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SAFETY SAGE

AIR FORCE OPERATIONAL SAFETY COUNCIL

The Air Force Operational Safety Council (AFOSC) was established in December 2003 to provide corporate governance of AF-wide mishap prevention efforts and to lay out the AF position for the Defense Safety Oversight Council (DSOC). The AFOSC created five subordinate Task Forces: Operational Safety Improvement, Aviation Safety Improvement, Motor Vehicle Accident Reduction, Industrial Operations and Safety Investment Strategy.

The AFOSC kickoff was in March 2004. The council reviewed the Air Force's 10-year mishap statistics and trends and presented MAJCOM briefings on their plans to meet the Secretary of Defense's goal of a 50 percent reduction in preventable mishaps.

Building on the Air Force Safety Analysis 1993-2002 (see link at http://afsafety.af.mil/), the HQ Air Force Safety Center is working on a follow-on, in-depth analysis of Class A and B mishaps. HQ AFSC will serve as the advocate for new technology, policy and training to assist in mishap reduction. In FY03, they established a traffic safety Integrated Process Team and hosted a motorcycle safety summit.

The U.S. Air Force Safety Strategic Vision and Plan for FY04 includes establishing AFOSC, attacking the Risk Reduction Target Areas, extending the safety analysis to Class C mishaps, establishing a process for corporate review, and accelerating the development of the Air Force Safety Automated System (AFSAS).

AFOSC's target areas for risk reduction include controlled flight into terrain (CFIT), midair collisions, powerplant, loss of control in-flight, A/C system (non-powerplant), impact damage (wildlife), impact damage (object), traffic safety, and sports and recreation.

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1 March 2004

The Secretary's Vector

DR. JAMES G. ROCHE
SECRETARY OF THE AIR FORCE

SecAF Focus Areas

The events of the past year offered an opportunity to demonstrate the contributions of the world's finest air and space force to the joint and coalition effort to defend our nation and friends. As we adapt to a new era, we will continue to leverage those capabilities that deliver military advantages. To date, we've made great progress in applying this approach to several focus areas, which General Jumper and I refer to as "Phase One" of an Air Force-wide effort to realize Secretary Rumsfeld's vision of transformation. Some highlights included:

Strategy: We've refocused Air Force strategic thinking on core competencies, concepts of operation, and joint doctrine consistent with the asymmetric nature of warfare. We've refined our AEFs, and focused our training to support a series of missions, including homeland defense, Close Air Support (CAS), and close partnering with land, maritime, and special operations forces. We have our space programs on track; we've increased the unity of effort among the Air Force, NRO, and Intelligence Community; and we have enhanced space support to the warfighter.

People: We've adopted a new Force Development program to provide focused education, training, and experience for our officers, enlisted, and civilians across the Total Force. We've expanded our pool of deployable Airmen to 75% of our active force; and we have a renewed focus on fitness. We're adjusting our skill mix to reduce demand on stressed specialties, and we are reshaping our force to meet the new demands, while respecting and caring for our people and their families.

Efficiency: We delivered a transformed Air Force to the battlefield, with armed Predators, Global Hawk, bombers working with our Airmen on the ground to support the CAS mission, new tactics for Time Sensitive Targets, networked ISR, and advanced capabilities in our Combined Air Operations Centers. Where it makes sense, we've integrated active, guard, and reserve units as part of our Future Total Force. We've created new expeditionary organizations, such as our Contingency Response Groups and Air Component Coordination Elements. And, we consolidated the B-1 Bomber fleet, achieving its highest mission capable rate in 20 years.

Industrial Base: We transformed the F/A-22 by integrating new avionics and weapons that will make it the premier air-to-ground strike system in heavily defended areas, as well as highly effective against cruise missiles. And, we've engaged with industry to stabilize production of critical Air Force capabilities—the F/A-22, C-17, Predators, Global Hawks, and other systems.

Throughout, we have made the point that we are one Air Force. Whether our Airmen are in strike, space, mobility, support, or special operations, we are one Air Force. As we move forward with the next phase of transformation, General Jumper, Under Secretary Teets, General Moseley and I ask you to apply your intellect, energy, and ideas to further adapt to the needs of this new era. In doing so, we ask you to remain focused on the following Air Force priorities:

USAF Photos

Air Force Priorities

Sustain our Warfighting Readiness and Expeditionary Focus: At the height of OIF, nearly 55,000 Airmen were deployed. Our engineers, maintainers, and logisticians bedded down and sustained nearly 900 aircraft at 38 new or improved expeditionary bases. Our communications professionals established bandwidth capability eight times larger than we had in

OEF. And our work continues, at home in Operation NOBLE EAGLE, in our CONUS operational and training missions, and around the globe, with more than 23,000 Airmen and over 300 aircraft deployed to Iraq, Afghanistan, the Balkans, and elsewhere. Our mobility team is swapping out 240,000 people from the combat zone; our base defenders are conducting convoys and security patrols outside the wire; our medics are treating combat casualties. In short, we remain at war and we will continue to take the fight to the enemy. Every Airman must be ready—fit and trained when called to serve. As we complete our reconstitution and reenter the AEF cycle, every Airman must maintain an expeditionary mindset.

Expand our Contributions to the Joint Fight: This priority underscores the rationale behind our integration efforts—we are all on the joint team, and our Air Force exists to produce battlefield effects. Our future is closely tied to the future of our land forces. We have done a good job making this shift. But, we can do more. It is important that our land forces continue to see us demonstrate our obvious commitment to air-to-ground support, both deep interdiction and close air support. We will be fully integrated with them, whether they are Army, Marines, SOF, or coalition forces. As we modernize, we are also committed to delivering operational space support to the combatant commanders, expanding our sensing portfolio and global mobility capabilities, reorganizing our Numbered Air Forces to enable a total focus on warfighting planning and execution, and preserving a rapid, persistent long-range strike capability.

Increase our Focus on Special Operations: Special Operations in our Air Force is not a peripheral capability. We need to provide our Airmen with the advanced systems they need to continue their transformation into a single community of warfighting specialization. We intend to bring together our Battlefield Airmen—combat controllers, pararescuemen, combat weather, TACPs, and others—under a common training and organizational structure to strengthen the combat power they bring to the fight. Plus, we will realistically modernize our Special Operations aircraft and systems, starting with our helicopter force, and continuing with the tools essential to link air and ground capabilities.

Protect our Airmen: The threat of terrorism is real, it is persistent, and it is aimed at us. Yet, recent history has shown that terrorists prefer to attack soft, weak, or unprotected targets. Thus, we cannot let our guard down for a moment. Every Airman must be a sensor, and we must, at all times, ensure that our bases and facilities are hard targets. In addition to protecting our force, we must preserve our force. Virtually every week, General Jumper and I receive a report that an Airman was killed in a preventable accident or that a member of our Air Force family has taken his or her own life. We urge you to place a renewed focus on caring for each other, engaging early and often with those around you to prevent accidents before they occur, and to rescue those who, without our help, may make an irreversible choice to take their lives. Please make this part of your daily cross check.

I am extremely proud of your contributions to protecting America and supporting our allies around the world. Together, we've liberated two nations, and achieved significant objectives in our war on terrorism. With these priorities, and a sustained commitment to our core values of integrity, service, and excellence, we'll sustain our position as the world's premier air and space power.

James G. Roche
Secretary of the Air Force

USAF Photo

Air Force Safety...the goal is zero mishaps!

Over the past 10 years, we have prevailed in combat in Kosovo, Bosnia, Afghanistan, and Iraq. We have toppled dictators, provided opportunities for democracy to flourish, and destroyed terrorist networks. We have demonstrated time and time again that we are the greatest Air Force in the world. I am very proud of our record in combat and in securing our nation's safety. But we aren't doing enough to keep our Airmen safe.

During those same 10 years, the Air Force has lost more than 1000 Airmen in accidents that shouldn't have happened and could have been prevented. People are our most important resource and our greatest investment. We have to protect them. It is tragic to lose a fellow Airman and every time we do we also lose a piece of our combat capability. We can do better.

I have rarely heard of an accident that couldn't have been prevented and I'm asking for your help in reducing our mishap rate by at least 50 percent over the next two years. Secretary Rumsfeld shares this goal, and he established the DoD Safety Oversight Council to review our safety practices DoD-wide. But real change has to start with each of us individually. Commanders and supervisors are accountable for safety practices and performance and must take action to reduce mishap rates. Leaders have to make sure risks are balanced against mission requirements and mitigate the risks or stop operations when those risks become too great. Most important, we all have to get rid of the idea that safety is a concern only when "on duty." Safety has to be part of every Airman's daily life—in combat, on the commute to and from work, at home, and on vacation—anywhere you might be.

Our ultimate goal is "zero mishaps." Some people may think "zero" is simply too hard to be a realistic goal. To my way of thinking, however, any goal other than zero implies that some mishaps are acceptable. But no mishap is. The moment we stop pressing forward we start falling back. Over the past decade, despite some excellent safety programs, we haven't made much progress in making the Air Force safer. Instead, we've been moving in the wrong direction. Another program, procedure, or lecture won't help. Each of us paying attention will. The right attitude about safety in peacetime is no different than how we feel about surviving in war. The difference is that any loss of people or equipment in peacetime means that they will never get to the war.

We know that the mission always comes first and our environment will always be "high-risk." Plus, the Air Force cannot become so risk averse that we jeopardize the mission. But we cannot fall into the trap of accepting accidents as a cost of doing business, and almost all accidents are preventable. First, we have to turn around the trend in motor vehicle collisions. Off-duty private motor vehicle accidents have steadily risen since FY98 and remain the number one killer of our people. We're taking action to raise motorcycle safety awareness and skill level, but success depends on our people embracing and then practicing safe riding habits. We also have to decrease the rate of aviation accidents—midair collisions, controlled flight into terrain, and engine failures consistently drive mishap rates. We'll do our part to ensure that you get the training and the technology, but you have to put it into practice. Seat belts don't work if you don't buckle them; helmets don't save lives if you don't wear them. Motor vehicle and aviation accidents drive the statistics, but accidents occur everywhere, like in the workplace and on the sports field.

