commanders, evaluators, instructors: Set the example and encourage others to speak and share.

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

Now We're Gonna Beat Up On The Pax!

We ran an Ops Topics titled "Beatin' Up On The Boomer!" in the June 2001 edition of *Flying Safety*. We followed that up with "Beatin' Up On The Loadmaster!" in July 2001. Little did we suspect there would be a third episode in the "Beatin' Up…" series, but here it is.

The mishap aircraft (MA), a heavy, deployed with a full crew and nine duty pax—primarily Maintainers—to Base X for a short-duration TDY. Prior to departure, the pax were briefed the crew would be conducting receiver air refueling for currency training if a tanker was available en route to Base X and, as luck would have it, a tanker did become available.

The MA rendezvoused with the refueler at 26,000. During the first contact attempt, the MA got into a mild-to-moderate pitch oscillation, but the second contact was successful with no further problems. After the second contact, the MA proceeded to base X.

Until the full stop landing at Base X, nobody in the MC had a clue that anything out of the ordinary had occurred during the flight. That is, until one of the Maintainer pax complained that he had suffered a back injury. The MC notified the local Flight Surgeon, who examined the Maintainer and confirmed he wasn't faking it. The Maintainer had sustained a fracture to L1, one of the lower back vertebras. The Maintainer returned to home station, where he was placed on convalescent leave for nearly a month, followed by a period of light duty.

SOP for large aircraft expecting turbulence or involved in air refueling is to alert all aboard to ensure anyone who doesn't have a duty-related reason to be moving around is securely belted in. This Maintainer needn't have suffered the injury he did. Because there's always bound to be somebody who doesn't get the word—either because he's blocking out "outside distractions," napping, "indisposed" or just plain can't hear over the jet noise—never *assume* everyone's strapped in.

Yeah, You Could Call That A Firm Landing

The mishap crew (MC) planned a night copilot proficiency sortie for two copilot initial qualification students. This would be the first night sortie for the two student copilots, and their second and third sorties overall. Flight planning, preflight and takeoff were uneventful and, for the first 2.5 hours with the first student pilot in place, the mission went as planned. The mishap aircraft (MA) landed, there was a seat swap and, with the mishap student pilot (MSP) in place, the MA took off for the second half of the sortie.

During this portion of the flight, the MSP flew a non-precision localizer instrument approach for a planned 50 percent flap touch-and-go. On this first approach, the MA got slow on short final and developed a high sink rate. Power was increased, but the aircraft still had too high a sink rate and the MA started a go-around. The addition of power and increase in pitch created a nose-high attitude and "firm" touchdown, just before the MA had enough power to become airborne again.

Proficiency training continued without further incident, but the aircraft concluded the mission early and landed a little sooner than planned because of deteriorating weather. And that's when it was discovered one of those touch-and-go landings had indeed been *firm*. The MA required nearly $60,000 worth of repairs, with a crushed tailskid and extensive sheet metal and substructure damage.

Lessons re-learned? Student training is one of the most demanding professions you'll ever undertake. Balancing a student's need to learn from his mistakes with timely intervention to prevent someone from getting hurt or something from getting broken is one of the instructor's greatest challenges… Fly Safe!

Speaking Of Interesting Landings…

This mishap aircraft (MA) arrived in the pattern to accomplish some touch-and-go proficiency training. The mishap crew (MC), planned, briefed and performed a no-flap, full-stop landing.

Landing distance was calculated as 6600 feet with 10,000 feet available. From the performance charts, ground roll was determined to be 4600 feet. The MA landed approximately 2500 feet down the runway, lowered its nose and deployed thrust reversers and spoilers. It appeared as though the MA was still traveling at a pretty good clip with approximately 2000 feet of runway remaining, when the throttles were advanced to reverse idle. With only about 1000 feet of runway remaining, it *still* appeared that the MA was traveling at a higher-than-expected speed… See where we—and the MA—are going with this one?

The MA started veering toward the left edge of the runway at a 45-degree angle but, through application of differential braking and nose wheel steering, the MC managed to prevent the MA from departing the runway. Momentarily. Due to remaining speed and the MA's poor braking/steering capability, it slid over the runway end identifier lights and off the runway. The MC egressed safely and the unit had an opportunity to exercise its "emergency response system." Happily, the crew escaped without injury.

The MA was recovered and impounded for maintenance, where all aircraft systems were inspected for discrepancies. Tires, the anti-skid system, hydraulics, nose wheel steering and thrust reversers were all closely scrutinized and found to be serviceable and functioning normally. Whereas the crew escaped injury, the MA didn't. It could have been a lot worse, but total cost to get this aircraft flying again was "only" a little more than $150,000.

