APRIL 1997

flying SAFETY

U.S. AIR FORCE
50
1947 - 1997

BIRDSTRIKE!

See page 15 for a comprehensive guideline.

REFOCUSED

Official USAF Photo

CAPT TONY MONETTI
393 BS/DOV
Whiteman AFB, Missouri

■ I'm sitting in the seat of the B-2 simulator on the return trip to Whiteman AFB after completing a Global Power sortie. The past 36 hours have been filled with hours of boredom and minutes of excitement. The bombs dropped on this sortie, however, will not produce the same effect as the already proven destructiveness of a 2,000-pound Global Positioning System-Aided Targeting System (GATS/GAM) bomb. This mission was a simulation.

The lessons learned from this experience are enormous. I must admit I wasn't exactly gung-ho about jumping into a "sim" for 36 hours, especially when my N.Y. Yankees were playing Baltimore for the A.L. championship. However, I did learn some valuable lessons.

Aside from the physiological lessons learned, the greatest thing this sim did was refocus my direction. I found myself digging in the books, searching for answers to system problems. I found myself second guessing what the range of a certain threat was, or how to do a replanning exercise.

The point is, I wasn't concerned about typing hangar fly minutes or creating new aircrew books. The admin job will always be waiting on my desk, and e-mail will always be filled with unread messages. However, when it comes time to drop bombs on bad guys, I won't have wished I had spent more time on the "fluff stuff." My focus needs to be on getting the bombs on target, knowing the enemy, and recognizing my aircraft's capabilities and limitations.

The enormous responsibility placed on our shoulders as airmen cannot be underestimated or forgotten. It's too easy to do that in our environment. I'm not saying we shouldn't be concerned with the "fluff stuff." We understand there is a need to find balance for our responsibilities.

The sad part is I had forgotten it was only 5 years ago that I was sitting in the seat of a B-52, dropping bombs against a real enemy with real bullets coming at my crew and me. How could I forget the fear of combat as we attacked the Iraqis at 400 feet at night in the weather? I have experienced the sting of battle, and I understand what it is to fear the unknown. This sim brought it all back for me.

Although I am tired and gruffy, I am grateful for the experience. What an incredible tool we have at our fingertips! Use that sim to its potential. The SAM's from the sim won't hurt. The poor decisions made on a bomb run can be replayed. Systems knowledge can be refreshed.

So as I prepare myself for recovery to Whiteman AFB, I can reminisce about what a wonderful sight it was to see the east coast of America as I returned from the war. As I look out the cockpit of the B-2 simulator and see the lights of the city, I see them through the eyes of a refocused airman. ✈

UNITED STATES AIR FORCE

AIR FORCE RECURRING PUBLICATION 91-1

Flying Safety

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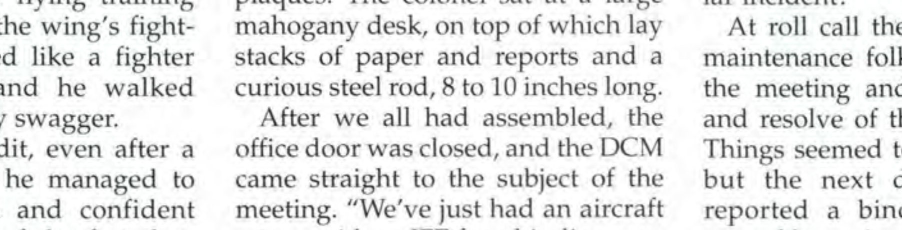
CONTRIBUTIONS
Contributions are welcome as are comments and criticism. No payments can be made for manuscripts submitted for publication. Call the Editor at DSN 246-0936 or send correspondence to Editor, *Flying Safety* Magazine, HQ AFSC/PA, 9700 G Ave., S.E., Ste 282, Kirtland Air Force Base, New Mexico 87117-5670. The Editor reserves the right to make any editorial changes in manuscripts which he believes will improve the material without altering the intended meaning.

THE LONG STEEL PIN

CMSGT ROBERT T. HOLRITZ
Technical Editor
Reprinted from *Flying Safety*, Oct 90

■His name is not important, although many who read this article will recognize the person it is about.

He was an excellent Deputy Commander for Maintenance (DCM). Unlike his predecessor, who ruled the maintenance complex like Castle Grayskull, the colonel enjoyed an excellent rapport with both officers and enlisted folks whose job it was to keep the aging fleet of fighters combat ready. Also, unlike many DCMs, he was a command pilot and maintained his proficiency by regularly flying training missions in one of the wing's fighters. He even looked like a fighter pilot—tall, slim—and he walked with a kind of cocky swagger.



It was to his credit, even after a year as the DCM, he managed to maintain his calm and confident demeanor in spite of the fact that, like most maintenance outfits, we had our bad days. Even when the flying schedule came apart like a $2 watch, and the stats were lower than a snake's belly, he maintained his composure. For this reason, I was surprised when the maintenance officers and senior NCOs were called to his office for an "immediate" meeting.

The colonel's office was typical. Just inside the door stood a glass case full of books and memorabilia. The walls were cluttered with plaques. The colonel sat at a large mahogany desk, on top of which lay stacks of paper and reports and a curious steel rod, 8 to 10 inches long.

After we all had assembled, the office door was closed, and the DCM came straight to the subject of the meeting. "We've just had an aircraft return with an IFE for a binding control stick," he said. He placed a piece of hardware on the desk just in front of the metal rod. Then, in a voice that quavered with more than a hint of anger, he said, "QA found this jammed under the stick boot."

His point was quite clear. This small piece of widget almost caused the loss of an aircraft and possibly the lives of its crew. "I don't want this to happen again."

As he rose from behind the desk, it was evident the meeting was over. Everyone was surprised at the DCM's attitude. Why, after a year in the maintenance business, with IFEs almost a daily occurrence, did the boss get so upset over this particular incident?

At roll call the next morning, all maintenance folks were briefed on the meeting and on the sternness and resolve of the colonel's words. Things seemed to return to normal, but the next day, another pilot reported a binding control stick caused by a piece of stray hardware. Except for a short moment of controlled rage at the morning meeting, nothing came of it. Once again, the maintainers were reminded of the colonel's strict policy on preventing FOD.

The next morning, the word came down from the squadron commander a third aircraft returned from flight with a binding control stick, and the DCM would hold a mandatory meeting for all maintenance people in one of the hangars that afternoon.

Anyone with any sense avoided the DCM's office that day. It would do little good to try to convince the colonel three incidents in as many days were just bad luck and not the beginning of a potentially disastrous trend.

The flying schedule was cut short, and the maintenance people assembled in the hangar at 1530. The colonel arrived exactly on time and climbed on top of a flatbed trailer parked along the back wall of the hangar. I noticed he was holding what at first appeared to be a pointer. But after a closer look, I realized it was the long steel rod the colonel kept on his desk.

I don't recall the exact words of his address, and to my knowledge they were not recorded, although they probably should have been. In a firm, but not threatening tone, he expressed his concern over the recent flight control incidents.

"There is nothing more frightening for a pilot than to have his flight controls jam," he reminded the audience. All three of the recent mishaps were caused by maintenance-generated FOD. He went on to describe the incidents which occurred during the past 3 days. Then he paused for a second, took a step back, and began a recount of his personal experience with jammed flight controls—which nearly cost him his life 15 years prior.

He was the pilot of an F-4C during a two-ship training mission, flying over England at about 16,000 feet. As he began to bring the aircraft into an inverted flight maneuver, the controls jammed, causing the aircraft to enter an upright, wings-level dive. The aircraft accelerated to about 400 knots and entered a cloud layer at 5,000 feet. In spite of his efforts to free the jammed controls, the aircraft continued to dive.

The jet broke through the cloud layer at about 3,000 feet, and at the pilot's direction, the WSO ejected. With the aircraft now approaching 2,000 feet, he knew he had to get out. He also knew that at more than 550 knots, his chances for a successful ejection were almost none. With one hand on the stick to stabilize the aircraft, he said a quick and humble prayer, then pulled the ejection handle with the other hand.

He ejected at less than 1,800 feet. At nearly 600 knots, the force of the windstream was incredible, ripping the gloves from his hands and tearing off his helmet. His 6-foot, 4-inch, 200-pound frame was flailed about like a marionette. The chute opened at just under 1,000 feet, and after clipping the top of some trees, his twisted body landed only a few feet from a pond.

As he lay there, both arms and legs broken, he knew only by the grace of God was he alive. The aircraft crashed in a wheat field not far from where its pilot landed. There was no fire. The Phantom hit in an almost perpendicular attitude, penetrating 45 feet of earth and leaving a crater nearly 40 feet deep and 30 feet wide. The drag chute and a small wing panel were the only hints an aircraft was buried beneath the crater.

Although he survived, he was seriously injured. His chances for recovery were good, but the doctors agreed he would never fly again. He spent the next few years in and out of the hospital with a steel pin inserted in one of his legs to allow the bone to heal.

But the young pilot did not accept the doctors' prognosis. Instead, through his determination and faith, he recovered and made it back into the cockpit. The curious steel rod he kept on his desk, and now held in his hand, was the pin that once joined the broken bone in his leg.

As he walked out of the hangar, I realized, for the first time, his walk was not that of a cocky fighter pilot, but a reminder of the day FOD almost cost him his life. ✈

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POSTAL INFORMATION — *Flying Safety* (ISSN 00279-9308) is published monthly by HQ AFSC/PA, 9700 "G" Avenue, S.E., Kirtland AFB NM 87117-5670. Second-Class postage paid at Albuquerque NM and additional mailing offices. **POSTMASTER:** Send address changes to *Flying Safety*, 9700 "G" Avenue, S.E., Kirtland AFB NM 87117-5670.

Intro to DIGITAL COMMUNICATIONS-102

Part 2

(What you won't hear anymore!)

MAJ BEN RICH
Air Force Reserve

Last month, we gave you some background information on Aeronautical Radio, Inc (ARINC) and Aircraft Communications Addressing and Reporting System (ACARS). ACARS is the communications vehicle through which ARINC communicates with subscribing aircraft. We also talked about weather information availability and terminal weather information for pilots. This month, Part II will cover pre-departure clearances, digital automatic terminal information service, and digital delivery of taxi clearance. For readership ease and reference, the many acronyms used in this article are spelled out in the article as well as listed in sidebar, "Acronyms."

Pre-Departure Clearances

Probably the biggest crew enhancement was the deployment of the Pre-Departure Clearance (PDC) program. With commercial airports running in excess of 75-100 IFR departures per hour, frequency congestion and timely retrieval of enroute clearances was nearly impossible. Before PDC implementation, the ATC clearance delivery process was labor intensive in terms of controller voice-communications workload and was susceptible to human error. Also, frequency congestion reached highly undesirable levels at many facilities, and a solution was found.

In July 1989, PDC first began as a demonstration of a Mitre Corporation prototype using the ARINC data networks at Dallas-Fort Worth International Airport. American Airlines was the first participating carrier. By December 1989, Chicago O'Hare joined the demonstration and United Airlines was added. USAir and Delta began receiving PDCs in mid-1990. In September 1990, San Francisco began the demonstration, and all four carriers participated. As a result of the great success at the towers and with the airlines, other airlines wanted to participate, and the Air Transport Association (ATA) petitioned the FAA for a national program.

The FAA established a fast-track (I know, an oxymoron—FAA/fast track) program to develop and deploy PDC at 30 airports. By the spring of 1991, ARINC completed conversion of the Mitre software into an operational system and completed the deployment by the summer of 1992.

Tower personnel compose enroute clearances for data link delivery based upon information contained in the departure flight strips plus local operational instructions selectable from menu lists (active runways, specific Standard Instrument Departures (SID), altitude restrictions, etc.). After reviewing and appending any local information, the clearance is transmitted to participating subscriber computers. The subscriber then takes responsibility for delivering the clearance directly to the appropriate aircraft using ARINC ACARS or to a dedicated

This clearance was issued on the 25th @ 1553Z.