I have established the Air Force Operational Safety Council (AFOSC), chaired by the Vice Chief of Staff, to oversee safety matters. The AFOSC will monitor safety performance, examine new or emerging technologies from both the operational and safety perspectives, and direct required changes in Air Force policy, programs, and investment. But all the oversight in the world won't help if our Airmen don't take each other's safety—their survival—seriously.

I need your help—let's get it right on safety.

AIR FORCE
Air & Space Power

Welcome to the Infantry, Welcome to the Fog: Safety Implications and Coping Strategies

LT COL ROBERT R. SINGLETON USAFR

USAF Photo

It is a conversation played out in cockpits countless times a day, every day of the year. Thirty-some thousand feet below rests an abandoned runway and ramp. The question passes between pilots and air traffic control: Is it a former commercial, Army, Navy, Marine, or Air Force runway? The standard answer, from all parties: If it has a golf course, it is an Air Force runway!

Welcome To The Infantry

There were no golf courses in the most recent Air Force experience. The tales from OPERATION ENDURING FREEDOM and OPERATION IRAQI FREEDOM more closely resemble the reports filed by the correspondents embedded with the 82d Airborne and the 3d Infantry Division.

Upon initial arrival, aircrew members completed the After Landing Checklist, carried a few hundred pounds of professional and personal gear several hundred yards through the sand, and erected their own tents. They would continue to carry their several hundred pounds of gear for the duration of their stay, over sand, in 120°F temperatures.

Aircrew members climbed on backhoes, and constructed ditch latrines for a tent-city of 4000 troops. Aircrew members climbed on bulldozers and road graders and built tent-city roads. Aircrew members laid the electrical wires, dug the ditches, and laid the plumbing pipes.

No running water for weeks. No electricity for weeks. No hygiene for weeks. Eight weeks of Meals-Ready-To-Eat (MREs).

Five hundred cots under a single hangar roof; supporting the work/rest cycles for a 24-hour, seven-day-a-week operation; a wall of sheets; cots on one side, MRE and water bottle issue on the other side. Constant noise, no sleep.

Ramp temperatures exceeding 120°F; aircraft interior temperatures exceeding 140°F. Perimeter security duty in desert boots and lightweight uniforms, with temperatures in the negative teens. Sand. Incessant winds. Minimal flight-line shelter.

Welcome To The Fog

A Marine airfield. An Australian control tower. An Air Force radar approach control. Army rotary aircraft talking to the Army. Fixed-wing aircraft talking to the Air Force. Nobody talking to the vehicles randomly transiting runways, taxiways, and ramps.

No running water for weeks. No electricity for weeks. No hygiene for weeks.

Fourteen civil engineers deployed to construct a tent city for 4000 personnel. An aerial port contingent staffed by passenger handling specialists; with no passengers in sight for the duration. An aerial port contingent tasked to support a C-130 cargo operation; a contingent devoid of any cargo handling, special handling or ramp specialists; a contingent which deployed without their publication guidance.

No secure communications. Air tasking orders delivered via a several-hour round trip to/from the embassy: Hope the package is not out-of-date.

A less-than-ideal air traffic control environment. Unexplained ATC directives to hold, orbit, or take up a heading until further advised. Unexplained ATC-directed holds, orbits and vectors leading to "Bingo" fuels, missed "slot times" and missed "control times." No ATC replies to requests, or relayed requests. An ironic ATC inability to approve aircrew initiated requests for orbits, holds, 360-degree turns, early or late descents, vectors or headings.

ment of truth to the airline cockpit conversation: While we may not all golf, we are accustomed to crew transport, private rooms, hot meals, hot showers, TV remotes, an in-room mini-bar, secure and plentiful communications, and a hospitable ATC environment. Our exercises are marked by a few hours of MOPP Four, an MRE meal, with two hot meals a day. And a beer before hitting the clean linen sheets.

There is an element of shock and awe to the experience. If injury, incident, and accident stem from several "links in the chain;" this chain is unlike any other: No beginning, and no end. Non-linear, and

The accidents are literally out there waiting to happen.

Altimeter settings in millibars of mercury, hectopascals, and QFE. Pancake flat terrain. No discernible horizons. Black holes. No cultural lighting. High-density altitudes.

FOD everywhere. Gravel ramps, gravel parking pads, gravel taxiways.

The Safety Implications

The safety implications resident in the infantry and fog experience are countless, with additional countless permutations; and, as the line goes, they "are intuitively obvious to the most casual observer."

Starting an 18-hour crew duty day, by lugging several hundred pounds of gear through the sand in 120°F. And doing so again after the 18-hour day. And doing it again 12 hours later.

Aircrews on backhoes, bulldozers and road-graders, laying electrical wire and plumbing pipes—an OSHA and CDC nightmare! The impact upon health and fatigue from weeks of no running water, no electricity, no hygiene, and nothing more than MREs. The fatigue impact of sleeping among 500 cots under one hangar roof, MRE and water bottle issue an earshot away, and heading out to turn a wrench on an engine change. The injury, incident and accident potential in an airfield operation characterized by Army rotary, Air Force fixed-wing, uncontrolled vehicle traffic, an allied tower crew, and no one talking to each other. A ramp, cargo and special handling operation without qualified aerial porters. The in-flight stress of missed slot times, missed control times, and unanticipated "bingo" due to air traffic control.

While each stressor has its attendant safety impact, it is the cumulative impact of the myriad of stressors inherent in the "infantry and fog" which poses the greatest threat to safety.

Similarly, the unfamiliarity of the myriad of stressors poses a considerable threat to safety: There is an elexponential. The accidents are literally out there waiting to happen.

Coping Strategies

The leading ground/flight safety success story inherent in the OEF and OIF experience with "infantry and fog" is the internalization of Operational Risk Management (ORM). As one wing commander put it, both operations were marked by "ORM on the fly." The ORM evidenced in both operations was not the formal, paperwork version of stateside training missions; rather, it was the on-the-spot judgments made at all command levels. In virtually every interview conducted for this article, ORM was mentioned both as a term, and as a day-to-day practice. It permeated both operations, from top to bottom.

The Comm Flight stringing cable at Baghdad Airport lacked the required "fall protection" equipment; their fall-back ORM position was to ensure no sharp or damaging objects rested below the work area. Throughout their Baghdad stay, the Comm Flight's motto was, "If it does not look right, fix it, and fix it now." The cable was strung, the risk managed within the confines of the equipment available.

The C-130 unit charged with in-theater cargo airlift worked around an inappropriate aerial port

USAF Photo by SSgt Lanie McNeal

personnel package by assigning port-qualified loadmasters to the cargo handling task. Lacking the special handling (hazardous materials) AFIs, they secured higher headquarters approval to reject special handling material pending arrival of the AFIs. What could be moved, was moved safely. What could not be moved safely, was not moved. ORM in action.

One Air Expeditionary Wing (AEW) Commander canvassed his subordinate unit commanders on a daily basis: What was their number one safety issue? He ensured corrective action in each instance. In one instance of round-the-clock construction and vehicle activity in, and adjacent to, tent-city, he directed "quiet hours" from 2200 through 0700. This commander's involvement sent this fortunate AEW a very powerful message regarding ORM.

With chronically erroneous altimeter settings to blacked-out night landings, inbound crews coordinated for ground personnel to climb into parked cockpits, spin field elevation into altimeters, and read back the altimeter settings. A risk was managed; the missions succeeded.

Lacking facilities to cool maintenance water bottles roasting in both sun and shade, and denied ice at the chow tent, a flying squadron commander arranged for morgue ice to be delivered to the flight line for maintenance water bottle cooling. Wrenches were turned and pre-flights were conducted, with an extra margin of safety against dehydration and the attendant inattention to detail.

Operating into unfamiliar, black-hole airfields, flying visual and/or non-precision approaches, aircrews constructed FMC/GPS approaches as back-ups. Use all the tools; manage the risk.

Given extremely congested ramps, minimal ramp lighting, and a shortfall in qualified ramp and maintenance personnel, aircrews volunteered to back aircraft into parking stands. ORM: Use the best-qualified personnel available.

Given a shortfall in aircraft generation squadron personnel, the shop personnel of the maintenance squadron developed an on-the-spot, formal, in-house training program, complete with trainee and trainer initials, to augment their aircraft generation squadron brethren with the mundane but critical tasks of landing gear safety pins, cargo and entry door operations, external air and power connections, fuel/defuel fire guard, engine oil servicing, wing walking and hydraulic system pressurization. A knowledgeable assist reduced risk.

Maintenance squadrons started each shift with a safety brief, and a review of "What did we do wrong yesterday?" The ORM power of self-critique and the sharing of lessons learned.

"Do not be afraid to step back and say, 'This is stupid.' "

The Mindset

While the particulars of ORM in action are worthy of note; the mindset of the deployed personnel provides equally fertile ground for safety lessons in a combat environment.

A consistent theme among many was the focus on "overcoming" challenges, as opposed to "fighting" challenges. The positive mindset implicit in that focus likely carried through to every aspect of the safety field.

A likewise common theme expressed by many was confidence in their training. That confidence in their core-task proficiency enabled them to focus on the margins, the realm in which safety is most imperiled.

Several one-liners illustrate the mindset. From a flying squadron commander: "Even though this is operational/war/combat, do not be afraid to step back and say, 'This is stupid.'" From a Chief of Safety: "Do not lean so far forward that you fall on your face." From a maintenance squadron commander: "We make the mission happen, but no one goes home missing a limb." From a maintenance superintendent: "Back each other up, use the buddy system in everything." From a Chief of Standardization and Evaluation: "Trust others, but do not depend on others."

Cockpit Conversation

Cockpit conversations in the years to come are not likely to focus on the airfield golf course. Rather, they are likely to focus on the hardships endured, and the challenges overcome, on days spent in the infantry, and on days spent amid the fog of war. The stories will reflect the success of years of safety effort, and years of operational risk management training. And that is a good thing.

Just Give Me The Guidance

And I'll Give You The Tactics

Photo Illustration by Dan Harman

LT COL MARK KELLY
4 OSS
Seymour Johnson AFB SC
Courtesy *USAF Weapons Review*

In the 4 FW, we talk about risk level in every mission we fly. We design our tactics based on the mission risk level and implement more aggressive (hence riskier) tactics as the risk level rises. Mission commanders, in particular, must make several key decisions, particularly the go/no-go type (such as minimum package size and abort criteria), that will vary based on the mission risk level.

