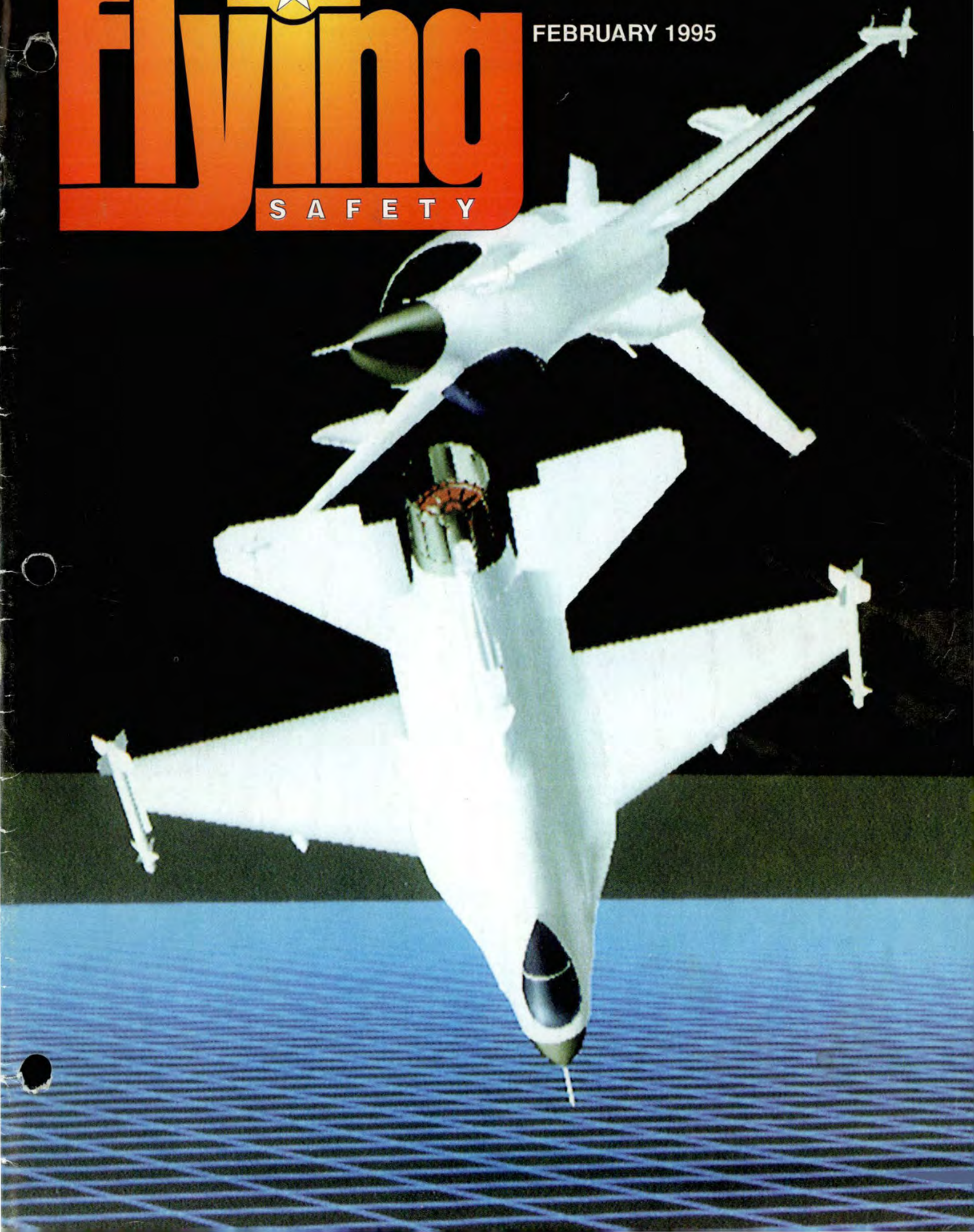
Flying SAFETY

FEBRUARY 1995



Safety in Air Force Materiel Command

by General Ronald W. Yates, USAF

■ Lessons learned from the past, a customer focused present, and an eye on a visionary future — guide our actions every day in Air Force Materiel Command. With AFMC's task of providing "cradle to grave" service of every Air Force system, our people are deeply involved in safety from system conception until retirement. From participation in design and testing the next generation fighter, to depot maintenance of our current aircraft, to dismantling and destruction of obsolete systems, the awareness, recognition, and prevention of hazards never stops.

AFMC has totally embraced Quality Air Force concepts. To that end, the command believes strongly in integrated product development. Every step of the way we get the customer — the operational commands, and the suppliers — the contractors, scientists, and engineers working as a team with program managers. This approach brings together experts that can apply past lessons learned, make sure the focus is right for current needs, and ensure systems consider future technological and operational developments. Every step of the way we ask: Do our products meet our customers' needs? Are our products safe? How can we reduce risk? What will it cost?