The aircraft registration is N001ZZ at Atlanta.
It is for Flt #103 on the 25th from ATL to DFW.
It is being issued through PDC.
Aircraft identification and Transpndr Code 4115.
Aircraft is MD-80 w/TCAS and VOR NAV &
departure is sked for 1600Z & planned for FL310.
Route of flight is West 2 transition to Birmingham

Specific Departure Instructions

```
251553 FROM 52 52
AGM
AN N001ZZ/AP ATL
- FLIGHT 103/25 ATL-DFW
PDC
ZZL103 XPNDR 4115
T/MD80/A P1600 310

ATL WETOW VUZ SQS SCY7 DFW

CLEARED VIA ATL FOUR DEPARTURE
JETS MAINTAIN 10,000, PROPS
MAINT 4,000
REFER TO ATL4 SID FOR DEP FREQ

END
```

Figure 1
A typical PDC issued clearance.

printer. Data link delivery of clearance messages relieves much of the voice congestion on the clearance delivery frequency by eliminating voice clearance delivery to users participating in the program.

The following information refers to figure 1. The ATC clearance for Global Airlines #103 from Atlanta to Dallas-Fort Worth for the twenty-fifth of the month was issued at 1553 hours. The aircraft was cleared via the West Two transition of the Atlanta Four Departure to maintain 10,000 feet. The departure freq is available on the SID, and the entire route of flight is listed. All of this was accomplished in approximately 15 seconds without a single radio transmission! There are now 56 PDC participating airports with nearly 340,000 clearances issued via data link monthly (over 4 million annually).

Digital Automatic Terminal Information Service (D-ATIS)

The next logical step in the information availability through ACARS was to include Digital Automatic Terminal Information Service (ATIS). (See figure 2.) ATIS is presently a continuous voice broadcast over VHF and UHF air/ground channels. It provides local weather, approach(es) in use, departing runway, Notices to Airmen (NOTAMs) in some cases, and hazardous weather warnings. Pilots are encouraged to obtain ATIS messages before requesting departure clearance and upon arrival in the terminal airspace before contacting approach control.

The controller uses a Tower Data Link Services (TDLS) system to make both the PDCs and ATIS available to the

continued on next page

(Houston Intercontinental Airport-IAH)

For Aircraft N465ZZ
This is ATIS Information Uniform for 0253Z
Calm Wind, 8 mi vis, temps 23/22 Altg 2987
Active Runways

NOTAMs

```
.ANPAIXA 050303
AGM
AN N465ZZ
- IAN A038 - IAH ATIS INFO U 0253Z.
00000KT 8SM BKN250 23/22 A2987
ARRIVALS EXPECT ILS RY 14L, ILS RY 26,
ILS RY 27. DEPG RY 14L, RY 14R, RY 26
NOTAMS... UNLIGHTED TOWER 2 MILES
SSW RUNWAY 14L ONE HUNDRED
TWENTY FEET AG. TWY NK SOUTH OF
TWY NB RESTRICTED TO DC10 AIRCRAFT
AND SMALLER... ADVS YOU HAVE INFO U
```

Figure 2
A typical D-ATIS transmission for Houston's Intercontinental Airport, the first operational site for D-ATIS.

A typical push-back approval message telling the aircraft the push is approved and a taxi limit of the "top of the circle."	- PUSH 1047/15 DTW - PUSH APPROVED - TAKE IT TO THE TOP OF THE CIRCLE
A typical taxi message telling flight 1047 to plan the "Silver 1" published taxi route to RWY 21R while using 121.8 Mhz. The current ATIS is "Delta," and the aircraft should "hold" on Spot 5 and "Monitor" ground control.	- TAXI 1047/15 DTW - FREQ 121.8 - RUNWAY 21R - TAXI RTE: Silver 1 - ATIS "DELTA" - REMKS-HOLD SHORT OF TXY "A" AT SPOT 5 AND MONITOR GROUND

Figure 3

At the request of ground control, the aircraft would acknowledge with the call sign (1047), runway assignment (21R), taxi route (Silver 1), current ATIS code (Delta), and any restrictions to the taxi route (hold shorts, etc.). With only one radio transmission, the aircraft received three clearances (enroute ATC, push, and taxi) and initiated taxi to the active runway. This would have taken at least four radio transmission without the automation.

crew through ACARS. The TDLS system receives the Surface Aviation Observation or Meteorological Aviation Report from the communications line of the Automated Service Observation System (ASOS—a dirty word for pilots—to be discussed in an upcoming lesson!) or one of the other weather systems supported. Using an editor, a controller can modify the weather information and add or modify airport information. The TDLS system compiles the ATIS text message and the computer-generated ATIS voice message. The text message is sent to the ATIS server from which the flightcrew can request the Digital ATIS (D-ATIS) message via ACARS for any of the on-line sites. Data link delivery of the ATIS message eases the difficulty of understanding and transcribing ATIS messages and reduces human error associated with garbled communications. More important, **it eliminates the need for one pilot to leave the controlling ATC frequency as an aircraft initiates descent and during one of the busiest periods of a flight profile. SAFETY WINS!**

For a bit of trivia, the first aircraft to receive a D-ATIS was American Airlines flight #33 going into Houston's Intercontinental Airport on 19 July 1996. Stations scheduled for early installation of this capability include Albuquerque NM, Philadelphia PA, and Denver CO, just a few of the approximately 60 stations scheduled to receive D-ATIS.

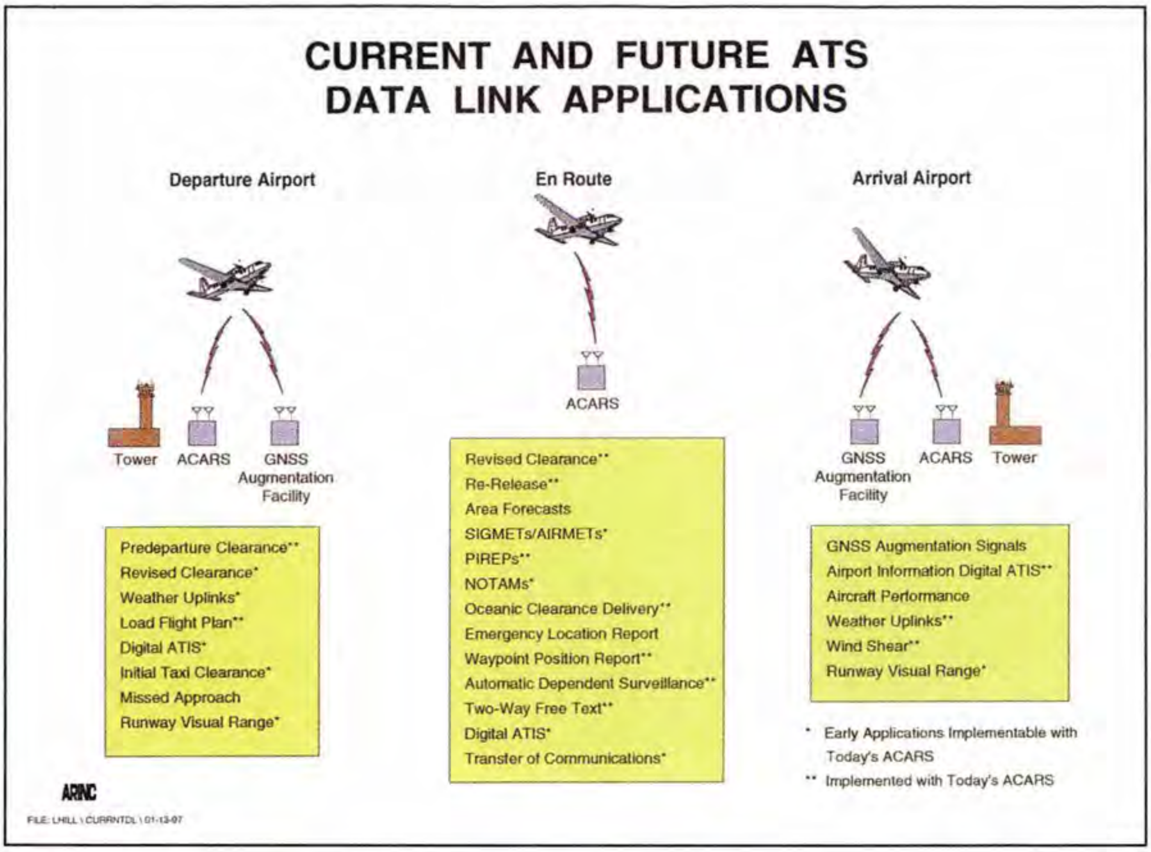
The D-ATIS Automatic Voice Generation (AVG) capability provides the computer-synthesized ATIS voice message. This enables all non-data-link equipped aircraft to continue to receive the ATIS message over VHF/UHF while providing the controller preparing the message with an automation tool which decreases workload and increases efficiency (and enables the controller to do more of his or her primary task-control traffic).

Digital Delivery of Taxi Clearance (DDTC)

The last feature to be discussed is the digital delivery of taxi clearances which is still in the building stages but

ACRONYMS

ACARS—Aircraft Communications Addressing and Reporting System
ARINC—Aeronautical Radio, Inc.
ASOS—Automated Service Observation System
ATA—Air Transport Association
AVG—Automatic Voice Generation
D-ATIS—Digital Automatic Terminal Information Service
DDTC—Digital Delivery of Taxi Clearance
NOTAMs—Notices to Airmen
PDC—Pre-Departure Clearance
SID—Standard Instrument Departures
TDLS—Tower Data Link Services



scheduled to begin testing at Detroit, Michigan, in early 1997. Some of our older airfield layouts, which we have been unable to modify to accommodate 1990's aircraft sizes and capacities, present operators with extensive ground delays costing time, fuel, and cause aggravation on the part of crews and passengers.

At the urging of Northwest Airlines, ARINC and the FAA embarked on an aggressive plan to bring organization to complex taxi plans through the use of automation. Since the program is still in the architectural stages, final procedures have not been published. However, operators also found that like the clearance delivery function, ramp control functions were experiencing frequency saturation and blocked communications. Delays, extensive fuel burns, and operational efficiency suffered.

Through the use of automation (see figure 3), permission for gate departure and taxi route will be issued digitally, eliminating an estimated 70 percent of the radio transmissions associated with today's ground operations. An interface between the ground control function in the FAA control tower and the subscriber's ramp control will allow efficient dispatch and routing of aircraft which will optimize the "flow" of ground traffic. Positive control over traffic by ground control will still occur through the other 30 percent of today's radio transmissions, but like PDC and D-ATIS, routine non-control information will be automated through digital links.

A typical ACARS control panel. Aircrews can request information and acknowledge receipt of information by use of subscriber designed codes.

Summary

Like the enhancements of TCAS addressed in the first lesson, digital communication offers significant enhancements to safety and efficiency which cross the spectrum of aeronautical operations. Through the digital delivery of ATIS broadcasts (D-ATIS), taxi clearances (DDTC), enroute clearances (PDC), real-time terminal weather (TWIP), enroute weather, and numerous other informational transfers, ACARS proved to be a "mission multiplier" to put it into military terms. When implemented, we will be able to accomplish much more with less, and all of this enhancement of efficiency and safety will result in increased combat efficiency.

AIR REFUELING— A Pilot's Perspective

USAF Photo via Author

MAJ CHRISTOPHER TIMBERLAKE
Offutt AFB, Nebraska

WARNING: Because of the magnitude of interrelated aerodynamic effects, flying two airplanes in close vertical proximity is not safe. Upwash and downwash effects may occur, drawing the airplanes together. Low pressure areas created by an overrunning receiver flying under the tanker will affect static ports, causing possible erroneous airspeed and altitude indications to both airplanes. The tanker autopilot altitude hold function may sense the low pressure as a climbing indication and initiate a descent into the lower airplane. (Ref. 1-1C-1-3, Page 4-1)

Whew! As tanker and receiver aircrews, we are all familiar with this warning, but we "violate" it simply because we are in close vertical proximity during air refueling. Although this "violation" is done in the name of our mission, the warning should not be ignored. This warning outlines for us the hazards we may encounter when bringing two or more aircraft into close proximity of each other. What this warning does not tell us, however, is how we, as both tanker and receiver aircrews, can minimize these hazards through various familiar procedures and techniques.

Essentially, when participating in an air refueling maneuver, we all must remember that we no longer have only ourselves and our aircraft to consider. Instead, we must take into account how our movements and adjustments as pilots might affect the other aircraft in the refueling formation. Whereas the procedures and techniques discussed below are probably familiar to you, the point of this article is not to teach you new capabilities but to review and emphasize the importance of what we already know.