Right now, there is no common Air Force or Joint definition of what constitutes an acceptable level of risk for a given mission. The purpose of this article is to:

(1) Propose a definition for risk level in terms of the number of friendly losses that can be expected, and

(2) Propose tactics that will maximize F-15E offensive potential while satisfying the assigned risk level.

First off, what is an Acceptable Level of Risk (ALR)? For the purposes of this article, *ALR is defined as "a commander's directive to subordinates to shape further planning and execution decisions that specifies what level of potential losses is acceptable in order to achieve mission objectives."*[1]

So, whose job is it to determine what the ALR is? It is primarily the job of the Air Component Commander (ACC) and the Air Operations Center (AOC). Wing and group commanders also need to give guidance if the ACC does not articulate it well. Our job in the trenches is to design and execute tactics appropriate for the level of risk assigned.

Unfortunately, tactical risk level guidance is not well defined in the Air Tasking Order (ATO). When risk level is defined, it is usually in ambiguous terms written into the commander's intent section, such as "my first priority is to minimize friendly losses." At times it has been more specific, such as Brig Gen Buster Glosson's directive to Air Force units after the first week of DESERT STORM to "shift to medium altitude for ingress, egress and weapons release."[2] So, is that low, medium or high risk? Current Air Force Training, Techniques, and Procedures (AFTTP) 3-1 guidance acknowledges that "…in many situations…mission commanders will have to determine their own risk level after careful consideration of mission objectives…"[3]

Definition of Risk Level

Table 1 offers a definition for five ALRs and examples of types of missions associated with these risk levels. This table is adapted from a Naval War College academic research paper and an Air, Land, Sea Application (ALSA) Center Bulletin notice.[4] It uses five levels of risk, vice three, to better capture the entire spectrum of military operations from no-fly zone enforcement up to nuclear strike operations and defense against weapons of mass destruction (WMD).

Table 1. Definition of Acceptable Level of Risk (ALR)

Acceptable Level of Risk	Definition	Example
NEGLIGIBLE	No losses acceptable except those completely unpredictable and unpreventable.	Current ONW/OSW ROE[a]
LOW	Losses only at that expected for normal training or peacetime attrition rates. Accept only favorable engagements.	OCA Sweep Mission[b] Desert Storm Tank Plinking
MEDIUM	Losses expected at historical combat rates. Accept neutral or disadvantageous engagements; withdraw to preserve forces.	DCA Mission with IADS[c] OCA Force Protection Mission Vietnam Linebacker I and II
HIGH	Expected losses may render unit unfit for further combat. Accept major losses to achieve objective; preserve some future capability, if able.	DCA Mission without IADS[d] WW II B-17 Raids
EXTREME	Losses may result in complete force annihilation. Accept any losses necessary to accomplish mission.	Execution of SIOP[e] Defense against WMD

[a]Operation NORTHERN WATCH / SOUTHERN WATCH Rules of Engagement–strategic impact of any losses would be extreme.
[b]Offensive Counter Air Sweep Mission–can withdraw at any time.
[c]Defensive Counter Air Mission with Integrated Air Defense System support–need to defend point or area, but can withdraw to prevent heavy losses and still have point/area defended by other systems.
[d]Point/Area will be undefended if withdrawal required, but loss of point/area will not impact strategic objective and preservation of combat capability desired for follow-on missions.
[e]Any mission where consequences of failure are strategically, politically, or morally unacceptable; if mission fails, there is no tomorrow.

Ideally, we at the wing level would like to see these ALRs assigned to us in two places.

- First, we want to see an ALR assigned for the overall air campaign or air operation. This would be found in the commander's intent statement of the air operations plan and would serve as broad, general guidance on how much risk we are to accept as we execute the air campaign.
- Second, we would want to see an ALR assigned for each and every mission tasked on the daily ATO.

Risk level may vary by ATO mission. For example, the overall ALR for an air campaign might be LOW. The majority of missions tasked on the ATO will also be assigned an ALR of LOW. However, certain missions could be assigned an ALR of MEDIUM, or even HIGH, by the Joint Force Air Component Commander (JFACC) if he felt either:

1. The increased mission risk was worth a potentially significant gain. An example of this would be a four-ship precision attack against a high-payoff, time-critical target, such as an attack on the national leadership HQ. Successful attack of this target of fleeting opportunity could have a favorable strategic impact and might justify the potential losses.

2. The increased risk assigned to a particular mission would lower the risk to the overall force. An example is force protection of a bomber package. The fighters would be expected to accept more risk to keep the risk to the bombers low. A more extreme example is an interdiction mission against a biologically tipped missile expected to launch against a friendly city in two hours. The mission would be expected to assume almost unlimited risk to destroy the missile before launch.

Once we get well-defined ALR guidance from the JFACC, we are ready to design tactics. Our tactics should maximize offensive potential while maintaining enough defensive capability to keep our losses down to an acceptable level. The following sections of this article offer limits on just how aggressive we should make our tactics based on the assigned ALR. It's important to recognize that these tactical limits only set upper boundaries to manage how much risk we can take on.[5] They do not preclude accomplishing the mission with less risk. If a mission commander or flight lead can complete a mission assigned an ALR of HIGH without ever entering a SAM or Bandit Weapons Engagement Zone (WEZ), more power to him!

Table 2. Air-to-Ground Tactics Limits based on ALR		
Acceptable Level of Risk	**Definition**	**A/G Tactics**
NEGLIGIBLE	No losses acceptable.	Do not enter lethal WEZ of any SAM or AAA. Use medium/high altitude tactics only.
LOW	Accept only favorable engagements.	Do not enter lethal WEZ of AAA or MANPADS. Enter SAM WEZ only with fully effective SEAD.
MEDIUM	Accept neutral or disadvantageous engagements; Withdraw to preserve forces.	Enter AAA, MANPAD WEZs as required. Enter SAM WEZ with partially effective SEAD. No reattacks if being engaged.
HIGH	Accept major losses to achieve objective; Preserve some future capability, if able.	Enter S/A WEZs with marginally effective SEAD. Reattack as required but withdraw if threat overwhelming (e.g., suffer 25% losses).
EXTREME	Accept any losses necessary to accomplish mission.	Enter S/A WEZs without SEAD if required. Do not withdraw until target destroyed.

Tactics Versus Surface-To-Air Threats

Table 2 shows a way to limit the aggressiveness of our tactics against surface-to-air threats based on the ALR assigned:

Notice that the tactics I've laid out for each risk level are highly dependent on the effectiveness of accompanying Suppression of Enemy Air Defenses (SEAD). Here's a proposed definition for SEAD effectiveness:

- **Fully effective:** Can deny tracking engagements by keeping missiles on the rails or allow ballistic shots only.
- **Partially effective:** Cannot deny all tracking engagements but can distract operators, delay acquisition or disrupt guidance. On-board countermeasures and maneuvers can effectively degrade terminal guidance.
- **Marginally effective:** Cannot deny or delay tracking engagements. On-board countermeasures have limited capability to degrade terminal guid-

Table 3. Air-to-Air Tactics Limits Based on ALR		
Acceptable Level of Risk	**Definition**	**A/A Tactics Limits**
NEGLIGIBLE	No losses acceptable.	Do not enter Bandit WEZ. Use L&L tactics only or decline engagement entirely.
LOW	Accept only favorable engagements.	Avoid Merge when possible. Accept Merge only with *superior* merge ratios. Use L & L or L & D tactics as desired.
MEDIUM	Accept neutral or disadvantageous engagements; Withdraw to preserve forces.	Accept Merge with *equal* merge ratios. Use L & D tactics if required. Aircraft recovery higher priority than mission goal.
HIGH	Accept major losses to achieve objective; Preserve some future capability, if able.	Accept Merge with *inferior* merge ratios. Use Launch and Defend Tactics if required. Recover aircraft if able (no fuel morts).
EXTREME	Accept any losses necessary to accomplish mission.	Accept Merge with *inferior* merge ratios. Use Launch and Defend Tactics if required. Aircraft recovery not an issue.

ance. Depend primarily on numbers to saturate defenses and maneuvers to defeat shots.

These definitions are primarily effects-based, not based on numbers and types of SEAD platforms present. That means if the SAMs can't track you because all the EW radars have been previously destroyed and the SAM operators went on strike, well then, you have fully effective SEAD.

Assessing the overall effectiveness of SEAD assets against a particular threat array is something probably best left to SEAD specialists. For any given mission, the mission commander should rely heavily on intelligence (Intel), the wing Electronic Warfare Officer (EWO), information warfare (IW) experts, and the SEAD package commander in determining SEAD effectiveness. Once SEAD effectiveness is determined, the mission commander can determine whether or not he can meet the assigned risk level.

Tactics Versus A/A Threats

Table 3 shows a proposed way to define upper limits for A/A tactics based on ALR assigned.

Just as the previous A/G tactical limits varied with SEAD effectiveness, so the A/A tactical limits I've laid out vary in a large part based on our willingness to accept a merge. When is a merge accepted? Simple. A merge is accepted when you can no longer kinematically defeat a Bandit WEZ. How many live bandits yield a superior, equal, or inferior merge ratio? AFTTP 3-1, Vol. 4 (F-15) obliquely discusses the issue of "willingness to buy a merge" under winning or losing circumstances but does little to quantify how many live bandits will make the fighter willing or unwilling to buy the merge for a given risk level.[6]

The F-16 community has a more developed concept of when to "buy a merge." AFTTP 3-1, Vol. 5 (F-16) defines the following term:

Acceptable Merge Ratio (AMR). AMR is the ratio of friendlies to adversaries within factor range (FR) *(factor bandit range [FBR] to EAGLE drivers)* that the flight/element is willing to accept. AMR is directly linked to the mission's ALR. AMR differs based on adversary awareness and the friendly offensive capability.[7] *(Exact F-16 AMRs are classified. See AFTTP 3-1, Vol. 5 for Barre R. Seguin,* "Acceptable Merge Ratio and Factor Range Assessment" *(S), USAF Weapons School, 19 Jun 99 for examples.)*

To apply this concept to the STRIKE EAGLE, we need to make a few changes to AMR. (To keep things simple, I'll only discuss aware bandits.) First, the F-16 is a BFM machine; the F-15 is not. Hence, any definition of AMR for the F-15E should probably be more conservative than for the F-16. Second, although the F-16 definition recognizes that AMR differs based on friendly offensive capability (e.g., A/G configured versus A/A configured), I think AMR also needs to vary according to bandit airframe performance, weapons capability, and pilot proficiency.