Now, for the rest of the story… How would *you* have handled this landing, if you were flying through light rain and mist, and also knew beforehand, as this crew did, that the runway surface was reported as "wet"? It's too late for Operational Risk Management to help this crew, but not you…

Inadvertent Inflight Refueling

"Routine" pretty well describes start, taxi and takeoff for this mishap aircraft (MA). En route from Base X to Base Y with 22 pallets of AGE, everything was copasetic until the MA was passing through 10,000 feet on climbout. *That's* when fuel was discovered leaking from one of three MA-30 air conditioning units the mishap crew (MC) had taken aboard as cargo at Base X.

With the MA in a climb, the uncontained fuel was flowing ever more quickly aft, toward places that nobody wants the fuel to go for fear of possible ignition. Hazmat cleanup materials were used to stanch the fuel flowing in the cargo compartment and an emergency was declared. The MA dumped more than 37,000 pounds of its own fuel and diverted to the nearest field, where it landed safely.

With few exceptions, aren't vehicles and equipment supposed to be defueled and drained before being taken aboard as cargo? Yep. Then how could this have happened? Scrutiny of the shipper's declaration paperwork revealed it had been signed more than three weeks prior to the flight. Throughout the ensuing three weeks, the three MA-30 air conditioning units had been positioned in a "special handling area" awaiting shipment. Sometime during the storage period, a fuel truck was dispatched to the special handling area, with instructions to "fuel all the equipment in the area." Which the fuel truck driver did.

The stage for the inflight emergency was finally set when the three MA-30s were loaded, the outdated shipping documents were presented and accepted, and there was no further examination of the (now fully fueled) air conditioners. 'Nuff said? ✈

Maintenance Matters

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

MAINTENANCE MATTERS PRESENTS… COMPLACENCY BITES, PART ONE

Somebody once said—and *please don't try this at home,* kids—that if you put a frog in a boiling pot of water, it will jump out. But if you put a frog in room temperature water and heat it slowly, he *won't.* Meaning…what? That you'll soon be ready for some delicious (?) frog soup! No! Meaning that when you get too comfortable in your routines, it isn't very difficult at all to lose situational awareness (SA) and suddenly find yourself in trouble. Maybe, *serious* trouble. There's a sign post up ahead… Next stop, *The Complacency Zone.*

Hangar Door 1, Maintainer, 0

Ever been told you aren't supposed to pass between hangar doors that aren't open at least ten feet? If you're a Maintainer, then you've probably been taught (or warned) that it's "illegal." But do you understand *why* it's "illegal"? The short answer is this: To prevent you from being crushed should the hangar doors start closing while you're moving between them. And that's one of the reasons why AFOSHSTD 91-100, *Aircraft Flight Line Ground Operations and Activities*, has the "ten foot width" rule reference in the section titled "Hangar, Nose Dock and Shelter Door Design Guidance and Operations."

The building custodian initiated a work order to repair stop switches on the outside of one of the hangar doors. A CE electrician responded, did the repair work and, while performing a final op check, noted that the door's brake was defective. Instead of the hangar door coming to an immediate stop, it was continuing to travel an additional 4-6 inches after the door operating switches were released. The electrician informed the building custodian of the new problem and initiated a work order for another CE work center to fix the faulty door brake. Within the week, the hangar door brake was put back in working order and the door system was given a clean bill of health.

Not too many days later, a couple of Maintainers arrived at the hangar to store a high-reach inside. Maintainer No. 1 (M1) dismounted, opened the newly repaired hangar door 20 feet or so and released the door "Open" switch just as M2 was driving the high-reach inside. No sooner had the "Open" switch been released than the hangar door immediately began closing, all by itself. The door closed quickly enough to trap the high-reach, but no one was injured and damage to door and vehicle was insignificant. M1 and M2 re-opened the hangar door, extracted their high-reach and, just as before, the defective hangar door closed on its own when the door open switches were released. The two Maintainers drove around to the opposite side hangar door, opened it, parked the vehicle inside and told another Maintainer about the original hangar door's new problem. This Maintainer directed them to notify a supervisor.

In the meantime, our mishap Maintainer (MM) was returning to the building. He attempted to enter the hangar through the malfunctioning door, unaware—at least when it was most important to know—of its "auto close" feature. The MM opened the door a little, started walking through and, before anybody could say "Holy Schnikes," *he was pinned*. Luckily, several coworkers were nearby to free him and summon medical help. CE responded right away to troubleshoot the faulty door, pinpointed a bad switch and replaced it.