Whenever you have described to friends or family that you are in one of two large planes joined together within 20 feet of each other at 450 mph, you probably had to calm a few fears as the potential hazards of such an operation became clear. You probably also had to explain that we cannot eliminate these hazards unless we avoid air refueling altogether. Instead, we perform this maneuver in a carefully controlled environment to keep it as safe as possible.

Air refueling accidents represent a significant percentage of large military aircraft accidents simply because of the precise parameters the task requires. Through continual awareness, practice, and refinement of procedures and techniques unique to the task of refueling, we can all perform this maneuver safely and help our relatives sleep easier at night.

Our technical manuals are full of procedures designed to ensure our safety. Two of these procedures are particularly relevant to air refueling and should be in the forefront of each of our minds while performing this task. First, the accomplishment of our checklists is paramount to safety during refueling. Some universal items on these checklists include ensuring that each person is seated with the seat belt fastened at all times during periods of refueling!

In addition, we are required to monitor the radios on our predetermined frequency, as well as properly configure the aircraft lights. Furthermore, we must ensure that we have coordinated the responsibility of each crewmember in the event of a practice or emergency separation.

Second, when flying in refueling formation, it is imperative that everybody in that formation needs to be situationally aware of their relative position to all others in the flight to minimize the chances of midair collisions.

The list of air refueling procedures mentioned above is certainly not complete, but it does stress the importance of adherence to such procedures. These procedures might seem rather elementary, but we should never underestimate the chances of an emergency by being complacent. For these procedures and all others listed in our technical manuals, being mentally alert and ready to react to any problem or situation is critical. Aircrews cannot let distractions or fatigue interfere with the necessity of flying safely AT ALL TIMES!!

In addition to the procedures provided by our technical manuals, there are numerous flying *techniques* that will minimize risks during air refueling. We have probably all heard of these techniques at one time or another, but keeping in line with the theme of this article makes reemphasizing these techniques important.

• For the tanker, if you are using EMCON 1 procedures, give the receiver a call when you are making a power adjustment. One power adjustment by the tanker requires three power adjustments on the part of the receiver to restabilize. In addition, receiver pilots must make trim adjustments as the result of their own power adjustments. These trim adjustments are required due to the pendulum effects of underwing mounted engines (typical of large receiver aircraft). Receiver pilots are better off finding a stabilized power setting to avoid having to continually trim their aircraft. The increased communication between tanker and receiver in EMCON 1 procedures will help train receiver pilots understand the effects of tanker power adjustments. This practice will translate into better proficiency during sorties using EMCON 2, 3, or 4 procedures.

• When in a multi-ship formation as a tanker, remember the significance of being smooth with the receiver on your boom. If you are in a position other than lead in a tanker formation, this smooth platform is especially important! Although you are attempting to maintain your formation position, platform stability cannot be compromised. Anticipate your movements so you can maintain your proper position relative to the lead tanker with minimal movement. If the receiver is coming up to you from below, do not take him through the jet wash of aircraft ahead of you.

• For autopilot off refueling, the importance of *both* aircraft being smooth cannot be emphasized enough. As a tanker, your aircraft provides an attitude reference for the receiver pilot, especially at night! Avoid abrupt pitch changes to maintain altitude when the receiver aircraft is in the contact position. You are given an altitude block in which to maneuver, go ahead and use it. If you find yourself deviating from your altitude, stop the deviation, and then slowly correct back to your proper position. Making slow, deliberate corrections back towards your designated altitude will make the job of the receiver pilot much easier.

• During autopilot off refueling, ensure the boom operator provides 10-foot calls to the tanker pilot in order to offset the tendency of the tanker to pitch down as the receiver closes. To benefit the tanker, we, as receivers, should close in from pre-contact to contact in a smooth and controlled manner. Doing so will minimize effects on the stability of the tanker from the receiver's bow wave.

Probably one of the best strategies we all can engage in during air refueling is to keep in mind the effects of our aircraft on the other aircraft in the formation. This strategy applies to either the tanker or receiver. For each movement we make, we must think about the effects this movement has on the other aircraft, and then attempt to minimize these adverse effects as much as possible. Furthermore, large aircraft typically have numerous people riding in the back end of the aircraft during flight. As the flightcrew, we want to make the flight as smooth as possible for these individuals. As anyone who has ever been a passenger in the back end of a large aircraft during air refueling could attest to, the effects of control inputs are magnified greatly toward the rear of the aircraft due to the longer rotational axis of large planes. Minimizing unnecessary pitch movements and power adjustments will make the ride much more comfortable. More importantly, however, we will all benefit from proper procedures and good techniques during air refueling because of the resulting enhanced level of safety.

We *can do* this necessary operation safely as a team, in spite of an increased operations tempo from just a few years ago. With the drawdown of the total tanker fleet, and tankers being more involved in channel missions, actual refueling missions have probably become less frequent than before the Gulf War. If we remember the basics, however, we will continually water the eyes of our relatives and in-laws with our ability to do our unique task with minimal risk. ✈

FOD

A LOOK BACK AT '96

MAJ TIM TOWNE
HQ AFSC/SEFO

A Very Bad FOD Year

Based on our data at the Air Force Safety Center, FY96 was a bad year for aircraft engine foreign object damage (FOD). With 127 incidents reported, FOD incidents increased by over 100 percent of the FY95 numbers and over 30 percent of the FY94 numbers! Exactly why the increase, I'm not sure. One reason may be that FOD was always underreported, and we're starting to see greater integrity in reporting by field units. Kudos to those units out there that accurately reported all their FOD incidents.

To figure out why the increase in FOD, we may want to ask ourselves a few questions. Did we let our guard down in that constant fight against FOD? In the spirit of frugality, did we fail to expend the manpower and money to enhance FOD prevention programs and equipment? Did we work hard enough in our FOD incident investigations to discover what caused the FOD so we'd know where to spend the resources to prevent subsequent occurrences? Did commanders and senior supervisors spend as much time as they should have personally involved in FOD prevention?

What Did FOD Cost Us?

I won't address the "combat readiness cost" of FOD here, but FOD damage just to engines alone cost the Air Force over $13.7 million in FY96. That's just the reported FOD, and it doesn't include one Class A flight mishap where FOD was the initiator in the chain of events that led to the mishap. The average cost per engine FOD incident was $107,042.

It was heartening to note that the majority of the units that reported their FOD incidents provided good, accurate damage costs. However, some units provided obvious low-cost errors, and out of the 127 reported incidents, 11 units provided such sketchy reports that they didn't even provide damage costs.

What Caused the FOD?

• In 29 of the incidents, the cause of the FOD was totally undetermined! In other words, the unit didn't know if it was a stone, screw, bolt, washer, ice, or soft FOD that caused the damage. This is especially alarming, because if you don't know what caused it, you'll never prevent it. With those numbers, it makes me wonder how many commanders and supervisors out there have sent their wing FOD monitors to the Jet Engine Mishap Investigation Course at Sheppard AFB, Texas. Effective mishap investigation is difficult when you're trained, but when you're untrained, it's almost impossible to break the code on what's causing FOD mishaps.

It's also important to note that there's some extraordinary new commercial technology out there that, in nearly all cases, will help you ascertain what object caused the engine damage. Use of these commercial products and services, as well as sending your FOD monitor TDY to the engine mishap school, all come with a very small price tag when you consider each FOD incident cost an average of $107,042.

• In 21 of the incidents, complacency and lack of basic maintenance discipline on the part of a maintainer or operator caused the engine FOD. Here are some examples:

- Tech orders left in inlet.
- Headsets sucked into inlet.
- Flight checklist left in inlet.
- Flashlight left in inlet.
- No area FOD check accomplished prior to engine run.
- Cotter pins not installed in vari-ramp components.

And the list goes on. Every single one of these incidents were immediately preventable.

• Three incidents were caused by collateral damage, such as a blown main gear tire on landing that threw pieces of the tire into the inlet.

• Twenty-nine of the engine FOD incidents were caused during flight by ingestion of birds. Although I couldn't always tell because of the quality of the report, I suspect most of the ingestions occurred either on low-level routes or traffic pattern—something we've known for years. Adherence to a solid BASH program and using Bird Avoidance Model (BAM) information for scheduling and mission planning may have prevented a few of these.

• Fifty-nine of the 127 incidents were the more common types of FOD. Things like loose fasteners, deteriorating ramps, and aircraft parking spots provided constantly occurring hard objects which were ingested. Again, way too many of these incidents had "CAUSE UNDETERMINED" in the report, thus well-focused preventive actions were also "undetermined" and unknown by the units that experienced them. Certainly, the vast majority of those 59 incidents were preventable.

• When looking at FOD incidents associated with specific aircraft types and mission profiles, it was interesting to note that the B-1 had the most number of engine FODs with 23 incidents. Of those 23, 9 were caused by flying through icing conditions. In fact, 18 of the 127 incidents were caused by flying through icing conditions. C-130s, which often operate out of unimproved landing strips, were second with the most number of incidents with 18.

What's New in the FOD World?

For those who may still not know it, there's a nonprofit organization out there whose goal is FOD prevention. That organization is called National Aerospace FOD Prevention, Inc. (NAFPI). At their August 1996 national convention in Milwaukee, Wisconsin, they had over 400 attendees, with a significant number coming from the Air Force.

Leading the way for FOD prevention in the Air Force, as they have for a number of years now, was HQ ACC's Propulsion Branch (ACC/LGMP), and specifically MSgt Kevin Schwan and Sq Ldr Graham Wingrove, an RAF exchange officer. These two spent many long hours developing a Military Day for the convention, lining up speakers and serving as the Air Force's single point for coordinating with all Air Force units that wanted to send their FOD monitors.

The speakers, seminars, and vendor displays provided great ideas and new technical innovations in FOD prevention. NAFPI has a web page on the Internet, and they can be reached at HTTP:\\WWW.BOEING.COM\FOD. This year's NAFPI FOD conference will be held 23-26 June 1997 in Seattle, Washington. Will your unit spend the money to send your FOD monitor?

New Strategies for FOD Prevention

You may want to start looking at your operation from an operational risk management (ORM) perspective and make decisions on how you're going to conduct maintenance and ops functions that will best lower your risk for FOD. For instance, the next time you're trying to decide if you want to spend your too-few dollars on deteriorating ramps and taxiways, "ORM it" from what it may cost you in FODs caused by loose stones and concrete. You may decide you can't afford the risk of *not* spending the money on new airfield surfaces.

ORM can also be used in planning operations that may involve bird risks, icing risks, or even maintenance actions that may involve high FOD potential. We need to get more creative and innovative in our approach to FOD prevention. At $107,042 per incident, we can't afford not to. ✈

DON'T FORGET THE FORMS

ACT III

CMSGT DON A. BENNETT
Technical Editor

■ This is the third time I've written about this particular subject in this magazine, and it's getting old. Oh, I'm sure you're also tired of reading the same old foreign object damage (FOD) prevention messages, but I make no apologies. As long as Air Force maintainers and pilots continue to let their aircraft forms get gobbled up by an engine during launch activities, and I'm still hired on by the *Flying Safety* magazine, I will forever shout from the rooftops "DON'T FORGET THE FORMS!" These costly incidents are extremely embarrassing and represent the epitome of the preventable, no-brainer mishaps we suffer within the Air Force.

Yep, ladies and gentlemen, this is the third same-titled article about an unnatural phenomenon sweeping across Air Force flightlines that's got to stop. Seems both maintainers and pilots—together—aren't communicating with each other effectively, lack proper checklist discipline, lose situational awareness during launch activities, and just flat-out forget all about the aircraft forms sitting pretty as a picture in an engine intake. How can senseless, extremely costly engine FOD mishaps like these continue to happen?

These mishaps should be virtually impossible to occur. Why? Besides there being several checklists to prevent such mishaps, there are also at least two or more people involved whose jobs are to make double-darn sure they don't. Now, let's see how some folks failed to stop their own FOD mishap from happening.