So, a key point to remember is that *AMR is not simply a ratio of X Blue airframes to Y Red airframes; it varies based on risk level, bandit awareness and capabilities (both friendly and enemy).*

Using a bandit baseline of an aware MiG-29, flown by a pilot of typical adversary proficiency, and employing AA-10A and AA-11 *without* an HMS, I would assign the conservative AMRs in Table 4 for the F-15E in an A/A role.

AMR varies based on risk level, bandit awareness and capabilities.

Table 4. Example F-15E Acceptable Merge Ratio in an Air-to-Air Role

Acceptable Level of Risk	AMR vs. Aware MIG-29
NEGLIGIBLE	N/A (don't merge)
LOW	>2:1
MEDIUM	2:1
HIGH	1:1
EXTREME	1:2+

Using this baseline, we can think of AMRs for other types of bandits in terms of "MiG-29 equivalents." What if the bandit is a MiG-23 carrying only AA-8 for within visual range (WVR) use? Assume we assess him as only half

as capable as the MiG-29 in the WVR environment. We may want to decrease our AMR for risk level LOW (favorable merge ratio) to 1:1. What if the bandit is an F-16 flown by a western-trained pilot and carrying the Python IV and an HMS? AMR for risk level LOW may become N/A. This means don't merge; you can't achieve a favorable engagement without unacceptable losses no matter how many jets you have. AMR for risk level MEDIUM (equal merge ratio) may become 4:1 (almost the same as don't merge) and the AMR for risk level HIGH (inferior merge ratio) may become two F-15Es for each Python-equipped F-16.

Targeting ratio is the number of fighter radars versus the number of bandit groups.

An alternative way to express merge ratio that might be more familiar to the Eagle community is targeting ratio. Targeting ratio is the number of fighter radars versus the number of bandit groups. Assumptions here are that one fighter radar can target one bandit group and that each bandit group contains one or two bandits. I'd assign the targeting ratios shown in Table 5 against the same aware MiG-29:

Table 5 .Example F-15E Targeting Ratio in an Air-to-Air Role

Acceptable Level of Risk	AMR vs. Aware MIG-29
NEGLIGIBLE	N/A (don't merge)
LOW	2:1
MEDIUM	4:3
HIGH	1:1
EXTREME	1:>1

Notice that in cases of LOW and MEDIUM ALR, there remains an unallocated radar during initial targeting that can be used to sanitize and perform secondary targeter responsibilities. For HIGH risk, all radars are targeted and there is an increased chance of undetected bandits.

The implication of using targeting ratio, as a way to manage risk, is this: If the targeting ratio is satisfied, the fighters will commit to the merge if required to clean up anything that's left alive. If the targeting ratio is not satisfied, the fighters will "skate" or "short skate" off the initial launch.

I've only outlined the specific case of an F-15E in an A/A role versus various types of aware bandits. I haven't even touched on how AMR or targeting ratio varies if the bandit is unaware or if the F-15E is in an A/G role. Combining all these variables creates a much more complex subject that the squadron weapons officers need to tackle.

Application

Mission commanders can use these ALR definitions and associated tactical boundaries to determine the feasibility of mission accomplishment. If permission analysis reveals that the mission is unlikely to succeed using the tactical boundaries determined by the assigned risk level, the mission commander needs to inform Higher Headquarters (HHQ). HHQ then has three options:

1. Scrub the mission.
2. Allocate more assets to accomplish the mission or make other changes to the overall air battle plan that will enhance the chance of that mission's success while adhering to the assigned ALR.
3. Assign the mission a higher risk ALR using existing assets and the existing air battle plan.

In flight, mission commanders and flight leads can use the tactical boundaries associated with an ALR to make the following execution decisions:

1. Accept or decline a merge based on AMR or targeting ratio.
2. Make attack/reattack decisions based on real-time evaluation of SEAD effectiveness.
3. Abort a mission or package when it looks like ALR will be, or has been, exceeded.

Answers to Frequent Counter-Arguments

1. "The JFACC will always tell

me my risk level."

None of the Numbered Air Forces I've talked to have a plan to make it happen near-term. We should not expect that operational war planners will regularly give us a usable definition of risk level nor will they assign one for each ATO mission. At best, the AOC may phone the wing with a particularly "hot" mission and say, "This is high risk. Do whatever it takes."

2. "I don't agree with your choice of tactics for a given risk level."

Fine, design better ones! What's important is that we understand how varying degrees of ALR will have an impact on how much we "hang it out" and that we don't regularly suffer more losses than a JFACC envisions for a particular risk level.

3. "You can't dictate limits based only on ALR. Each situation is unique."

Agreed. ALR should not be dictatorial. But when the heat is on and you're the mission commander who has two hours to plan a 30-ship package, you need some useful Rules of Thumb to fall back on. Using these tactical boundaries as a starting point allows the mission commander to say, "OK, the guidelines for this MEDIUM risk mission say my tactics should be limited to X. Can I dial up (or dial down) my tactics for this mission and still hold the risk to MEDIUM?"

4. "Your definition of AMR is too aggressive (conservative)." Fine! Prove me wrong! What's important is that we accurately determine what is the maximum number of bandits of a particular type we can enter the WVR environment against and win!

5. "ALR is meaningless once people start shooting at you."

No argument here. ALRs represent planning and execution guidelines. Use of them implies being able to influence the situation early through premission planning, proper force packaging and smart execution decisions. Once you're merged 1 versus 2 or last-ditching a SAM, it's all EXTREME risk; you do what you gotta do to survive.

Conclusion

Planning and executing air missions in accordance with an Acceptable Level of Risk is a key component of strategic, operational and tactical level operations. ALR specifies what level of potential losses is acceptable to a commander in order to achieve his mission objectives. As we at the wing/squadron level apply the risk level assigned to us, we must recognize that tactical actions may have strategic consequences; a friendly shoot-down during current ONW or OSW operations would no doubt have significant negative implications for future operations.

Assuming we are given a usable definition of risk level, we can design and execute tactics that will meet HHQ intent. Whether we are operating against surface-to-air or air-to-air threats, the calculus is the same: Our ability to neutralize a particular threat, combined with a statement of just how much risk we are to assume, will set boundaries on our willingness to enter a threat WEZ.

Operational level air battle planners, the JFACCs and AOCs in the world, have not yet offered us a usable definition of risk level. In lieu of these definitions, they issue complex ROE and tactical guidance designed to accomplish the same thing, management of risk. We must fight to get risk level definition standardized throughout the Air Force and Joint community. In the meantime, we must use our best guess on what JFACCs construe the meaning of various risk levels to mean and build on that by setting smart tactical boundaries.

"ALR is meaningless once people start shooting at you."

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RUNWAY INCURSIONS

USAF Photos
Photo Illustration by Dan Harman

I Brought The Jet Back

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Does this sound like a mishap waiting to happen?

"Just bring the jet back." Those were the words I got from my Instructor Pilot (IP), a quirky Brit and great stick, as I headed out of the door for my initial area solo in the "Mighty Tweet."

"Just bring the jet back." I still think about those words from time to time because I almost didn't "bring the jet back."

There I was (isn't that how all great stories are supposed to start), strolling out to the Euro-NATO Joint Jet Pilot Training Program flightline in early fall of 1990 to get into the T-37 and go to the Military Operating Areas (MOAs) all by myself. Oh yeah, I was supposed to practice my basic acrobatic work: loops, rolls, and all that jazz, but what I really wanted to do was "pull Gs!" I mean, come on, I wanted to be a fighter pilot so what better place to "pull Gs" than on my first area solo?!? Does this sound like a mishap waiting to happen? It should!

Now, if you remember back to Undergraduate Pilot Training, the "limits" for the T-37 are G-limits: -2.67 to +6.67; Max Allowable Airspeed: 275 KIAS (due to longitudinal instability and rudder flutter); Structural Limit Airspeed: 382 KIAS.

My plan that day was to get into the airspace and pull the maximum G that the Tweet allowed me to pull. I was going to implement my plan by entering a slight dive, accelerate to around 320-330 KIAS, and then pull on the stick. Sounds simple, and I figured I was perfectly OK to do this. I mean, 320-330 KIAS isn't anywhere near the 382 KIAS Structural Airspeed Limit, so what's the problem? This is what we call poor Operational Risk Management (ORM).

It was a beautiful day. I got established in the MOA and accelerated beyond 300 KIAS. I then proceeded to plant the stick in my lap…and everything went black…immediately. What do I do now,

USAF Photo by TSgt Lance Cheung

I thought? I can distinctly remember hearing everything going on around me. The wind noise was loud, other flights were making radio calls, you know, the usual stuff, but I had no vision whatsoever. Complete tunnel vision.

After what seemed like an eternity, but in reality what was probably only a few seconds, I remember thinking to myself, "Am I going to be able to find the ejection handle without being able to see it?" And, "How am I going to explain this one to my IP? All he told me was "just bring the jet back."

"Just bring the jet back. Just bring the jet back. Just bring the jet back." I can remember hearing those words as I reached for the ejection handle. But, just before my hand got there, I regained my vision. After analyzing the situation, I put the throttles to idle, extended the speed brakes, and recovered my Tweet from a nose low dive out of the bottom of the airspace. And this was the first "maneuver" I'd performed in the MOA!

Needless to say, after gangloading my regulator and climbing back into the airspace, I trimmed the aircraft out and flew straight and level, back and forth in the MOA until my area time was up. I then returned to base and did a successful overhead to a full-stop landing. No acrobatics in the MOA; no pattern work at home base. I figured since I couldn't get my legs to stop shaking by the time I did my first pattern, I had no business trying anymore landings. All in all, it was a wasted training sortie. Or was it?

On that day almost 13 years ago, I made all the wrong decisions. I was wrong and yet for some reason, I'm still here. Looking back, I made three mistakes that day.