This MM suffered three broken ribs and received one helluva scare, but he was lucky: He *lived* to tell about it. The outcome could easily have been tragically different if either the MM's coworkers hadn't been there to render immediate assistance or if the hangar door's motor had a been a little more powerful. Hangar doors can be deadly. Get caught between them when they're closing and you won't have the breath inside your lungs to yell—much less scream—for help.

Two things we'd like you to remember here. Thing One: The hangar door "ten foot wide" rule was written in blood. It was almost written in blood again. Thing Two: When you come across a hazardous condition, take immediate—repeat, *immediate*—positive action to protect others from injury.

Think you're faster than those old, slow-moving hangar doors? So did this Maintainer. Don't bet your life on it. *Don't* walk through hangar doors that are moving or aren't open at least ten feet. Any questions?

"Next Time It's *My* Turn To Do The Inspection, I'm Taking Leave!"

Learning from the mistakes of others is a great way to gain experience without having to pay full price. The following tale is definitely worth learning from. It's *so* good we decided to give the moral of the story first! Take your pick from any one (or more) of the following:

- "The longer you use something that doesn't work properly, the more willing you are to accept its limitations and forego getting it fixed."
- "Left alone, a problem will get worse, not better." (Thanks, Murphy.)
- "Use a workaround long enough and it'll bite you in the butt." (Hey, we never claimed to be wise like Aesop!)

In accordance with applicable tech data, the mishap worker (MW) commenced the required semiannual facility inspection. Part of the periodic maintenance routine involved testing the facility's halon fire suppression system and associated circuits. In this system, as with most newer fire alarm and suppression systems, the "brain" is hard-wired to the base Fire Department's central alarm system. Testing verifies proper functioning of alarm system monitoring and, if the system detects problems, provides a "Trouble" indication by circuit.

During fire suppression system testing, the trouble alarm buzzer sounded and the "Trouble" light illuminated for one of the monitored circuits. Per tech data, the MW depressed the "Reset" button in the central system panel to clear the fault. No soap. The buzzer kept buzzing and the light stayed lit. Tech data steered the MW to the power distribution box to check circuit breakers and, after resetting a possible tripped circuit breaker, he returned to the central system panel to try the "Reset" button once more. The MW depressed the "Reset" button, but that ol' buzzer continued to buzz and that pesky "Trouble" light remained illuminated. There were, however, two attention-grabbing differences this time: The fire suppression system triggered the central system's alarm to the Fire Department. It also kicked into full-on, fire suppression mode, discharging thousands of pounds of Halon 1301 into the facility.

The Fire Department was on scene almost immediately. Once it was determined that the event was a false alarm and no one had been injured, one of the first things the unit did was take a good, hard look at what had happened to prevent a future identical, inadvertent fire suppression system activation. It took the first prevention step by looking into the *past*, where a records review made it apparent that the facility had a history of "false" trouble alarms going back several months. These false alarms proved elusive enough that facility workers were given *carte blanche* to use the central system panel's "Reset" function to reset the system themselves. Remember what we said up front? "The longer you use something that doesn't work properly…" "Left alone, a problem will get worse…" "Use a workaround long enough, and it'll bite you in the butt." Hindsight being 20-20 and all, those maxims sound like pure genius, don't they?

Complacency is the enemy. Situational awareness is the ally. So's a healthy recognition that blind acceptance of the status quo can be dangerous. Take a good, hard look around your own work center. Are workarounds in place that have existed for so long they're now "institutionalized," and a regular, expected way of performing maintenance? If so, sooner or later, something bad's going to happen and somebody's going to get hurt. Or worse. Don't jeopardize your safety or that of your co-workers. *Resist complacency.*

USAF Class A Flight Mishaps

FY01 Flight Mishaps (Oct 00 - Jul 01)

18 Class A Mishaps
8 Fatalities
15 Aircraft Destroyed

FY00 Flight Mishaps (Oct 99 - Jul 00)