Two fighters were sitting out on a transient alert (T/A) ramp being readied for departure. A T/A employee reportedly brought out the forms for both aircraft and placed the forms for one jet on a wing fuel tank and handed the other set of forms (mishap jet) to the pilot. But in an apparent confusion of the events leading up to the mishap, the mishap pilot saw only the forms being placed in the mishap engine's intake and did nothing to have the forms removed. Then another maintainer performed the prelaunch duties, including the preflight walk-around and the crucial pre-engine start clearance. *None* of these three individuals took the initiative to prevent the forms from being chewed up on the engine start—at a cost of over one-third of a million dollars in damages! (By the way, that's a Class B mishap category, but the unit didn't report it as such. Okay, okay, so they have problems with proper mishap reporting, too!)

When considering the other forms-FOD mishaps, here's some of the nasty indicators starting to emerge:

• Maintainers using the engine intakes as forms storage (tech data violation).

• Pilots allowing the forms to be stored in *their* engines' intakes (flight directive violation).

• Pilots *not* reviewing aircraft forms before preflights or engine starts (checklist discipline).

• Maintainers *not* properly clearing engines before the engine starts (checklist discipline).

• *Both* pilots and maintainers *not* removing the forms from engine intakes during their respective preflights (checklist discipline).

• Ineffective communication between pilots and maintainers during prelaunch activities as well as between maintainers on the same launch crew (culture).

Well, folks, I certainly hope this is the last article I write with this same title, but I doubt it will be. Too many disturbing signals are coming out of many other FOD mishap reports that point to some units having an unsafe environment or culture—cultures that allow operational shortcuts, unsafe acts, and lackadaisical discipline or attitudes. As in these past forms-FOD cases, several people from both maintenance and ops weren't performing their tasks in accordance with directives, tech data, or good old common sense.

So what do you say? Do we have a pact here? I won't write any more of the forms-FOD articles as long as you DON'T FORGET THE FORMS! After all, the Air Force can't afford the high FOD costs, and you can't afford the embarrassment. ✈

Building a BASH Program

MR. GENE LE BOEUF
Bird Strike Scientist
HQ Air Force Safety Center

After this last winter, I'm sure we 're all looking forward to the return of springtime and warmer weather. While this is a welcome thought, we must remember the change of seasons means different things to different people. If you're involved in airfield safety, this means it's time to blow the dust off your BASH plan and get it ready for the spring migrations. "BASH plan?" you say. "What is a BASH plan?"

The crash of the E-3 AWACS aircraft at Elmendorf AFB, Alaska, 22 September 1995, brought renewed interest in all things BASH. For the uninitiated, the acronym "BASH" stands for *Bird Aircraft Strike Hazard*. If you happen to be one of those folks who doesn't know what BASH means and you happen to work in a job description directly related to an airfield environment, it might be worthwhile to take a look at the 1 October 1995 Air Force Instruction (AFI) 91-202. This document outlines a BASH reduction program in more detail.

The Successful Plan

Frequently, the USAF BASH Team at the Air Force Safety Center is asked, "What does it take to make a successful BASH plan?" To be honest, a good BASH plan shouldn't require the skills of a brain surgeon or even a Ph.D. in wildlife biology. While it's wise to consult with a member of the BASH team before undertaking any program, a base can have a successful BASH plan if they keep a few simple things in mind.

First, from the book of Harry Callahan, "A man's got to know his limitations." No matter how well managed the control plan, it's impossible to completely control all birds and wildlife on an airfield. If you're successful in relocating one target population of wildlife, another will most likely take its place. Hopefully, the newcomer will be less hazardous or more easily controlled.

For example, if you allow your infield turf to grow taller to discourage flocking birds, you may see an increase in rodents which may, in turn, attract predators such as coyotes. Although coyotes have been struck by

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aircraft on takeoff roll and are thus a hazard, they are more predictable and controllable.

Now that we understand species composition around the airfield may change as a result of a successful control operation, we must next keep in mind that seasonal changes may also necessitate adjustments to the BASH plan. For example, a base may experience problems with gulls during winter months and smaller flocking birds in the summer. The gulls may migrate into the area during the winter to feed at a local landfill and be gone by spring, at which time small flocking birds may move into the area to feed behind mowing machinery. Just remember—the problem will dictate the solution, and if in doubt, call the USAF BASH Team for assistance.

Finally, *for a plan to be successful, it must have a clear protocol, personnel support, and a commitment to implement the plan with vigilance.*

Deer often weigh in excess of 100 pounds and can ruin a pilot's day if struck. And remember—they are most active after dark when they are difficult to detect.

Four-Legged Hazards

A point of clarification—a BASH plan shouldn't be limited to birds alone. Although birds provide the greatest hazard to aircraft, any animal on or near a runway area creates the potential for catastrophe. Deer often weigh in excess of 100 pounds and can ruin a pilot's day if struck. And remember—they are most active after dark when they are difficult to detect.

Smaller burrowing animals, such as woodchucks and prairie dogs, have undermined pavements, VASI bases, and safety areas. Woodchucks have caused runway blackouts by gnawing through underground wiring. Beavers have flooded airfields by damming drainage ditches. Small field rodents frequently attract larger predators to safety areas, such as hawks and coyotes, and so on. The point here is *BASH is more than birds*, and airfield managers should pay close attention to all wildlife sightings on the airfield and respond accordingly.

An Animal's Perspective

By now, some of you may be wondering why significant numbers of wild animals would be found around an airfield when there seems to be more hospitable choices elsewhere. Most would agree an airfield is a noisy place teeming with lots of activity arising from the frequent movement of large, jet-powered machinery. One would think timid denizens of the field and forest would have nothing to do with such a piece of real estate. Not so!

As you look at your airfield from a BASH perspective, keep in mind the recurrent theme from the movie *"Field of Dreams,"*—"If you build it, they will come." This same rule applies to your base. If the airfield provides habitat, wildlife will come. Viewed from the

perspective of an animal in the wild, an airfield has much to offer.

Airfields are normally surrounded by large expanses of open area to facilitate an additional margin of flight safety. In addition, most airfields are fenced to reduce inadvertent entry. As it's desirable to land on relatively flat surfaces free of standing water, it's necessary to provide storm-water capacity via retention basins and drainage ditches. As wildlife see it, the only visitors to these secluded, fenced-off grassy areas of ditches and ponds are usually operators of mowing machines who generally pose no threat. However, they leave behind lots of goodies, like mowed straw for nest construction and shattered seed heads or maimed insects for food. When one considers these points, there's little wonder why many wild animals call your airfield a refuge. All the food, water, and potential shelter, enclosed by a fence to keep out humans and their pets, is worth the risk of being struck by an aircraft.

The Mechanics of the Plan

Now that we are all up to speed on some basic ground rules, let's look at the mechanics of a general BASH plan. As mentioned earlier, the Air Force regulation regarding your wildlife management plan can be found in AFI 91-202. The AFI specifies the responsibilities of the Air Force Safety Center's BASH Team, MAJCOMs, AFRES, National Guard Bureau, and base-level programs. Each level mentioned may quickly identify their individual area of responsibility.

Another publication soon to be released is the Air Force Pamphlet (AFPAM) 91-212. AFPAM 91-212 will provide more thorough coverage of wildlife problems you may encounter, how to deal with them, or who you may call for further assistance. Although it is not signed at this time, a copy of the draft document may be obtained by accessing the Safety Center Bulletin Board.

With these two publications in hand, groundwork can begin. If you don't have a clue about what a BASH plan looks like, a sample plan may be obtained by contacting the BASH Team at the Air Force Safety

Center. Next, you should obtain a copy of your base's bird strike data profile from the BASH Team. Also, talk with base operations to see whether they have been keeping logs of their runway checks. Find out if they have been responding to any wildlife activity or when bird watch condition codes have been listed as moderate or severe. These two bodies of information can shed light on the kind of wildlife present on base and when they are creating hazardous conditions.

If these sources of information don't provide enough information, the base may

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Small field rodents frequently attract larger predators to safety areas, such as hawks and coyotes, and so on.

choose to contract a wildlife biologist who specializes in the field of wildlife damage control.

Bases have two contract choices. They may either choose to deal with a private company or a government agency. Regardless of the choice, the contractor should have a good background in wildlife control and be able to perform an ecological study to establish a baseline of wildlife activity that could be hazardous to aircraft. The United States Department of Agriculture (USDA) has an

If the airfield provides habitat, wildlife will come. Viewed from the perspective of an animal in the wild, an airfield has much to offer.

Animal Damage Control (ADC) program that has agreed to provide different levels of assistance through a signed Memorandum of Understanding (MOU) with the Department of Defense. This MOU allows the USDA to provide different levels of assistance from a cursory technical assistance visit to a contracted fully operational wildlife control program.

This baseline, or wildlife profile, is primary to the development of a successful BASH reduction program. The type of wildlife on or near a base and the habitat that's being used are what drive a program. Once these components are identified, you can then begin to assemble the respective parties who may be able to effect a change to the habitat the wildlife are using. These "respective parties" will become the members of your Bird Hazard Working Group (BHWG).

The Working Group

By regulation, the BHWG is supposed to meet at least twice a year. Can they meet more than twice a year? In a word, *absolutely*! The BHWG is chaired by the vice wing commander and is normally comprised of all those who have anything to do with airfield, operations, safety, and, of course, bird control. As a minimum, this group should include a representative from Civil Engineering (CE), Environmental, ATC, Airfield Management, Safety, and Security. Minutes are required to be maintained for every meeting.

Although they seem to be from unrelated fields, it is necessary for these individuals to attend BHWG meetings to openly discuss issues. For example, if the operations staff has frequently harassed birds away from an unmowed area near the north end of the airfield, CE may be asked why the area is not being maintained. The engineer may explain this area is holding water and can't be drained. Why? Because it is currently under investigation by the environmental staff as to whether or not it should be classed as a wetland and thus protected. Because the environmental staff is present, they may then discuss options available to the base to reduce the attraction to the area. One can quickly see why such meetings are so important to a bird hazard reduction program.

We're Not Quite There Yet

Let's say you have become more enlightened about the regulations, have a good baseline of wildlife activity due to surveys and good record keeping, and you are maintaining an open line of communication between all responsible parties. Does this mean you have a good BASH reduction program? Not quite. Just because you have blueprints doesn't necessarily mean you have a house. There are a few more things to consider.

Probably the most important part of a BASH reduction program is *implementation*—often the weak link in a good chain. It's absolutely necessary to have a sound protocol spelling out how you will react to wildlife activity near the airfield and who is going to respond. Since you're now keeping good records, you should be able to look back and, based on past history, "predict" when wildlife activity is greatest. This should give you a clue as to when to have your personnel ready for action. If your base records are lacking, go back to your strike data obtained from the BASH team.

You may be beginning to think you have all your bases covered, right? Not yet. Just because you have all your information going in the right directions and you have a reliable person ready to respond, does this person have the right tools?

Before we get into the tool department, let's back up just a bit. We should keep in mind the first line of defense should be to try to alter the habitat the birds or other wildlife are using. This could mean mowing the airfield to the recommended height or keeping drainage ditches open and free of tall vegetation. Another good rule of thumb for airfield maintenance is if it sticks up and isn't fixed by a function, then have it removed.

If the airfield has been well drained, made as uniform and unattractive to wildlife as possible, and a few wild nonbelievers still remain, then it's tool time.

Your Tool Box

The first tool many base BASH programs include in their wildlife control tool box is the propane cannon. Most expect far too much from a propane cannon. They place it in too large an area and set it to fire too frequently. Wildlife are accustomed to noise on an airfield, and cannons repeatedly going off do not affect them. Propane cannons require active management and serve to reinforce other harassment techniques.

Live ammunition should be part of your control program if it's legal for use. Studies at John F. Kennedy International Airport have shown conclusively that shooting is effective in reducing wildlife hazards to aircraft. If you're not occasionally shooting birds where and when legally possible, you're reinforcing a behavior of ignoring the sound of gunfire (propane cannons and pyrotechnics). However, one must never shoot live ammunition before making sure all questions of legality are answered.

One thing specifically required prior to using live ammunition to control birds is a depredation permit. This permit is issued by the U.S. Fish and Wildlife Service (FWS). The FWS will usually request you contact the USDA ADC specialist in your area to review your current program. They want to ensure no threatened or endangered species present on the base will be at risk and that other attempts at controlling wildlife have met with less-than-desired results.