Mistake number one was violating Technical Order (T.O.) guidance. Dash-1 limits are established for a reason…most of them have been written in blood. They're not just good advice. They're the law!

Mistake number two was thinking I was invincible. I was a big Tweet solo student gunning to be a fighter pilot! "There's nothing I can't handle," or so I thought. I was wrong.

And mistake number three…well, mistake number three was not telling my story about this until now.

Besides being an integrity issue, in my current job, that of a mishap investigator for the HQ Air Force Safety Center (AFSC), I too often see the results of T.O. noncompliance, bad decisions, breaches of flight discipline, and poor ORM to name a few. If you're lucky, you only lose an aircraft. If you're not, you may lose your life or someone else's.

I was lucky that day. It's a sortie I've never forgotten. Believe me. I tell you all about it now in the hopes that some young, "dumb" pilot won't make the same mistakes I did way back when. I don't want to get the call at AFSC that we've had a mishap. And I really don't want to be notified that I'm the AFSC representative on a fatality-involved mishap. Follow the T.O.s, know your Dash-1, listen to IP and flight leads, and only do what is briefed. And if you're an IP, don't be afraid to share your scary stories with young pilots. They can learn from your past buffoonery. These are only a few of the foundations which will help you "just bring the jet back."

Mistake number two was thinking I was invincible.

Photos Courtesy of Author

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"Bird strike, standard." How often have you heard that during flight briefs? Probably a lot, and whenever I do, my neck hairs stand on end. Bird strikes are anything but standard operating procedure when they happen, and "standard" isn't enough. Crew coordination and situational awareness are critical to successfully recovering the jet. This starts during the flight and crew briefings, and you better know exactly what each crewmember will do if a bird strike happens before you step.

My bird strike happened in 1992. I had been flying RF-4Cs at Bergstrom AFB, Texas, for over a year and had good knowledge of the local area. I was scheduled for an early morning, single-ship, low-level reconnaissance sortie with three fragged targets—a typical sortie. My pilot that day was the 67th Reconnaissance Wing vice-commander, Col Terry J. Klungseth. I had never flown with him before. We met at the squadron early and planned up the sortie. The specific low-level we were scheduled to fly was down by the Gulf Coast near several oil refineries, where helicopters and birds were known to be route hazards. A 1000-foot tower as the low-level route went "feet dry" defined where we could descend from 1000 feet above ground level (AGL) to our planned route altitude of 500 feet AGL. Even though we just planned the sortie together, the briefing was probably one of the best I have seen. Col Klungseth thoroughly briefed how he wanted to handle visual lookout to avoid the birds and helicopters and exactly what we would do if anything hit us. This was different from most briefings I received, and I clearly remember paying closer attention to the extra details.

We stepped to the jet shortly after sunrise and took off into a beautiful Texas sky. The enroute portion was uneventful, and we "fenced-in" as we approached the coast. We started our descent to 1000 feet AGL and accelerated to tactical speed as we entered the low-level. It was still early, and I don't remember seeing much traffic (no air-to-air radar made everything in the RF-4C visual pick-ups). We made the turn inland and began looking for the 1000-foot tower so we could let down to 500 feet AGL. We just cleared the tower and started the descent when there was a tremendous bang in the front seat. The cockpit was momentarily in a "white-out" condition and I couldn't hear anything over a very loud roaring sound. I noticed the jet was still descending, so I pulled back on the stick and throttles to get away from the ground and slow down. There was some movement of the stick as I flew the jet up to around 2000 feet and slowed.

The only forward visibility in the RF-4C was a small gap in the rear cockpit's upper left instrument panel above the radar warning receiver. I tried to talk to Col Klungseth but couldn't hear anything over the wind's roar, so I peeked through the gap to see if he was OK. I admit I was scared when I saw him slumped forward in the seat. I had no idea of the jet's condition but we were flying, so I used every radio in the jet

to transmit in the blind we had an emergency. I turned the jet towards the nearest field and started to formulate a plan. A minute or two later, I felt the stick, and the rudders begin to move again. I peeked forward again and was relieved to see Col Klungseth's helmet was up and moving. I slowly released the controls when I was sure he had the jet, and noticed he changed the emergency steering from Ellington Field (the nearest divert field) back to Bergstrom AFB. I then transmitted our new destination and got into the emergency procedure checklists.

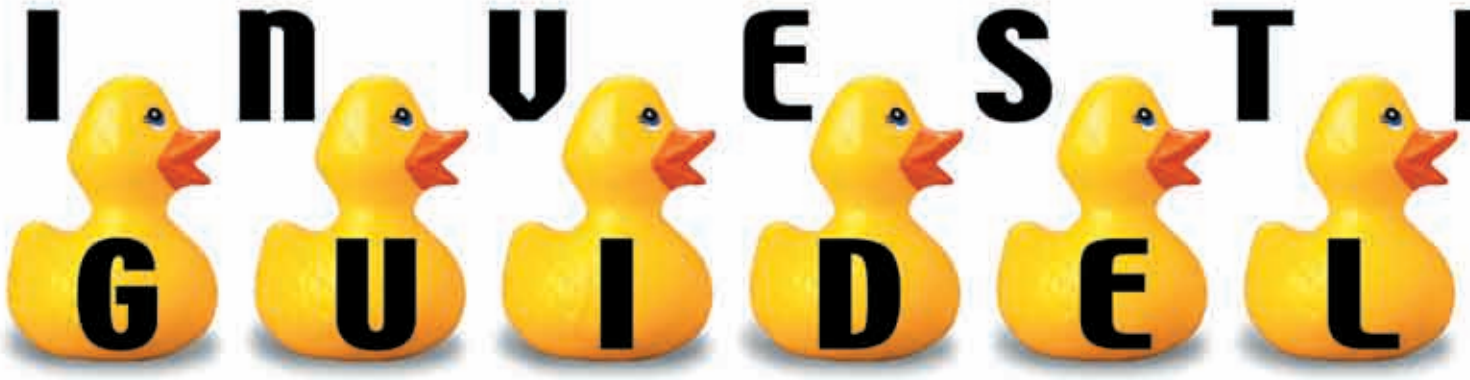
The return flight was the most intense of my entire career. We stayed about 2500 feet AGL and about 30 miles south of Bergstrom AFB, another RF-4C rejoined on our left side. We still couldn't hear incoming transmissions, but I transmitted that I had reviewed every checklist I could think of. The other jet signaled we looked all right and took up a wide route formation. Col Klungseth slowed and configured the jet on about a 20-mile final. We got thumbs up indications from our chase plane, and then they pressed out in front to land first. As we slowed to final approach speed, the windblast died to the point where we could barely hear each other yelling over the intercom. We confirmed we were both fine, and the jet was flying OK. Col Klungseth flew a shallow final approach with the jet in a right crab (so he could see the runway around the crazed windscreen) until touchdown. We touched down and successfully engaged the approach end cable. The emergency crews were waiting, and after we shut down the motors, they climbed up and safed our seats before we egressed the jet—because Col. Klungseth's face curtain handle had been ripped from his ejection seat. Both of us were covered in blood, guts and canopy shards when we egressed the jet.

We never found out what type of bird we hit. Post-flight analysis indicated the bird had struck the junction of the front cockpit canopy bow, the teardrop windscreen, and the left quarter panel windscreen. The impact shattered the canopy and the quarter panel, and crazed the windscreen to the point forward visibility was obscured. The bird then struck Col Klungseth in the forehead, stunning him, ripped the face curtain handle out of the top of his ejection seat and damaged his seat. Another quarter-inch of pull on the handle would have initiated a dual-sequenced, high speed ejection at impact. Hundreds of canopy pieces were forced into the rear cockpit; I have no idea how. Luckily, none of the canopy went down the engine intakes to compound the situation.

My bird strike happened twelve years ago. Bird populations have increased dramatically since then. Pelicans, Canada and Snow geese, cormorants, and all species of raptors are at all-time highs. You can blame the environmentalists if you want, but that won't change the facts—your probability of hitting a bird is higher now than ever before. Medium and high altitude is not a sanctuary either. Bird strikes have occurred as high as 37,000 feet. For bird strike and bird population statistics go to http://www.birdstrike.org and http://afsafety.af.mil/afsc/BASH/home.html. For route bird hazard forecasts go to http://www.usahas.com. Use the new tools and information available to plan and minimize your flight risk.

Very few bird strikes penetrate the canopy but you need to have a plan before it happens. Simulators can't accurately replicate the experience of such a bird strike. Verbal crew coordination is virtually impossible due to windblast. Single-seat pilots should have a comm-out game plan for what you expect from your wingman once you get your bearings back. Bird strikes that don't enter the cockpit are no less serious, as many accidents can attest to. If you do hit a bird, try to note your flight parameters so your flight safety representative can get the information out to the rest of us after your safe return.

I encourage all of my fellow aviators, nuggets to old craniums, to have a game plan for bird strikes and brief it! Who flies the jet; how do you transfer aircraft control; where/how are you going to land; how are you going to communicate (inside and outside the jet); how will you handle other emergencies/ejection—these are all subjects to brief. Don't accept "Bird strike—standard" because I can promise you, there is nothing "standard" when a bird decides to ruin your day.



CMSGT JEFF MOENING
HQ AFSC/SEMM

You want to get the big picture.

An aircraft mishap has just happened and a safety investigation is started. What are you, the maintainer, to do? Too many times here at the HQ AF Safety Center we get reports where an engine or aircraft part was improperly tagged or identified, or maintenance started tearing into the part before an investigation was started. Sometimes the true cause was not determined or several possibilities were left that couldn't be ruled out. Here are some tips that will help you, the maintainer, during the course of a safety investigation, and will help the Air Force find the true cause of a mishap. The goal is mishap prevention.

First, STOP and talk to the person in charge of the investigation before you touch anything. Maintainers are get-it-done types, and when an aircraft is broken they want to fix it. In addition, there is the push to get the aircraft back to mission capable status as fast as possible. We understand that, but if an investigation into a mishap is to be done, you must stop and leave things alone until a plan is set up as to what is to be inspected and torn down, before you proceed. You want to get the big picture and look at everything before you tear it apart.