12 Class A Mishaps
5 Fatalities
8 Aircraft Destroyed

04 Oct	♣✶	An RQ-1 Predator UAV crashed while on a routine test mission.
12 Oct	♣	An F-16C crashed during a routine training mission.
23 Oct	♣✶	An RQ-1 Predator UAV went into an uncommanded descent.
03 Nov		An F-15C experienced engine problems on takeoff. The pilot successfully RTB'd. Both engines sustained damage from FOD. (Revised repair costs resulted in this engine damage being downgraded to Class B mishap status.)
13 Nov	♣♣	Two F-16CJs were involved in a midair collision. Only one pilot was recovered safely.
16 Nov	♣	An F-16CG on a routine training mission was involved in a midair collision.
06 Dec	♣	A T-38A impacted the ground while on a training mission.
14 Dec	♣	An F-16C crashed shortly after departure.
12 Jan	♣	An A-10A crashed short of the runway.
09 Mar	✶	During a ground maintenance run a KC-135E's No. 2 engine suffered catastrophic damage.
12 Mar	✶	A USAF NCO died during a range training mishap.
21 Mar		An F-16B experienced a bird strike but recovered safely. A fire developed after landing. The aircraft suffered structural and engine damage.
21 Mar	♣	An F-16C experienced engine problems soon after takeoff and crashed.
23 Mar		A C-17A sustained Class A Mishap-reportable engine damage.
26 Mar	♣♣	Two F-15Cs crashed during a routine training mission. The pilots did not survive.
03 Apr	♣	An F-16CJ crashed while on a routine training mission.
04 Apr		An F-15E on a routine training mission recovered safely after sustaining a bird strike.
07 Jun		A KC-10A sustained Class A Mishap-reportable engine damage.
14 Jun	♣	An F-16CG crashed during a routine training mission. The pilot was fatally injured.
21 Jun		A C-130H sustained Class A Mishap-reportable damage during landing.
06 Jul	♣	An F-16CJ crashed while on a routine training mission. The pilot was fatally injured.
17 Jul	♣	An F-16B flying a chase mission crashed. The two crewmembers suffered fatal injuries.
18 Jul	♣	An F-16CG crashed while on a routine patrol mission.

- 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.
- Reflects only military fatalities.
- "♣" 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 frequently and may be viewed at the following web address: http://safety.kirtland.af.mil/AFSC/statspage.html
- **Current as of 17 Jul 01.** ✈

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THE Well Done AWARD

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

Captain David P. Blazek
99th Reconnaissance Squadron
Beale AFB, California

While flying an operational mission in support of Operation SOUTHERN WATCH, Capt Blazek showed extraordinary airmanship in managing one of the U-2's most serious emergencies. On climbout (passing FL 600) from his deployed base, hydraulic pressure fluctuated to near-zero. Capt Blazek acted quickly to configure the aircraft for landing by lowering the gear before loss of all hydraulic pressure. The landing gear extended, but he was unable to set the required trim for descent and landing. He declared an emergency, turned his aircraft for home and started a descent, using bank angles and the aircraft autopilot to lessen the heavy trim forces to stay within the required descent profile for structural integrity of the airframe and sensor package.

Poor weather conditions at the deployed base further complicated the emergency return. Crosswinds were gusting to aircraft landing limits, and blowing dust meant the field had only intermittent VFR conditions. The deployed base's runway is 13,000 feet long, but due to raised centerline lighting (hazardous for the U-2's tail gear), only the center 8000 would be usable. Operations personnel calculated the no-flap landing distance under ideal conditions to be 8000 feet, assuming the emergency brake system worked.

Capt Blazek dumped fuel and requested vectors to a runway 17 TACAN approach. Acquiring the field between dust storms, he flew a flawless no-flap, 1.5 degree glidepath approach within two knots of stall speed. Capt Blazek landed "spot on," 1000 feet from the beginning of his landing zone.

Capt Blazek maintained directional control using full rudder and aileron inputs, waiting patiently to begin braking until weight was firmly on the main gear strut. With the end of the center 8000 feet of runway quickly approaching, Capt Blazek applied the brakes and discovered they were completely ineffective. He immediately shut down the engine and cautiously lowered the left wing tip to the ground to create friction. As he left the center "U-2 friendly" 8000 feet of runway, he offset his aircraft to avoid contact with the raised centerline lighting. Wingtip friction and the engine shutdown enabled the aircraft to decelerate enough to stop with approximately 1000 feet of the 13,000-foot runway remaining. Capt Blazek egressed uneventfully. The aircraft suffered only minor damage and was towed from the runway.

Capt Blazek demonstrated exemplary airmanship in safely landing the U-2 in one of its most difficult configurations during extreme weather conditions. His actions were directly responsible for the safe recovery of a critical reconnaissance asset. WELL DONE!

USAF Photo by MSgt Rose Reynolds