If you are successful in reducing the numbers of birds on the airfield through depredation, you should try to learn as much as possible from them. By performing a necropsy (a fancy word for cutting them open), you may be able to identify the food source attracting the birds to your airfield. If you have problems performing a necropsy, specimens may be frozen for later inspection by a BASH team member or a USDA biologist.

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Other Harassment Techniques

What about those other techniques? It's often recommended broadcasting taped bird distress calls. Distress tapes can be effective, but they must be used properly. To get certain birds to respond, you must use a distress call tape recorded from that species of bird. In other words, gulls will not respond to blackbird distress calls.

Another thing to remember is birds will respond differently to distress calls. When gulls hear another gull calling in distress, they will usually take flight and investigate the source of the call. Blackbirds, on the other hand, will take flight, circle a bit, and leave the area. Knowing this can be very useful. If you want to move gulls away from the end of the runway, don't park your vehicle there to broadcast a gull distress call. It's recommended you park in an area where you can safely disperse the birds with pyrotechnics or use live ammunition to shoot a few.

BASH STATISTICS

- **Total Bird Strikes Since 1985...30,907**
  - **— Airfield - 14,887**
  - **— Low-level - 6,018**
- **Total Damage Costs...$457 million**
  - **— 12 Year Average - $38 million/year**

1985 - 1996 STRIKE STATISTICS

- **Average 2600 Strikes/Yr**
- **$40 Million/Yr**
- **14 Aircraft Destroyed**
- **33 Fatalities**
- **48% of Strikes at Airfield**
- **20% of Strikes During Low-Level Operations**

There goes one of those $20 words again! What are pyrotechnics? Simply industrial or agricultural fireworks. Pyrotechnics include shellcrackers, bird bombs, and screamer sirens. These devices are probably the most widely used wildlife harassment tools on the market today. They are safe, readily available, inexpensive, non-lethal, and normally don't require a permit for use. Recent rulings by the Air Force have authorized the purchase of these devices and their launchers. However, they would be illegal to use around birds actively occupying a nest site or around threatened or endangered species.

Another technique useful in reducing wildlife strikes is avoidance. If there are large, known movements of birds (such as migrations during spring and fall), you may choose to schedule flight operations around these well-known periods of bird activity. The BASH team recommends low-altitude flying be restricted 1 hour before and after sunset during increased bird activity. Before scheduling low-level flights, areas of known bird activity may be avoided by contacting the BASH team and having the desired routes checked against our Bird Avoidance Model, or BAM. The BAM plots known waterfowl movements by season of the year to give a prediction of bird activity for specific routes. The BASH team is currently revising this model by employing GIS techniques to include more data fields to provide schedulers up-to-date information.

What We Need From You

After providing all this information, we at the BASH team would like something in return. To better serve our bases, we need to know everything possible about your individual bird strikes. If you revisit the regulations, specifically AFI 91-204, you'll find a section for wildlife strike reporting. This regulation spells out the information we need to maintain our database. It's important to note here that all wildlife, not just birds, may be reported to us. The reports come to us via AF Form 853. This form has recently been computerized for convenience, and we will now accept your monthly strike reports via the

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Safety Center Bulletin Board. This reporting system allows us to easily track wildlife hazard trends as shown in the accompanying charts.

When submitting reports, do not forget to collect whatever non-fleshy bird remains you may find and forward them to the BASH team at Kirtland AFB. Even if you are positive of the bird's identification, you must always send a sample to the team. On more than one occasion, we have had to change an incorrectly identified bird type in our database after proper analysis. As a service we provide to all bases, we will have the remains properly identified by contract specialists at the Smithsonian Institution in Washington DC. Once we have an accurate identification, we will inform the base of the bird type. This information is important as the bird type will often dictate where control efforts may be best directed. Please see the sidebar for proper collection and submission of remains.

One Step at a Time

All this information may seem a bit overwhelming when considered all at once. However, once you get underway and take it one step at a time, you will see that most of these recommendations rely on good old common sense. *The key is you must remain flexible with your approach* because if you are successful in removing one species, another will likely move in to fill the void. The idea is to manage the wildlife population down to a number and type of species less hazardous to your specific operation. Always remember no program will ever completely eliminate all wildlife from an airfield or achieve the desired results unless properly implemented through perseverance.

Finally, when questions arise, don't hesitate to contact a member of the USAF BASH Team at the Air Force Safety Center, Kirtland AFB, New Mexico. My telephone number is DSN 246-5679 or commercial (505) 846-5679, and my e-mail address is leboeufe@smtps.saia.af.mil. Maj Pete Windler may be contacted at DSN 246-5674 or e-mailed at windlerp@smtps.saia.af.mil. Capt Christy Atkins may be reached by dialing DSN 246-5681 or e-mailed at atkinsc@smtps.saia.af.mil. ✈

If you ever happen to be in Washington DC, you may find yourself visiting the Smithsonian Institution's Museum of National History. Believe it or not, there is actually a case dedicated to the USAF Bird Identification Program on display until 29 June. The specialists, Roxie Laybourne and Carla Dove, are the most respected scientists in the world at identifying even the tiniest of remains.

To assure they are able to accurately identify all remains, you should take several precautions.

1. Always send whatever non-fleshy material you collect, no matter how small. Although more is always better, even a piece of hair-like material you scraped off the aircraft with a pocket knife may be identified.

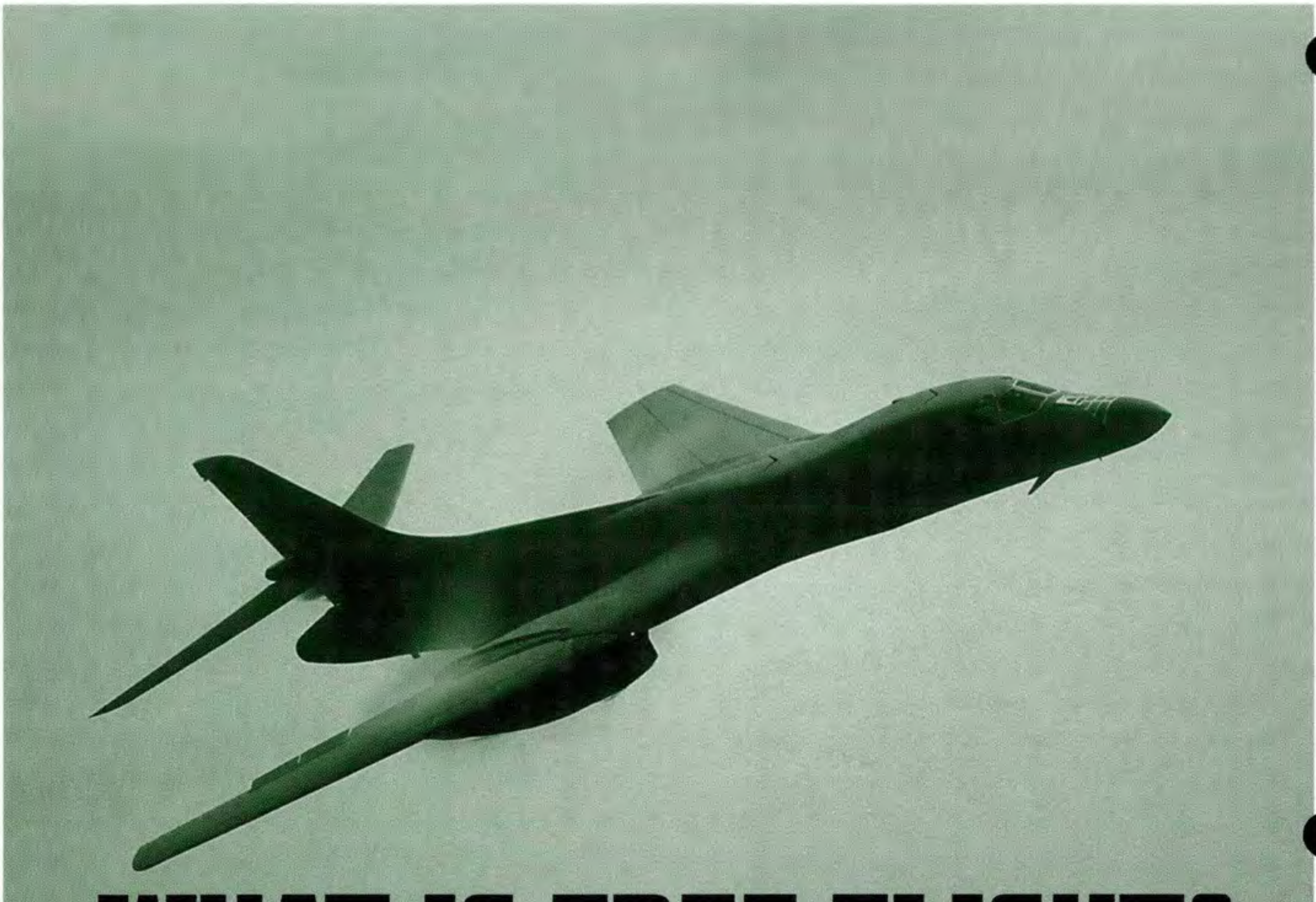
2. Send whole feathers when possible (do not cut).

3. Beaks and feet are acceptable material.

4. Do not use staples or tape to secure the remains. Simply place them in an appropriate-sized sealable plastic bag or envelope.

5. Blood smears often contain feather material that can be identified. Use a clean sheet of paper (not paper towels) to collect a sample.

6. Mail the remains and the accompanying AF Form 853 to the USAF BASH Team at HQ AFSC/SEFW, 9700 Avenue G., S.E., Bldg 24499, Kirtland AFB NM 87117-5671. We will handle shipping to the Smithsonian and provide the identification information back to your base for record keeping.



WHAT IS FREE FLIGHT?

MSGT GEORGE INGRAM
HQ AFFSA/XATP
Chief, FAA/Military ATC Procedures

The following explanation of Free Flight was published by the FAA Free Flight Steering Group (ASD-400):

"Free Flight is a concept that will provide aviation users visual flight rules (VFR) flexibility while maintaining the traditional protection afforded under instrument flight rules (IFR). This goal will be achieved by using integrated advanced airborne and ground-based technologies and new procedures to permit optimum trajectories and tactical separation. Free Flight will permit the system users and operators the flexibility to make tactical, real-time decisions to optimize flight patterns without compromising safety or efficiency. Free Flight will accommodate all users, air carrier, air taxi, general aviation, and the military."

So what does this mean to the average military controller? Our mission in the Air Force is to fly, fight, and win. We train daily to preserve peace by preparing for war. Our mission does not dictate the need for all of the advanced technology that accompanies Free Flight. The whole Free Flight concept is very dynamic. It allows aviators to fly from one point to another in a less congested air traffic environment. Aircraft characteristics, timing, and technology play a major role in the Free Flight concept. Technologies to improve conflict identification and resolution, data transmission and display, and direct exchange of data among aircraft and controllers are currently in the developmental stages, with full production well into the twenty-first century.

When, if ever, will Free Flight have a dramatic effect on military air traffic control? Probably not for 20 years or more. Some aspects of Free Flight are currently being exercised, but more in an en route environment.

With the congestion that goes along with the terminal environment, aircraft still have to be sequenced into the airport by the air traffic controller. The concept of Free Flight will not replace controllers from the air traffic equation or compromise safety. Air traffic controllers will remain a vital part in the separating and sequencing of aircraft. ✈

FOG
What it is and how it's formed

JACK WILLIAMS*
Courtesy *Flight Training*, Apr 94

If you're safely on the ground and not planning to drive or fly anywhere, fog can be romantic. At times it's downright dramatic. We've all seen photos of fog from the Pacific drifting into San Francisco Bay, engulfing the Golden Gate Bridge.

Fog doesn't have the violence and drama of an Oklahoma thunderstorm. It doesn't have the cold menace of ice building on an airplane in the clouds at night. Still, fog has been one of aviation's biggest hazards since pilots decided flying shouldn't be limited to sunny days.

Fog set the stage for the deadliest crash in aviation history. In March 1977, a Boeing 747 started its takeoff on a fog-shrouded runway in the Canary Islands as another 747 was taxiing across the runway. The crash killed 570 people.

Knowledge is a savvy pilot's best defense against fog. A weatherwise pilot understands why fog forms. He or she then collects the information needed to discover whether fog is likely along the route of flight.