Now that you have your plan of action and the safety/investigation team is in place, you can start the process. Pick a spot to start from and work your way through the engine or aircraft part, documenting what you are doing along the way. It doesn't really matter where your starting point is, as long as it is documented and you stick with it.

Mark your parts as you remove them. Make sure the tagging is correct and you log what is taken away. Make your numbers and letters legible. Make sure other people can determine if it is a 9 or a 6 and your S and 5 don't look alike. In addition, make sure the writing utensil that you use will actually mark on the part and will remain legible. The key to all this is consistency. Once you start marking things one way stay the course and don't change the horse in midstream. Otherwise you will just confuse the people who will be looking at your work.

The old saying that a picture is worth a thousand words is still true today. Digital cameras are everywhere, and if your unit has one, use it. If not, make sure you talk to your wing safety office as they will have one, or be able to get the base photo lab to assist. Take a multitude of shots that cover the process from the start, before you start the teardown, the disassembly process and the finished product with everything torn apart. Many things can be learned from

the photos that you may have missed as you took the aircraft/engine apart. The engineers and other analysts that will look at your pictures may pick up something that you missed, but is critical to the mishap sequence.

It's time again to talk about documentation. Make sure when you took all those pictures you wrote down what they were of and why you took them. This way you aren't relying on memory, but on documented fact. If you are really on top of the game, make little signs or ID numbers that you put into the picture that reference your notes. This way there is no doubt about what the picture is of and why you took it.

Go slowly! This is one time where time is not of the essence. Take the time to do the inspection correctly, as the faster you go you may destroy evidence of the failure. Pay attention to each part and ensure everyone involved understands why you are taking it apart. Look for differences in the parts as you take them off. If you are trying to set the record for the fastest investigation, you will miss the subtle differences that may tell the story.

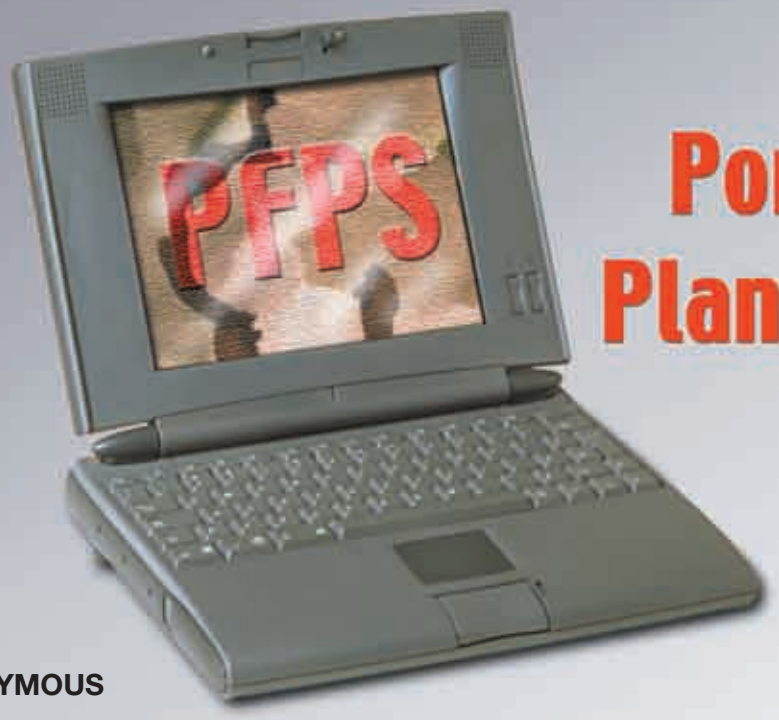
Observe everything and sweat the small stuff. This goes along with taking your time. Look at all the hardware and the little things that you would not normally look at. These little things can be the cause of the catastrophe. A key to look for is missing pieces. The little missing piece may be the starting agent for an engine FOD, or the cause of an electrical short. Besides, if the part has pieces missing, maybe there is a problem with the supply line that has gone unnoticed. Solving this could prevent the future loss of an airframe or aircrew.

Once you are all done, the safety gurus will pat you on the back for a job well done. Most importantly, the Air Force will have an effective record of what happened during the mishap. The goal of every safety investigation, or your own investigation, is to prevent future mishaps. Facts are what get the bad things changed in our Air Force. If you can present the bean counters with facts that the product is bad, or they need to redesign the process, or a supplier is not meeting standards, then they can act fairly fast and the money can come your way to fix the problem. Stating "I think it's bad" is not a good way to get the people who wear the stars, and direct where the money goes, to follow your suggestions.

I hope I have given you some guidelines to ensure your safety investigation is on track. If ever in doubt, contact your wing safety office. They are the local experts, and they can help ensure the right thing is done for the Air Force.

(Editor's note: Thanks to Product Support Quarterly, *Vol. 23, No. 4, 2002, pgs. 23-24, for the idea for this article.)*

Observe everything and sweat the small stuff.



Portable Flight Planning System in Combat

ANONYMOUS

Sitting in eighth grade DOS class on an Apple IIe computer in the early 1980s, I would never have thought I'd be relying on a computer to save my life one day. The rapid growth of computer technology, however, means computers pervade every aspect of life. In the flying world, the portable flight planning system (PFPS) is the current, vital, state-of-the-art tool for mission planners.

Although not an entirely new idea, the concept of flying with a laptop and integrated GPS is not one that has been wholeheartedly adopted throughout the Air Force. On many recent combat missions, however, the PFPS laptop has become a vital tool for rapid in-flight re-planning and situational awareness (SA).

On my first flight in support of OPERATION IRAQI FREEDOM, the PFPS did more than ease our planning; it wound up saving our lives. We were tasked to infiltrate SOF troops into northern Iraq on the longest special operations infil since World War II.

Because of the international climate and a need to launch the mission on a particular day, our crew was tasked to deadhead to a forward operating base and complete mission planning for the demanding infil sortie in a couple of hours—a task that normally takes days. Fourteen hours after landing, we married up with our plane and launched on one of the most demanding missions of our careers. As has become the standard in my squadron since initial operations in OPERATION ENDURING FREEDOM, we took off with the PFPS and GPS tied in as a moving map SA builder. With just under an hour of flying before we would enter enemy airspace, I finished up last minute "polishing" to the flight plan on the computer…entering actual winds and changing speeds accordingly. Timing was critical that night, due to multiple-timed landings at the destination landing zone.

Two hours into the flight, threat calls began coming in from aircraft further down track. We plotted them on our computer using the bulls-eye tool and derived accurate positions to enter into our onboard systems. As everyone knows, the original route you plan rarely becomes the route you fly when the fog of war creeps in. The EWO and I began assessing the fluid environment ahead of the plane with the newly plotted threats. We scaled in and out of charts down to imagery level, that our SOFPARS rep had loaded, to find those areas where we expected less danger. As we began a deviation around one of the plotted threats, tracer fire in the distance pushed us further off course than planned.

Suddenly I heard what sounded like a cue ball being thrown down on a pool table as enemy fire crashed into the pilot's swing window. This was followed by directed tracer fire lighting the black sky. We jinked and maneuvered the aircraft during a four-minute engagement. The flight engineer soon recognized that our number two engine had been hit as we had lost over half of our engine oil in less than two minutes. Per the Dash-1, we began the engine shutdown sequence just as we flew into a second hornet's nest. AAA was everywhere! We again began jinking, this time on three engines, and maneuvering the plane through all dimensions. The terrain-following (TF) system failed, leaving us in the moonless night with no radar at 250 feet and under attack. Anti-aircraft fire began to rip through the fuselage of the airplane and the smell of burning powder was evident in the cargo compartment.

The engagement lasted almost seven minutes, and I remember thinking to myself that our training scenarios never last this long. I kept up my SA with the ground map radar and PFPS while the pilot continued to jink. As we took more hits to the plane, it was clear we wouldn't be making it to our infil site—we had lost an engine and the aircraft structure was questionable; we had over-G'd, over-torqued, and over-temped all of the engines.

The utility of the laptop now became critical. I did a quick overview of the route on the laptop, noted our current position via the GPS track, and informed the pilot I could have him in a friendly country in 30 miles. He elected to take me up on the offer of a way out of the gunfire. I plotted a course on our moving map PFPS display from the latest track to the border using the range and bearing tool. Accuracy was critical as we skirted along another non-friendly border. We crossed the friendly border and entered the clouds, climbing into the mountains without a TF radar. With our compressed planning time, entering another country had not been part of our contingency planning. We had no VFR charts other than what was loaded on the PFPS laptop. I pulled MSAs for the flight path as we nursed the plane to altitude without radar control.

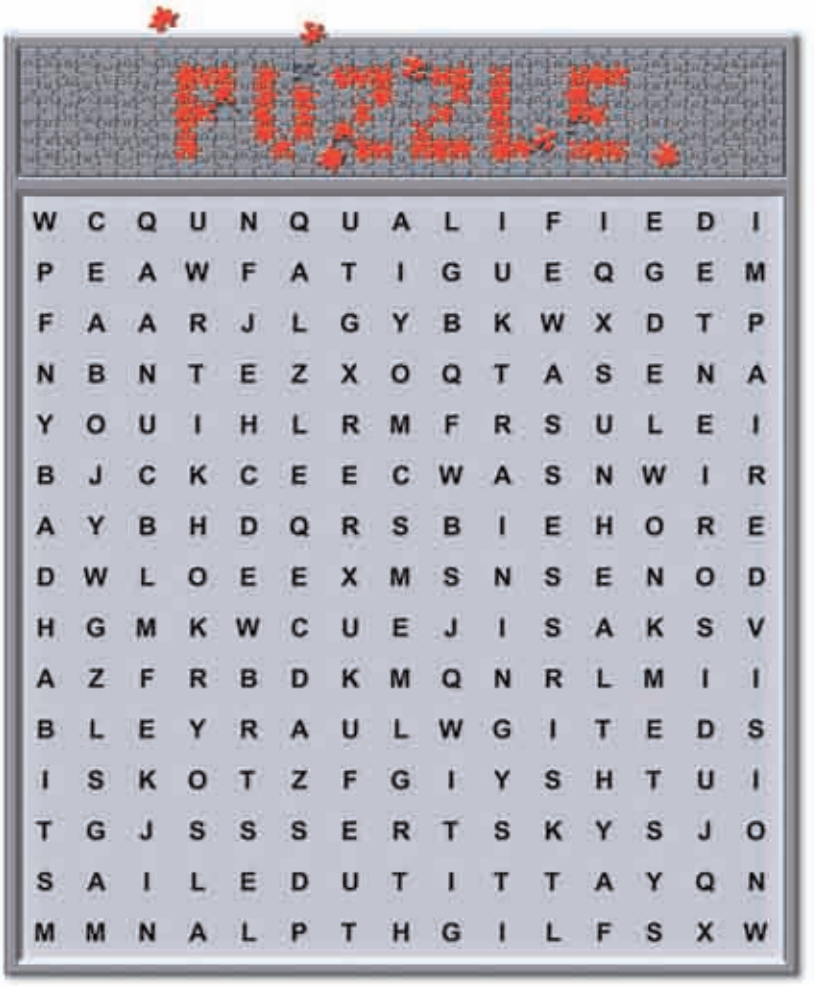
After throwing emergency in the transponders and pulling up Guard, we got an AWACS up who cleared us for an emergency landing. Again, I used the laptop to quickly look up unfamiliar fixes, build our flight plan for the route and pull a Self-Contained Approach off the hard drive for backup of the landing. After landing and egressing the plane, which was now spewing 30K of JP-8 through three holes in the wings onto the ramp, we went to debrief and used the GPS trail to complete a MISREP on the AAA sites.