With fielded systems, when a mishap occurs, finding the failed component is ordinarily the easiest part in any safety investigation. More difficult is determining why it failed. Did the design or manufacture process fail? Did it exceed its useful life or fail prematurely? Was it operated in an inappropriate manner or in a regime not anticipated during design and testing? As a whole, we have made significant strides in reducing materiel problems. But, we must do better in the human factors arena — our people must be dedicated to the very highest safety standards.

Any individual can stop a potential mishap. The key is involvement. We are all accountable for our actions ... or inaction. Our present quality focus emphasizes empowering our people, and they are eagerly meeting the challenge to accept responsibility and become involved. With that kind of commitment, a safer future is assured.

Each advance in technology creates a new set of problems. Development and testing eliminate a majority of a system's problems. But a few are not discovered until after being operationally deployed to the field. Our goal in Air Force Materiel Command is to satisfy our customers by preventing materiel failures. But, since we are operating on technology's edge, we will make design mistakes. When we do, we're committed to fixing them right the first time.

Air Force personnel displaying diligence, professionalism, attention to details, and common sense can prevent mishaps. Focus on safety — from the way we design a system to the way we maintain and operate it. As you do so, you will strengthen our safety chain. ■

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SPECIAL FEATURES

REGULAR FEATURES

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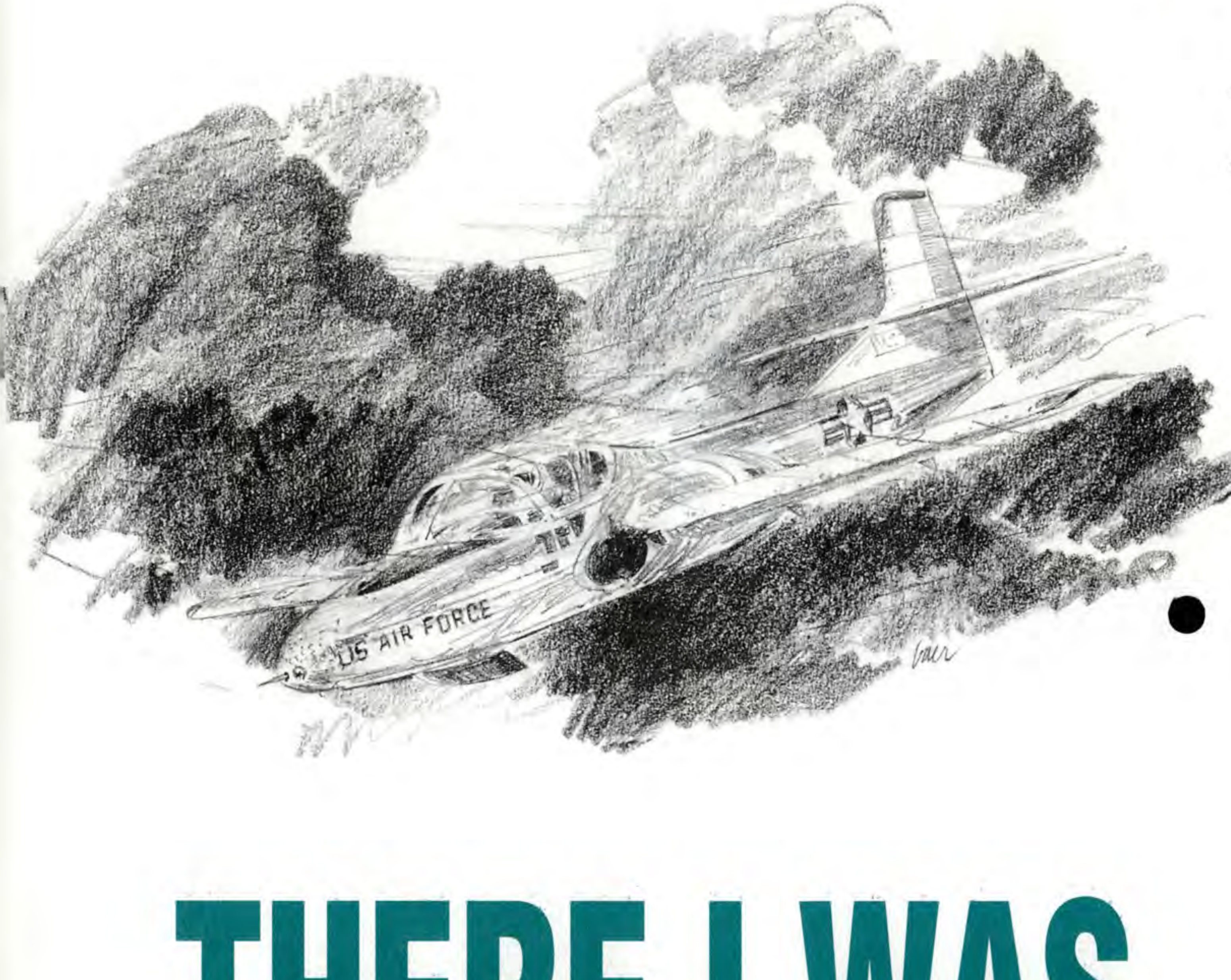