Fog is nothing but a cloud on the ground. It forms when the air can no longer hold all of the water vapor it contains and some of the vapor condenses into tiny droplets. Since the amount of water vapor the air can hold depends on its temperature, clouds, fog, or dew will form when moist air is cooled enough. The temperature at which this moisture condenses is the "dew point," and the actual temperature depends on how much water vapor happens to be in the air. The more vapor, the higher the dew point.

While most fog forms when air is cooled to its dew point, some fog is created when water evaporates into the air, increasing the dew point to the temperature. We'll see how this works when we discuss precipitation fog and steam fog.

First, let's examine the kinds of fog that give pilots the most trouble.

Ground fog is most likely to wreck plans for an early morning departure. If you live on a hill, you might awaken before dawn to see a sky full of stars. As you look toward the horizon, the visibility looks good. And the wind is calm. But as you drive into the valley where the airport is located, you begin running into wisps of fog; finally, the fog is so thick you can hardly see the road.

At the airport, you wait until after dawn, wondering when the fog will burn off. If you look straight up, you can see blue sky, but when you look down the runway, you can see only a couple hundred feet. The air has cooled to its dew point, causing water vapor to condense into fog. The fog is thicker in low places because the cold, heavier air flows downhill. Calm winds are also needed. Faster winds stir up the air near the ground, mixing cold air near the ground with warmer air higher up, meaning it's unlikely to cool to the dew point.

Ground fog is also called *radiation fog* because it forms on clear nights when the earth's heat radiates into space. On cloudy nights, the clouds act like a blanket and reflect it back toward earth, keeping the air warmed above its dew point.

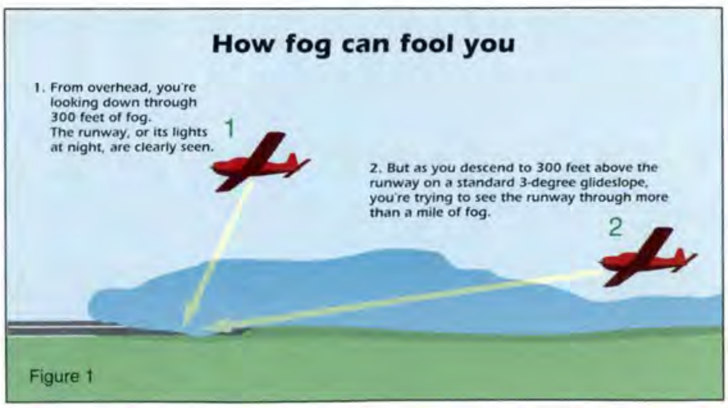


Figure 1

Usually, ground fog is only about 300 feet thick. After the sun rises, its heat begins evaporating the fog back into water vapor. If the sky is clear over the fog, it should dissipate—burn off—fairly quickly after sunrise. But if clouds have moved overhead and block the sun's heat, the fog can be slow to clear.

continued on next page

Clouds moving over fog is a common cause of busted forecasts for improving visibility.

While ground fog grows thicker as the night grows colder—it's usually coldest around dawn—it can form earlier in the evening if the air is humid enough and cools off fast enough. This can be dangerous for night flights. Figure 1 shows how an airport that looks clear when you're overhead can be too foggy for a safe landing.

If you're flying at night, make sure you find out the temperature and the dew point all along your route. If the temperature and dew point are separated by 7°F or less, and if the wind is calm, ground fog is a real possibility.

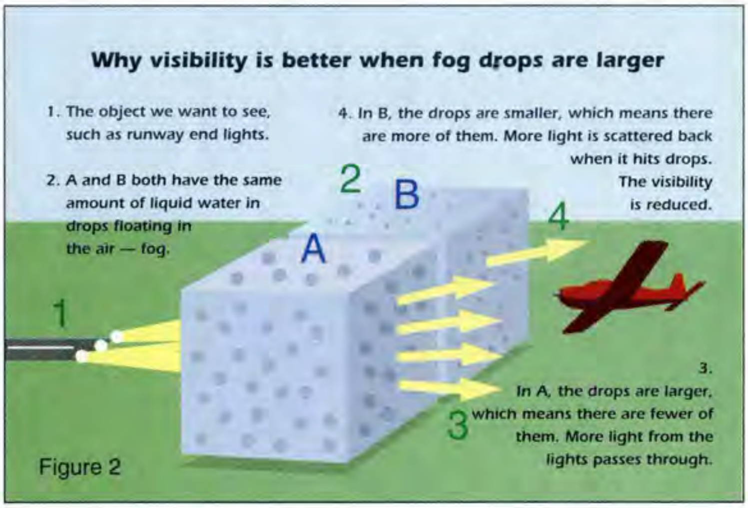


Figure 2

While ground fog normally burns off during the morning, it can sometimes hang on for days in the winter, especially in valleys. During the winter, not only are the days shorter, the sun is lower in the sky. Both reduce the amount of solar energy reaching the earth. At best, the fog might lift to form low clouds that only instrument-rated pilots can penetrate.

On clear nights, not only does the ground in the valley cool off, cold air flows downhill to make the layer of chilled air near the ground even thicker, meaning the winter sun is often too weak to burn off fog that forms during the night. Snow on the ground can also thicken ground fog because it reflects heat rather than absorbs it as bare ground does. Air above snow will cool faster and to a lower temperature than air above bare ground.

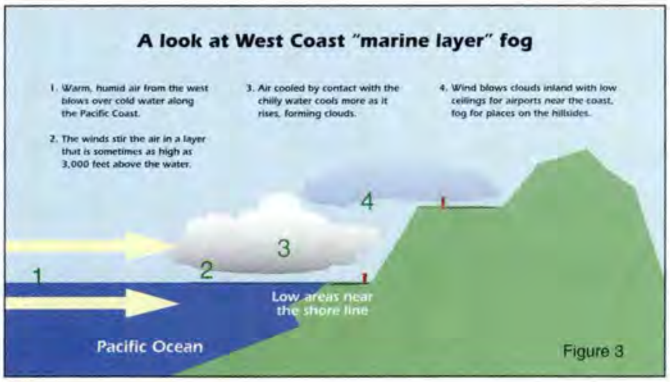


Figure 3

A city in the valley can make things even worse. Tiny particles of pollutants attract water that condenses on them. This makes for more, smaller fog droplets, which reduce visibility more than fewer, larger drops would. Figure 2 shows why smaller droplets reduce visibility more than larger ones.

Such "valley fog" is most common in the West and can sometimes slow flights for days in places such as Salt Lake City. Often, the fog and low clouds linger for days until a storm arrives with strong winds to clean out the valleys.

Advection fog is most likely to cause widespread flight delays. Meteorologists use "advection" to describe horizontal air movements that bring changes in temperature, dew point, or other properties.

Advection fog is caused by warm, humid air blowing over cold ground or cold water. While wind is needed for advection fog, it can't be too strong. Strong winds would stir up the air too much for fog to form.

As you can imagine, on some nights both advection fog and ground fog combine to make even the ducks think about filing instrument flight plans. This combination is most common in the East during the fall and winter when air, warmed over the Gulf Stream in the Atlantic, blows inland, forming advection fog. The fog thickens when the ground cools even more at night.

Such fog is also common along the Gulf Coast in the fall and winter, and in the valleys of the southern Appalachians in the fall when plenty of Gulf air is still flowing northward. Sometimes in winter, after a storm has coated the Mississippi Valley with snow down to northern Arkansas and Tennessee, winds can shift to the south. As humid air from the Gulf flows up the Mississippi Valley over snow-covered ground, it cools to the dew point. The result: poor visibility at airports across the middle of the country.

Local conditions, such as an airport's elevation or how close it is to a river, which can add more moisture to the air, can help determine when poor visibility will stop all flying. Along the West Coast, advection fog and widespread low clouds—called the marine layer—are most common in summer. Fog or low clouds might close airports near the ocean to all but instrument-rated pilots while airports a few miles inland are reporting clear skies and 50-miles visibility. Figure 3 takes a close look at marine layer fog on the West Coast.

Upslope fog usually doesn't cause widespread problems, and it's not as common as ground fog. Anytime air moves upward, its pressure decreases, which cools the air. Upslope fog, like clouds, forms when rising air cools. It's likely anytime humid air is flowing up mountains. It also forms on the western plains when winds are blowing from the east.

People who drive toward the Rocky Mountains from the Mississippi River think the land is flat. Pilots, especially those who fly at relatively low altitudes, know better. The Plains slope upward. If you took off from Coffeyville in southeastern Kansas—elevation 752 feet—and flew to Goodland in northwest Kansas at 3,000 feet, you'd run into the ground before reaching your destination. Goodland's elevation is 3,656 feet.

A blob of air being blown across Kansas by a southeast wind would cool around 15°F as it flowed upward along the ground from Coffeyville from Goodland. Remember, air cools as it rises. If the air is humid, there's a good chance that it will cool to its dew point, forming upslope fog.

Fog on the Plains is likely to be a combination of upslope and radiation fog. While such fog is a concern, it's not nearly as common on the Plains as in places near the oceans and their unlimited moisture supply. Figure 4 shows how often thick fog forms during an average year in the United States.

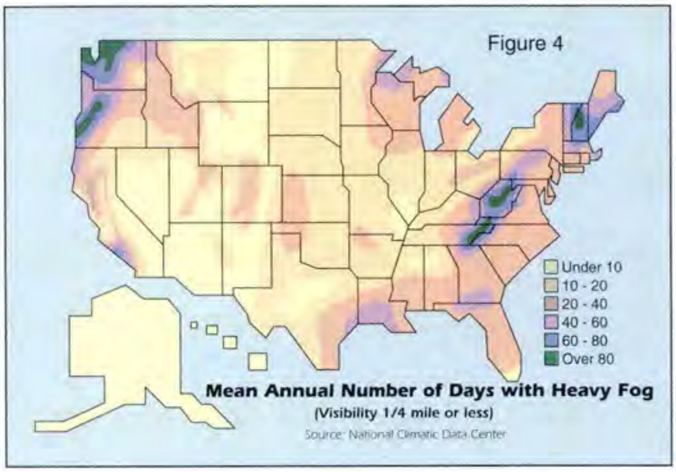


Figure 4

What kind of fog forms when it's cold? Unless it's very cold, say around minus 40°F, fog is made of tiny water droplets. You often hear that water freezes at 32°F, but that's not really true. A pond, or even a glass of water, freezes at 32°F, but the tiny droplets that make up clouds and fog can be liquid water at temperatures much below freezing.

Ice fog—ice crystals instead of water forms in very frigid air, which means it's common in the Arctic or near the Arctic Circle, such as in Alaska. When it does form, it can restrict visibility as much as ordinary fog.

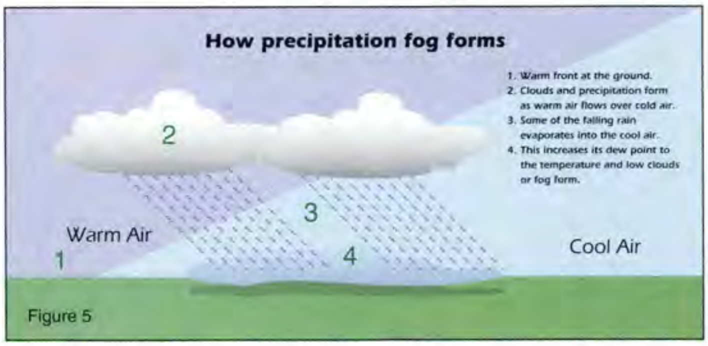


Figure 5

Ground fog, advection fog, and up-slope fog all form when air is cooled to the dew point. Fog also forms when water evaporates into air, increasing the dew point until it matches the temperature. Sea smoke, or steam fog, forms when cold air flows over warm water. It's usually of little concern to pilots, but at certain times and places it can cause trouble.

You're most likely to see steam fog in the fall when cold air blows across relatively warm rivers and ponds. It looks like smoke rising from the water and is usually thin and rises only a few feet. As the cold air passes over the warm water, some water molecules evaporate into the lowest layer of air, not only increasing its humidity, but warming the air. As the warm, moist air rises, it mixes with cold, dry air and cools to the dew point. The condensation is sea smoke. Sea smoke makes the Grand Banks, in the Atlantic off the New England coast, one of the world's foggiest places.