As we sat down for our crew debrief, the crew and I discussed how fortunate we had been to have had the PFPS. We got ourselves into a situation demanding immediate and absolutely accurate data that only a computer could have provided. Had we not had the laptop, there is a good chance we could have flown into a third-party country, crashed into a mountain in the weather, or lost situational awareness while jinking and flown deeper into the threat environment. Our PFPS laptop became our most important safety tool that night, and I haven't flown a combat mission without it since.

Human Factors in Mishaps

By 1Lt Tony Wickman
Alaskan Command Public Affairs

- Assess Risk
- Attitude
- Bad Habits
- Boredom
- Careless
- Crew Rest
- Disoriented
- Fatigue
- Flight Plan
- Impaired Vision
- Major Dumb Ass
- Mistake
- No Checklist
- Panic
- Stress
- System Knowledge
- Unqualified
- Unhealthy
- Training
- Weather



OPS TOPICS

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

Aircrew members face many hazards in the air, but what about the hazards on the ground? Here are a few cases where the aircraft and other objects collided when they shouldn't have.

A-10 Versus Step Van

The event pilot (EP) taxied north-bound on the taxiway at approximately 15 mph. He was beginning his third of three scheduled sorties during an exercise. The event driver (ED) was driving south in a high-top step van on the east side of the taxiway. The ED saw the A-10 approaching and pulled over to the east edge of the pavement just north of a taxiway intersection to allow the aircraft to taxi by. The intersection was under construction and the ED had several barriers that blocked access to the intersecting taxiway. The EP did not see the step van on the side of the taxiway until it was approximately ten feet in front of his right wing tip. The EP continued to taxi and the right wing tip contacted the top of the step van. The impact between aircraft and step van destroyed approximately three inches of the lowest portion of the right wingtip, and dented and creased the step van's roof. The EP did not feel the contact, but did see composite "confetti" come from his right wing as it scraped across the top of the step van. The EP quickly stopped the aircraft after contact.

What are the conditions you will face when you taxi out for a sortie? Is there construction and/or vehicle traffic you need to be aware of? Make sure your path is clear. You need to keep heads up on the ground as well as in the air.

C-17 Versus Backhoe

During recent C-17 combat offload training, the windshield of a backhoe was destroyed. The vehicle was from the base civil engineering heavy equipment section complying with a work order to fill a low lying section of the airfield north of a taxiway and the C-17 ground operations area. The C-17 had just completed an assault landing and was preparing to accomplish combat offload training. In order to accomplish the combat offload, the C-17 had to back up to within 30 feet of the northern edge of the maneuvering area. At the time of the incident, the backhoe was approximately 244 feet from the aircraft, slightly off to the side of the aircraft. The mishap worker (MW) heard the engines of the C-17 spool up (that always get people's attention), and stated that there was a very strong wind that sounded like a "tornado." He heard a "pop" like a firecracker on the windshield of the backhoe, felt compression in the cab of the vehicle, and ducked down as the windshield shattered. The C-17 aircrew was unaware of the incident and completed their combat offload training and departed the area. There was no further damage to the vehicle and the driver only received minor scratches from flying glass.

Do you think there was a scheduling error here between base ops and CE? Why didn't the loadmaster or other crewmember see the backhoe? The crew probably wasn't looking for one, and thought the area was cleared for them as they were cleared to perform their training. Just a note to be aware of all the surroundings and look for unexpected vehicles.

C-5 In A Tight Spot

At an overseas location, a C-5 refueled at the main ramp and was directed by the tower to park on the adjacent ramp. The aircraft commander (AC) requested to remain where he was, but was directed to move for subsequent arrivals. The AC taxied to the taxiway and noticed a tremendous amount of

FOD, including hundreds of old box lunches and papers littering the ramp. Tower advised the AC to park on the current taxiway and to anticipate a 180-degree turn for departure the next day. When the crew arrived the next day, an aircraft was parked behind the C-5, blocking the crew's exit through the taxiway. The only other out available for departure was a different taxiway. This taxiway is listed as 42 feet wide in the Airfield Suitability and Restrictions Report (ASRR); however, the crew measured it as 75 feet, tapering down to 70 feet at its narrowest point. The AC called home station and spoke with a pilot who used this taxiway during a recent mission and knew of three other ACs who had done the same. While surveying the taxi route, the AC observed a 24-foot high wind sock located 107 feet left of centerline of the taxiway. Scanners were deployed to ensure adequate wingtip clearance, and the aircraft taxied safely past. The scanners returned from the long grass with numerous ticks on their clothes and hair. The remaining taxi out and takeoff were uneventful. Why bring up a successful and undamaged aircraft? How about the increased risk factors for potential damage to the aircraft? Here are some factors that applied to this situation:

- The ramp is relatively small and congested with a moderate number of daily commercial movements.
- When the crew arrived at the aircraft the next day, another aircraft was parked behind them, blocking their exit through the planned taxiway.
- The crew's only other out was a different taxiway, listed as only 42 feet wide in the ASRR.
- After calling home station, the AC learned that four C-5 pilots had used this taxiway during a recent mission.
- The taxi route actually measured as 75 feet, tapering down to 70 feet at its narrowest point
- The AC surveyed the taxi route and observed a 24-foot high wind sock located 107 feet left of centerline on the taxiway that could damage his aircraft.
- Using risk management, the AC deployed wing walkers to ensure adequate wingtip clearance to the wind sock.

Because the crew used sound judgment, thought through the potential dangers, and reassessed what they faced, they avoided an accident and damage to their aircraft. Even though the crew had to deal with numerous ticks on their clothes and hair, this is a success story. They thought enough of it to warn other pilots of what they could face by filing a HAP. Thanks to them for putting safety first!

Where's The Ground?

An HH-60 was participating in an exercise and the mission was briefed to be a two-ship tactical mission to include aerial refueling, low-level flying on night vision goggles, gunnery, and a live personnel pickup at an unfamiliar landing zone. The crew of the HH-60 briefed the mission and stepped to the aircraft. The crew completed an operational risk matrix, and the risk was deemed "high" for the mission profile. The weather was clear, winds were forecast to be 10-15 knots, and lumination was minimal at 5 percent (starlight only, no moon, no cultural lighting). Both aircraft took off and refueled from an HC-130, then proceeded to the gunnery range. Both aircraft then proceeded to the range to pick up survivors as part of the exercise.

The survivor was located on the side of a mountain, and the mishap aircrew directed the survivor to move to a road that was more suitable for the pickup. The lead aircraft marked a landing area that was next to the road oriented west to east. The flight engineer (FE) ran the power to affirm power was available for landing. The mishap aircraft (MA) flew an observation pass over the spot to determine the best position to land, and on this pass the crew lost sight on downwind. A second pass was flown to a 120 heading and winds were 020 at 10. On this approach, a vehicle on the road was spotted and the crew went around. Another approach was flown with the same run-in parameters. This approach was stable and controlled. Prior to the MA tail wheel hitting the ground, the gunner and FE called dust approaching from the tail. This dust eventually engulfed the aircraft and the mishap pilot transitioned to instruments in accordance with brown-out procedures. As the tail wheel hit the ground, the aircraft had approximately 10 knots ground speed.

As the aircraft landed, it rolled over a two-foot berm hitting the Forward Looking Infrared Radar (FLIR) turret and damaging the Lightweight Airborne Recovery System (LARS) antennas and color weather radar radome. The FE called brakes and the aircraft came to a stop. The FLIR scope went black and the MP directed the FE to deplane and inspect for damage to the aircraft. The FE determined the aircraft was still flyable and that power was available for takeoff. The survivor was directed to get on board the aircraft for the return flight to base. The lead aircraft was notified of the mishap and the two aircraft returned directly to base.

The crew encountered a ground obstacle they didn't plan for and, due to brown-out conditions, couldn't see. This resulted in $15k of damage to an aircraft and a bunch of lost mission-capable time. How do you avoid this? One suggestion from the crew would be installing a "lift kit" on the USAF HH-60 fleet, similar to that utilized on the UH-60l model helicopters employed by the California Department of Forestry. Another possible solution would be to upgrade all USAF rotary wing assets with sensors to allow detection of obstructions (capable of damaging the aircraft) in landing zones. Until we can get a system designed and installed, mishap prevention rests with you, the aircrew to avoid the ground obstacles that will always pop up when least expected.

Maintenance Matters

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

FOD it is the ultimate enemy of our aircraft and engines, and unfortunately we put it there. Here are a few cases where we, the maintainers, created more work for ourselves and damaged aircraft.