In the Arctic, or on the Great Lakes, where frigid air flows over warm water, sea smoke can become more dangerous. Instead of rising only a few feet, the warm, humid air can rise high into the sky. This is convection, and it can at times create turbulence to match a growing cumulus cloud in the spring. In addition, the water drops can freeze when they hit an airplane, coating it with ice.

Precipitation fog forms when rain falls into colder air. Such fog is also called "frontal fog" because it may form ahead of a warm front, where warm air is flowing over colder air. Some of the falling rain evaporates into the cooler air, increasing the dew point to the temperature. Figure 5 shows how precipitation fog forms.

The key ideas needed to understand fog are fairly simple. A pilot who has even a basic understanding of fog is prepared to ask the right questions during a preflight weather briefing. If the temperature and dew point are within about 7°F, the winds are nearly calm, and night is coming, be prepared for fog. Even if your airport is clear, check conditions at your destination and at airports along the way before taking off early in the morning. Fog might hide all your options in the event of a precautionary landing.

As we've seen, fog can form at any time of the year, on frigid days and when the temperatures are mild. When you fly to a new part of the world, you ought to ask about local weather, including the times and places where fog is most likely.

Combine your basic knowledge about what causes fog with what you learn about local conditions and you're prepared to avoid running into unsafe visibility. You'll be a lot happier—and safer—on the ground enjoying the romance of fog than in the air wondering how you're going to make it safely back to earth. ✈

**An instrument-rated private pilot with advanced and instrument ground instructor ratings, Jack Williams has been the "Weather Page" editor for* USA Today *since the paper was founded in 1982.*

am I the only one left ALIVE?

LT COL JAMES M. LEAVIS, USMC*
Courtesy *Approach Mech*, Mar-Apr 96

■ As I drove to the base on this beautiful Southern California morning, I was excited. Two months earlier, I had been designated an H2P in the CH-53A/D. The reason for my high spirits was that we were deploying to San Clemente Island with 10 helos to support the Fifth Marines during their combat-readiness evaluation.

I had flown a few FRAGS during the last month, and the sense of power I got from completing those simple tasks made me want more. Today, I was about to take part in a 10-plane lift, the largest number of 53s I'd seen launched at one time. I was also copilot to the mission commander, flying in the lead aircraft.

I liked the major I was flying with. I was still very rank conscious since I was only a few months out of Pensacola where captain aviators were treated with awe and reverence. To me, anyone above the rank of captain should not have been approached by a junior officer.

I discovered he was friendly and showed a genuine concern for us copilots and our training. He had recently transitioned from A-4s after 3 years out of the cockpit as an instructor at a military academy.

We kicked off our brief on time, broke down the flight into sections, then finally into individual crew briefings. The major and I discussed some peculiarities of this morning's lift, and then he went into a lengthy emergency-procedures discussion. I listened to the same NATOPS items that I'd heard dozens of times and noted no differences. Then we walked to maintenance control, screened the book, and the copilots were dispatched to begin the preflights.

We had to shut down on our first attempt to replace an Nr tach generator. We were going to be delayed a few minutes, and the major told our wingman to take off without us. The 10-aircraft launch had been broken into five sections, and each section was staggered by

15 minutes.

Troubleshooters replaced the bad tach generator in minutes. We began to make our way through the start and run-up checklists, this time without any glitches. The HAC called for taxi, and we launched as a single aircraft.

Once we entered military airspace over Camp Pendleton, we checked in with range control to see if any of the ranges were hot. They cleared us down the coast at 2,000 feet. Somewhere near Pulgas Canyon, they passed us to Camp Pendleton tower, and I reported in.

I had been doing my copilot duties, striving for precision, but looking to the right seat for approval of my every action. I told the HAC I was going to start the descent from 2,000 to 1,000 feet to be at the proper altitude for the MACS 7 checkpoint and entry into Camp Pendleton's pattern. He acknowledged, and I lowered the collective slightly to begin the gradual letdown.

It was at this point that our day turned into a nightmare, and my life changed forever. I felt or heard something snap somewhere in the aircraft. The helicopter immediately rolled left-wing down 10 to 20 degrees, and the nose dropped 15 degrees below the horizon. A yaw to the right quickly developed, which I countered with more, and finally full, left rudder and aft-right cyclic.

I told the major in a strained (but what I hoped was professional) voice that we had a "catastrophic tail-rotor drive failure." He responded coolly that he had the controls. I told him that we had to enter an autorotation, and he responded with a call to "relax and secure the yaw servo."

I glanced out my window. The roll was becoming more severe at nearly 45 degrees, and the aircraft was now 20 degrees nose-down and yawed almost 45 degrees to the right. I was terrified. Fully aware that our lives were in danger, I decided to do my copilot duties. Bracing against my side window, I pulled myself uphill by grasping the right side of my seat to reach the center console. I reminded the HAC once more that he needed to autorotate as I punched off first the AMP and then the yaw servo. No more than 10 seconds had elapsed since I'd relinquished the controls. Almost simultaneously with the securing of the yaw servo button, the aircraft started rolling to the left, becoming completely ballistic.

The helicopter was rolling rapidly along its central axis while spinning right around the center of gravity. I was thrown against my window once more, and while the helicopter tumbled wildly, I saw the crew chief and the first mech trying to brace themselves in the open crew door. They couldn't hold on, and both spilled out.

I turned back to my instruments, convinced that my crew was gone. I checked the collective and noted that it was full down. All the caution lights were flashing at the completion of each roll, but other than that, the gauges appeared normal. Something behind me was thumping rhythmically, and my attitude gyro spun freely in a vain attempt to follow the aircraft's erratic motions. I lowered the landing gear and transmitted a frantic "Mayday!" to Camp Pendleton Tower. After that, I told the major that I was going to try to secure the engines. He didn't answer, so I assumed that he concurred with that decision.

Adrenaline was pumping wildly through me. I was completely lucid, maybe for the first time in my life, but I couldn't fathom why this was happening. I understood what the initial indicators told me and passed it on to the HAC. It was clearly a drive-shaft failure, but why were we rolling? NATOPS said nothing about this. I believed I was going to die as I watched the ground rush up at me.

...I saw the crew chief and the first mech trying to brace themselves in the open crew door. They couldn't hold on and both spilled out.

A disjointed thought raced through my mind: I hoped that dying wouldn't hurt too much and prayed that it wouldn't be by fire. I used all my strength to haul myself back across the cockpit and allow my hand to fall back onto the speed-control levers. The lateral Gs were enormous, and the simple act of lifting my arm was beyond me. My hand found the speed-control levers, and I tried to haul them aft. I was unsuccessful at first, because there was a foot in the way. This, too, made no sense because the crew was gone, ejected a few seconds before. I found out later that the crew chief and first mech had both been on gunners' belts. They climbed back into the aircraft after a few terrifying seconds suspended in space.

The rolling stopped suddenly after six complete turns, but the aircraft was spinning at a

continued on next page

"Let them go, lieutenant, we can't help them."

sickening rate. I continued to provide essential information such as altitude and airspeed.

We were now below the ridge line. I was able to keep my reference on a lone scrub oak adorning the otherwise barren crest. The Nr increased to 125 percent, and I contemplated raising the collective a bit to bring it down, but the major was at the controls and surely he saw that. Besides, the rolling had stopped, and I was afraid that if I brought the Nr down, the rolling might start again.

We were falling straight down, and the radar altimeter was giving me pretty stable readings. I read out each hundred feet below the 500-foot AGL limit as briefed and expected the HAC to flair the helo at around 150 feet.

I started to think that I was the only man left alive in the helicopter. I'd seen the crew dive out the door, and the major hadn't said a word to me since he told me to turn off the servos. I glanced over at him a time or two and saw his hands were still on the controls, but why wasn't he talking to me? I was chattering up a storm. The least he could do was acknowledge me. I also couldn't figure out why we weren't complying with NATOPS. We should have entered that autorotation immediately, but we took a few precious seconds fiddling with the yaw servo, an action that, even with only 320 hours, I knew was not related to our emergency.

I was still absolutely terrified. I began to suspect the HAC was dead. I watched as we plowed through the altitude at which we should have started our flair and moved my left hand to the collective as I continued my altitude litany on hot mike. My right hand was still on the speed-control levers, so I wrapped my knees around the cyclic to keep it somewhat steady, and when the radar altimeter read 50 feet, I pulled the collective full up to the stops. The helicopter hit the ground very hard but flat, made a quarter turn to the right, and came to rest.

Debris hit me and forced me to turn my head to the right in time to witness the pilot's seat explode from its moorings and exit through the overhead green-house window. I remember being awed by the sight, thinking that it looked like an ejection. The rotor blades struck the ground at the 1 o'clock position, broke up, and crashed through the right side of the cockpit, and shrapnel hit my helmet. Some of this debris cut off my right ear cup. I looked at my right hand, wondering why it no longer responded to my demands to secure the speed-control levers, which were turning the now-bladeless rotor head at ground idle.

The impact had broken my arm above the wrist. Things were serious, but I was alive and pretty much intact. I told myself, "It's time to get out of here!"

Unstrapping, I turned right to exit by the crew door, but a fireball forced me back into my seat. Something had flashed. Sitting back in my chair, I covered my mouth and nose with my gloved hand and waited until the fireball subsided, and then I must have exited the aircraft.

What happened after the flash fire is still a mystery to me. I do not remember a thing up to the point that a nurse broke through the mental barrier I'd erected. I had burns on the back of my neck and head where the seat belts ran through the armored seat, but I had no recollection of exiting the aircraft. The AMB told me I had popped out my window and that my boot prints marked where I'd jumped free. I'd never practiced an egress drill from this aircraft. I was amazed that I'd found the egress handle in the smoke and flames.

I remember, almost dreamily, a nurse in her whites talking calmly but insistently to me, saying, "Let them go, lieutenant, we can't help them." I was in shock, and it took a few seconds for what she was saying to register. I looked at my hands, and I was hauling two people by their harnesses from the burning aircraft. One was dead, and the other was bleeding profusely from his nose and mouth. I put them down gently and wandered around the wreckage searching for the aircraft commander.

After leaving the aircraft initially, I had made my way some distance from the helicopter, deposited my helmet and kneeboard in a neat pile, then returned to the wreck where I had somehow managed to drag the crew chief and a passenger some 30 yards. The nurse happened on the scene because she was taking her husband (a gunnery sergeant) to work at Los Pulgas when our ballistic helicopter almost swatted their truck from the road as it passed directly over them. She was at my side within minutes.

She chased me and convinced me to lie down in spite of my protests about locating my crew. I did what she said and was suddenly exhausted. I woke up to find myself strapped into a stretcher and being carried to a waiting H-1 for the short trip to Camp Pendleton Hospital.

I have relived each horrifying second of that flight a thousand times. My inactions were partially responsible for the deaths of three very fine aircrew. If I had entered the autorotation immediately after recognizing the drive failure, the aircraft would have remained somewhat controllable. Instead, I'd relied on the HAC to handle the emergency. He was the first to die. He suffered an aneurysm (a ruptured artery in the brain) almost immediately after the onset of the aircraft rolls. I had truly been on my own. ✈

*Lt Col Leavis is the CO of HMH-366.

SHORT FINAL...

A Mexican newspaper reports that bored Royal Air Force pilots stationed on the Falkland Islands have devised what they consider a marvelous new game. Noting that the local penguins are fascinated by airplanes, the pilots search out a beach where the birds are gathered and fly slowly along it at the water's edge. Perhaps 10,000 penguins turn their heads in unison watching the planes go by, and when the pilots turn around and fly back, the birds turn their heads in the opposite direction, like spectators at a slow-motion tennis match. Then, the paper reports, "The pilots fly out to sea, then turn back directly toward the penguin colony and over fly it. Heads go up, up, up, and 10,000 penguins fall over gently onto their backs."

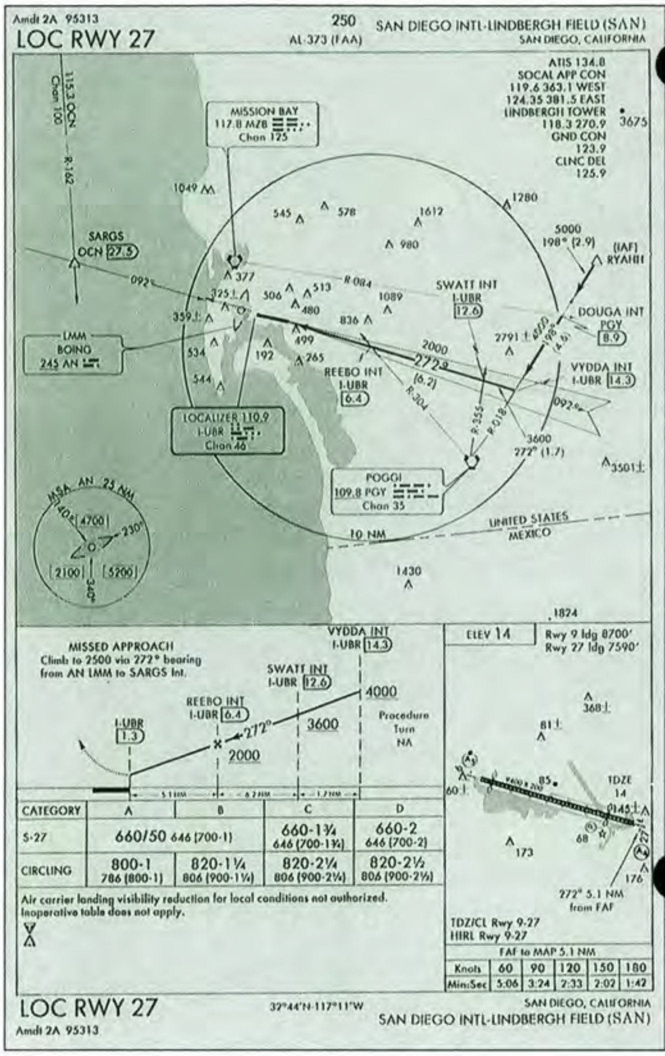
—Audubon Society Magazine

MRS. ANN BEHRNS
HQ AFFSA/XOIA

It's time for the old instrument quiz. If you thought we had asked enough questions about the approach plate, think again. You could fill a book (and, in fact, NIMA has) on all the details behind the instrument approach. This is just a quick look at some of the questions we have answered this month. Cheers.

THE AFFSA INSTRUMENT QUIZ

AF FLIGHT STANDARDS AGENCY



1. What is the latitude and longitude displayed at the bottom of the Instrument Approach Plate?

A. The Airport Reference Point (ARP). The center of the longest runway.

B. The Airport Reference Point (ARP). The center of all usable runways.

C. The Airport Reference Point (ARP). The center of entire airport including taxiways and apron areas.

D. The Airport Reference Point (ARP). The location of the Control Tower.

2. What does the abbreviation on the approach plate MSA mean?

A. Minimum Safe Area.

B. Minimum Safe Altitude

C. Minimum Service Altitude.

D. Minimum Sector Altitude.

3. What is the MSA based on?

A. The facility the Instrument Approach Procedure is based on.

B. A facility near the airport.

C. Usually based on the facility the approach is based, but another facility can be used if the approach facility is not suitable.

D. Any facility near the airport the procedure specialist decides to base it on.

4. The altitudes listed in the MSA circle provide how much obstacle clearance?

A. A clearance of 1,000 feet above the highest terrain or obstacle within the radius given; i.e., 25nm, 30nm from the noted facility.

B. A clearance of 1,000 feet above the highest terrain or obstacles and 2,000 feet for mountainous terrain with-

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in the radius given; i.e., 25nm, 30nm from the noted facility.

C. A clearance of 2,000 feet above the highest terrain or obstacle within the radius given; i.e., 25nm, 30nm from the noted facility.

D. None of the above.

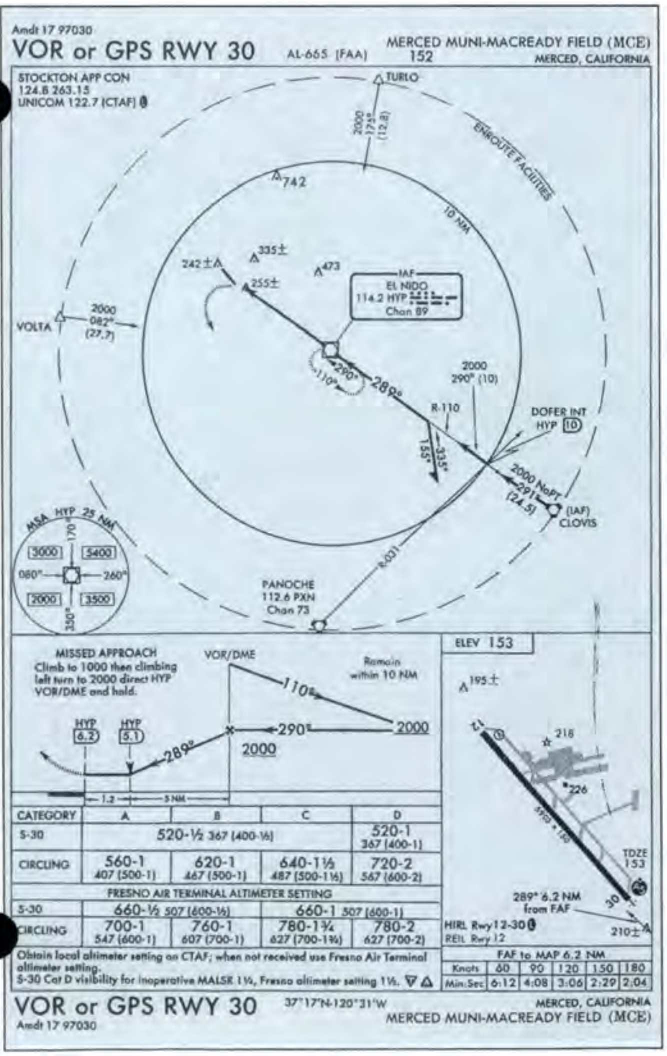
5. What information is to scale on an Instrument Approach Chart when *only* an inner ring (8, 9, 10, 12, or 15nm solid ring) is shown?

A. Only the points and drainage inside the ring.

B. All points and drainage within the neat lines (the lines on the outer limits on the Planview) are to scale unless a scale breaker is used on a line. Then the facility or fix on the other side of the scale breaker is the only point not to scale.

C. The points and drainage inside the circle are to scale. All points and drainage outside the circle are relational but not to the strict scale.

D. All points and drainage within the neat lines are to scale unless a scale breaker is used on a line. Then all points beyond the scale breaker are not to scale.



6. What information on an Instrument Approach Chart is to scale when a second ring (Feeder or Enroute Facilities) is used? This is the dashed circle outside the 10nm ring.

A. All the points and drainage within the neat lines of the chart.

B. Only the points and drainage within the middle ring.

C. Only the points and drainage within the 10nm ring.

D. Any of the above.

ANSWERS

1. **B.** The center of all usable runways. This information is also found in the IFR Supplement. This does not mean the point is on any particular landing surface. It could be the center of the runway if you have a single runway.

2. **D.** Minimum Sector Altitude. The term Minimum Safe Altitude is a more general term referring to both the Minimum Sector Altitude and the Emergency Safe Altitude. As a point of interest, you will note that Emergency Safe Altitudes (ESA) are not listed for either of our examples. This is because normally only the military use ESAs.

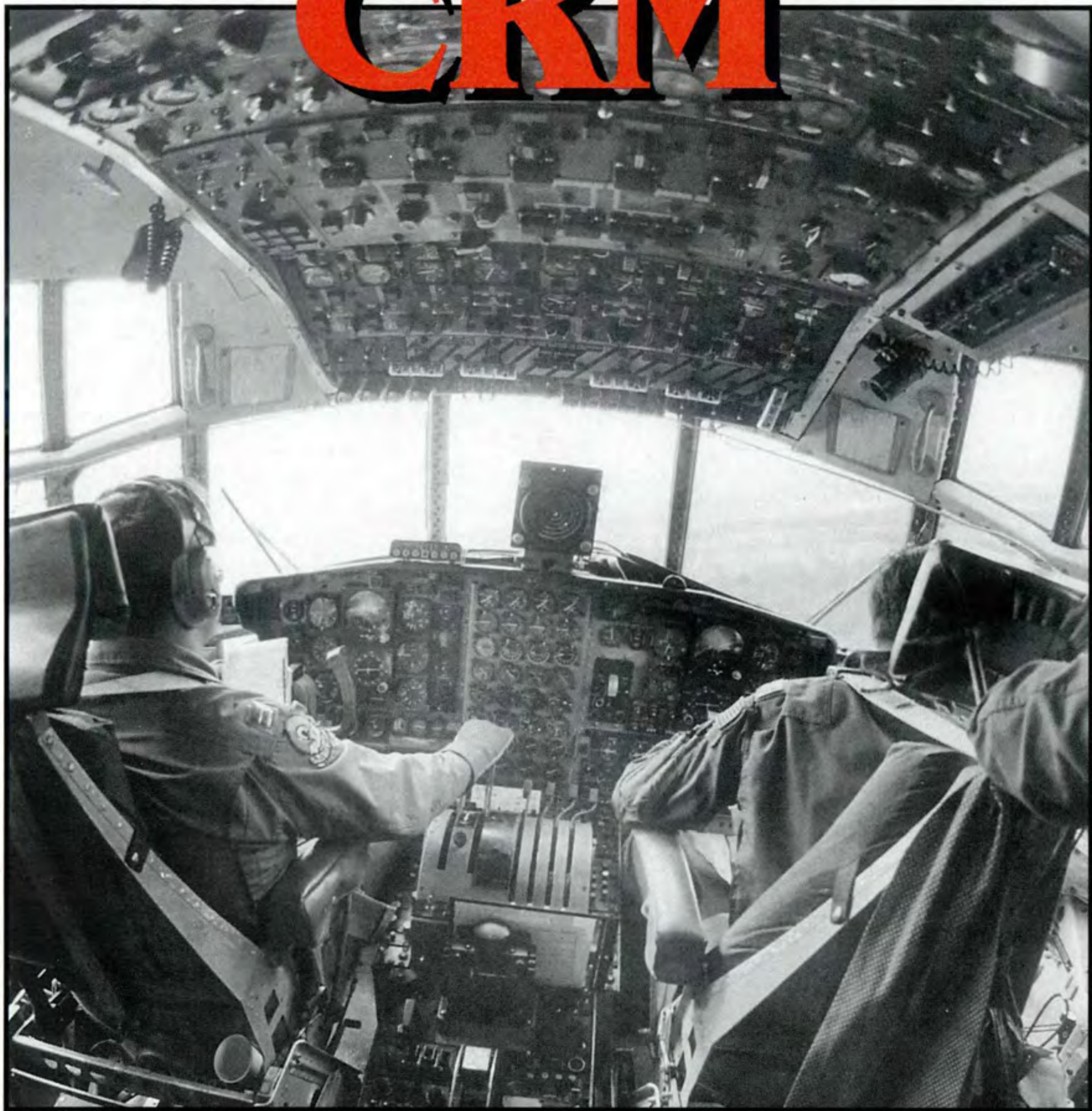
3. **C.** Usually based on the facility the Approach is based on, but another facility can be used if the approach facility is not suitable. The rationale here is to define the MSA off the same NAVAID the pilot will be using for navigation and situational awareness. For example, on an ILS Chart, the Localizer does not provide 360° coverage, so a TACAN or VOR would be used to determine the MSA. The Minimum Sector Altitude typically runs out to 25 nautical miles from the facility. It may run out to 30 nautical miles depending on the location of the NAVAID and the airfield.

4. **A.** A clearance of 1,000 feet above the highest terrain or obstacle with the radius given; i.e., 25nm, 30nm from the facility given. No allowance for mountainous terrain is given when determining the MSA.

5. **B.** All points and drainage within the neat lines (the lines on the outer limits of the Planview) are to scale unless a scale breaker is used on a line. Then the facility or fix on the other side of the scale breaker is the only point not to scale.

6. **C.** Only the points and drainage within the 10nm ring.

CRM



**"You're a member of a flight crew.
You aren't here to sit on your hands.
You are to fly and assist me.
I need your help.
That's why there are two seats in our cockpit."**

quoted from *RNZAF Safety Insight Magazine*