F-15 Engine FOD

The mishap sortie was planned, briefed, and flown as an F-15E air-to-ground operational test mission. The mission was uneventful until after landing. The aircraft displayed an automatic thrust departure prevention system (ATDP) caution, indicating a possible problem with the avionics interface unit 1. The maintenance crew chocked the aircraft and began troubleshooting the ATDP caution. To facilitate the maintenance repairs, the left engine was shut down and the right engine rpm increased to 78 percent to allow sufficient avionics cooling for extended single-engine ground operations. Approximately one minute after increasing the rpm on the right engine, the crew heard an abnormal amount of noise and felt abnormal vibrations from the right side. The right engine was shut down and the crew egressed normally.

After engine shutdown, maintenance performed a borescope inspection on the right engine and found damage to four blades, in the 3d, 4th, 12th and 13th stages of the compressor. This damage was square and sharp at the edges and consistent in size, indicating that something metallic had caused the damage. Maintenance impounded the aircraft, pulled the engine and sent it, along with the borescope recordings, to the engine back shop. After opening and dismantling the engine core, engine back shop technicians discovered numerous areas of FOD damage, including blades and stators throughout the compressor section.

Photographs of the damage, as well as three of the damaged blades, were sent to a laboratory to be analyzed. Results of the analysis indicated a high amount of zinc and iron in the damaged areas. This result is consistent with galvanized steel. The size and shape of the damaged portion of the blades were analyzed. The laboratory personnel concluded that a general-purpose cotter pin was the most likely object. Further, because aircraft-grade cotter pins are typically fabricated from stainless steel, the cotter pin most likely came from flightline-authorized ground equipment.

This example shows that we must ensure the ramp, as well as the aircraft, is FOD free. Do you do a ramp FOD walk prior to your aircraft coming back from a sortie?

Old C-130 Engine FOD

After a local night vision goggle training mission, maintenance personnel discovered damage to the #3 engine compressor section, and reported it as a FOD incident. The engine was taken to the engine regional repair center for tear-down and analysis. The engine was replaced and the mishap aircraft returned to service.

During teardown, FOD damage to the first stage rotor and stator, the third stage stator, and the fifth stage rotor was discovered. The first stage damage was partially coated with a small amount of blue dye, used after repair to alert other maintenance personnel to the repair and that the damage is within technical order limits. The third and fifth stage damage had the presence of soot trails behind the nicks, which could mean that the damage had been there for a while. There was no evidence of any repair attempt to the damaged third and fifth stage areas. Impact marks on the third and fifth stages are consistent with damage caused by cotter pin ingestion.

Investigation of maintenance and home station check records revealed no documentation of a prior blend job or FOD damage to the engine. This is not unusual since prior to the Oct 02 release of AFI 21-101, blend repair documentation was not required. Somehow, this engine ingested a cotter pin that damaged the engine. Maintenance personnel discovered the damage to the first stage, repaired (blended the blades) and dyed the area to indicate the damage was within specifications. However, personnel did not inspect further sections of the engine for any additional damage, nor did they report the FOD.

During a routine intake inspection maintenance noticed the dent in the first stage, saw the blue dye and assumed the engine damage was within technical order specifications. Over time, most of the blue dye wore off, so maintenance personnel "assumed" the damaged was new and reported the FOD incident.

How good is your FOD program, and when FOD is found, how good is your inspection? Do you look just at the surface or perform a thorough investigation?

MH-53 and A Cotter Pin

While performing the intake inspection for a compressor wash, a maintenance technician noticed some nicked #2 engine compressor blades. Further inspection, including a borescope, found all 14 stages of the compressor damaged beyond repair. During the inspection, technicians found a partially intact cotter key jammed in the root of one of the first stage compressor vanes. The cotter key originated from the support stops located on the #2 engine air particle separator (EAPS).

The MH-53J/M has an EAPS air filtering system attached to the intake section of each of the two engines. The EAPS slides forward or aft on channel-type rails for maintenance access on the engine inlet assembly. Tech data mandates straight-headed pins secured by cotter keys be used at the support stop attach points located on the channel at the aft end of the EAPS assembly. Instead of the proper straight-headed pin/cotter key assembly, only the cotter key was used to secure the EAPS. The edge of the upper hole that normally houses the straight-headed pin on the number two EAPS assembly was elongated and broken allowing the unauthorized cotter key to work loose and be ingested through a small gap in the EAPS ring, damaging all 14 compressor blades.

A random sampling of three aircraft was completed and none of the EAPS support stops were configured IAW tech data. Instead of the required straight-headed pin/cotter key assembly, the support stops were configured with either one or two cotter keys, safety wire or nothing at all. Maintenance supervisors stated that the cotter keys had been used in place of the straight pin/cotter key assembly for as long as they could remember. Supervisors estimate the unauthorized configuration probably originated at a much earlier date when the straight pin was not available and the cotter key was used as a temporary fix. This configuration then became the unauthorized standard. There is no T.O. supplement or waiver in place or on request authorizing this temp fix.

How many other procedures are out there that are accepted as the right way even though the tech data doesn't authorize the procedure? If you don't know or haven't looked, maybe it is time you did!

MC-130 Throttle Binding

The event crew was on a day pilot proficiency mission performing some pattern work. The flight was cut short due to an in-flight engine shutdown, and the crew returned and landed uneventfully. Maintenance impounded the aircraft after the crew wrote up the aircraft for a binding number two engine throttle. Maintenance disassembled the throttle quadrant and discovered a rosebud light lens was binding the number two engine throttle pulley. Review of maintenance documentation revealed that the crew from the previous mission had written up a missing rosebud light lens from the landing gear handle, but it was not found on the subsequent post-flight inspection.

I guess the FOD on the flight deck inspection wasn't as thorough as it could have been. What are your procedures for FOD in the cockpit? Make sure you check all the areas, as the pieces and parts can get into some really weird and dangerous places.

F-16 Versus Mirror

A crew chief was tasked to clean the intake of the mishap aircraft due to a bird strike during the previous flight. Tools used to accomplish the cleaning of the intake were a magnifying glass, flashlight, inspection mirror, and two pieces of cheese cloth. After the cleaning was done, the crew chief was tasked to preflight the aircraft for an afternoon mission.

The afternoon mission was flown without any noted anomalies. The swing shift crew chief performed a post-flight intake inspection of the aircraft and found a magnifying glass at the bottom of the intake wedged between two of the inlet guide vanes. The magnifying glass was missing an inch of its rubber handle. The engine was removed from the aircraft and borescoped—no internal damage noted to the engine, but three first stage fan blades were damaged beyond repair.

We were lucky on this little incident, as we didn't trash the engine. However, if a proper CTK inspection had been done, do you think the mirror would have flown with the aircraft? Tools belong in the tool box and not on the aircraft. The CTK program is only as good as the integrity of the maintainers who use it!

FY04 Flight Mishaps (Oct 03-Mar 04)

12 Class A Mishaps
6 Fatalities
4 Aircraft Destroyed

FY03 Flight Mishaps (Oct 02-Mar 03)

11 Class A Mishaps
3 Fatalities
10 Aircraft Destroyed

05 Oct		A C-17 experienced internal engine damage.
09 Oct		A KC-135E experienced a number 3 engine fire.
14 Oct	✈	A T-38 crashed during takeoff.
17 Nov		A KC-10 experienced a destroyed engine.
18 Nov	✈	An A-10 crashed during a training mission.
23 Nov	✈	An MH-53 crashed during a mission. Five fatalities.
31 Jan		A KC-10 experienced an engine failure.
03 Feb		An E-4B had an engine failure in flight.
04 Feb		A C-5B had a right main landing gear failure.
25 Feb	✈	An A-10 crashed after takeoff. The pilot did not survive.
27 Feb		A B-1B departed the runway during landing .
01 Mar		An F-15 departed runway during landing.

Editor's note: 5 Oct C-17 engine mishap has been changed from a Class B mishap to a Class A.

- 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 USAF 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 and ground safety statistics are updated frequently and may be viewed at the following web address: http://afsafety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/statspage.html.
- **Current as of 10 Mar 04**. ✈

AVIATION

The Aviation Well Done Award is 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.

MAJ DARRELL L. THOMPSON
420 FTF
Mesa, AZ

On 18 December 2002, Major Darrell L. Thompson was flying a T-38A aircraft from Columbus AFB, Miss. to Mesa, Ariz. for the T38C avionics upgrade. After passing through FL 200, the aircraft experienced uncommanded pitching of +/-10 degrees and oscillating rolling between +/-30 degrees. Maj Thompson declared an in-flight emergency and turned back to base. Both hydraulic systems indicated normal with no caution or warning lights, but the aircraft's flight controls seemed spongy and randomly unresponsive. This unusual emergency situation was not covered by any single Emergency Response Checklist.

Maj Thompson suspected a possible rudder yaw damper system failure or a runaway trim malfunction. But after conferring with a pilot delivering another aircraft, he ruled out a trim malfunction and determined that a rejoin to inspect his aircraft at night was not practical. Preparing for a controllability check and a possible ejection, he requested technical assistance from the Columbus AFB Supervisor of Flying (SOF). Given a block altitude between 15,000 and 20,000 feet MSL for his controllability check, he determined his aircraft was controllable and that a landing with gear and full flaps was possible with a touchdown speed within 10 knots of normal.

Surface winds were 30 degrees off runway centerline, gusting between 15 and 25 knots. With roll oscillations increasing to +/-45 degrees and continuing but controllable pitch oscillations, Maj Thompson decided that landing was preferable to ejecting at night in high winds. He ran the pre-ejection checklist as a precaution and resumed his recovery to Columbus AFB. The increased roll oscillations required more stick deflection to maintain aircraft control, and this caused the aircraft landing speed to increase to 200 knots. At about 50 feet above the ground, the aircraft rolled 30 degrees to the right. Maj Thompson quickly recovered to wings level and landed at 185-190 knots (more than 50 knots above normal touchdown speed). He brought the aircraft to a stop on the runway without using the arresting barrier.

Post-flight investigation revealed several critical hydraulic system component failures, including a temperature probe, pressure relief valve, and hydraulic pressure gauges (which continued to give normal readings after failing). These failures caused the hydraulic pump seals to melt, allowing foreign object damage to the pumps and their eventual failure. Metal fragments from the hydraulic pumps damaged the servo actuators of the flight controls and in turn caused the pitch and roll oscillations.

Maj Thompson's courage and expert pilot skills enabled him to save a valuable Air Force aircraft. Well Done!


Mishap Reduction...
MJ-1B
It's everybody's Business