THERE I WAS

■ One day many years ago, as a young second lieutenant and recent "Top Graduate" of T-37 pilot instructor training, I was busily imparting my vast knowledge and experience to a group of second lieutenant student pilots.

It was at this time an "old-head IP" approached me with a proposition: "Hey, how about going cross-country with me this weekend!" I was happy to accept his offer since I hadn't been before. "Great," was his reply. "I'll take care of all the planning, and you just don't worry 'bout a thing." With the deal sealed, I eagerly awaited my first grownup, unsupervised cross-country flight scheduled for that weekend.

On the morning of our departure (Friday), I discovered I was scheduled to fly two student sorties. This would delay our departure until afternoon. When I approached my cross-country partner and told him of my scheduling problem, he didn't seem to mind a bit.

"No problem," he said. "Don't worry 'bout it. All the flight planning's done. Just tell me where your bags are, and I'll have us filed, packed, preflighted, and ready to crank by the time you finish. I'll meet you at the jet when you get done." With this good news, I instructed two sorties without incident, quickly debriefed, and rushed out to my waiting jet.

I strapped in and called clearance delivery, and the old-head IP started engines. After I "rogered" the clearance, I opened the Hi-chart to find our route of flight. I looked and looked but was unable to locate our destination and half of the en route points. I asked the IP about this, and he calmly suggested I open the chart one more panel. Sure enough, there it was, a long, long way beyond what my limited judgment would dictate as reasonable.

Usually (in a T-37) your maximum IFR route of flight (250 nm) at altitude can be approximated by laying your Form 70 on a Hi-chart. The length of the Form 70 is roughly equal to the distance you can fly and still land with legal fuel reserves. This route of flight was over a card-and-a-half long.

I also noticed the Form 70 indicated "Zero" fuel remaining at the destination after adjusting for fuel reserves. This situation concerned me, so I asked the IP about it. His response was that he had done the fuel calculations, had flown this route before, and he *knew* a "special" fuel-saving climb procedure (AC in "vent"). "No sweat," he said, "we can make it."

Here is where I deferred good judgment to the old-head IP. Mistake No. 1. I accepted his explanation without further challenge.

So we took off, and for a great while everything was fine — that is, until we passed a major Texas city, encountered headwinds associated with the massive, unanticipated thunderstorms directly off our nose, and my fuel calculations indicated we didn't have enough to reach our destination. Well, we did, but we didn't have enough to land without dipping into our 60-16 fuel reserves. I mentioned this fact to the old-head IP, and he stated he had a "special" en route descent procedure which would "make us gas," and everything would be fine.

Mistake No. 2. Again I believed him over my best judgment.

Unfortunately, shortly thereafter we were committed — too much headwind to make it without arriving "EMERGENCY FUEL" and too little gas to turn back. And, to make things worse, ATIS at our destination was calling weather at mins for an ILS approach with thunderstorms and lightning within 5 miles.

It was at this time I began to grow some chest hairs. I suggested to the old-head IP we declare EMERGENCY FUEL. He stated it wasn't necessary to do this and didn't. Being somewhat intimidated by this old, experienced captain, I simmered in anger but said nothing (mistake No. 3).

As time and distance crept by, the weather got worse. Soon we found ourselves "EMERGENCY FUEL." I began to feel real uncomfortable with this situation and told the old-head IP if he didn't call Center with our fuel status, I would. He relented and declared "minimum fuel." (Great — not much — but better than nothing.)

Thus we began our descent into the now omnipresent thunderstorms. My stomach was in knots, and I was wondering if we would survive. We contacted approach control, the old-head IP did his "special" descent and didn't save any gas, and we ended up on a 10-mile base with no intention to configure until we had landing assured. Our fuel status was well, well below EMERGENCY FUEL.

Here we were, in the goo, thunderstorms all around, lightning going on about us, with no gas, which means no options. But it seemed we might just pull this off. On dogleg, we picked up the ILS, then it went away due to a lightning strike. We quickly asked for a PAR and were informed no PAR was available. We asked for an ASR and were informed the weather was below minimums for that type of approach. The old-head IP finally exhibited good judgment and declared EMERGENCY FUEL, and we got our ASR vectors.

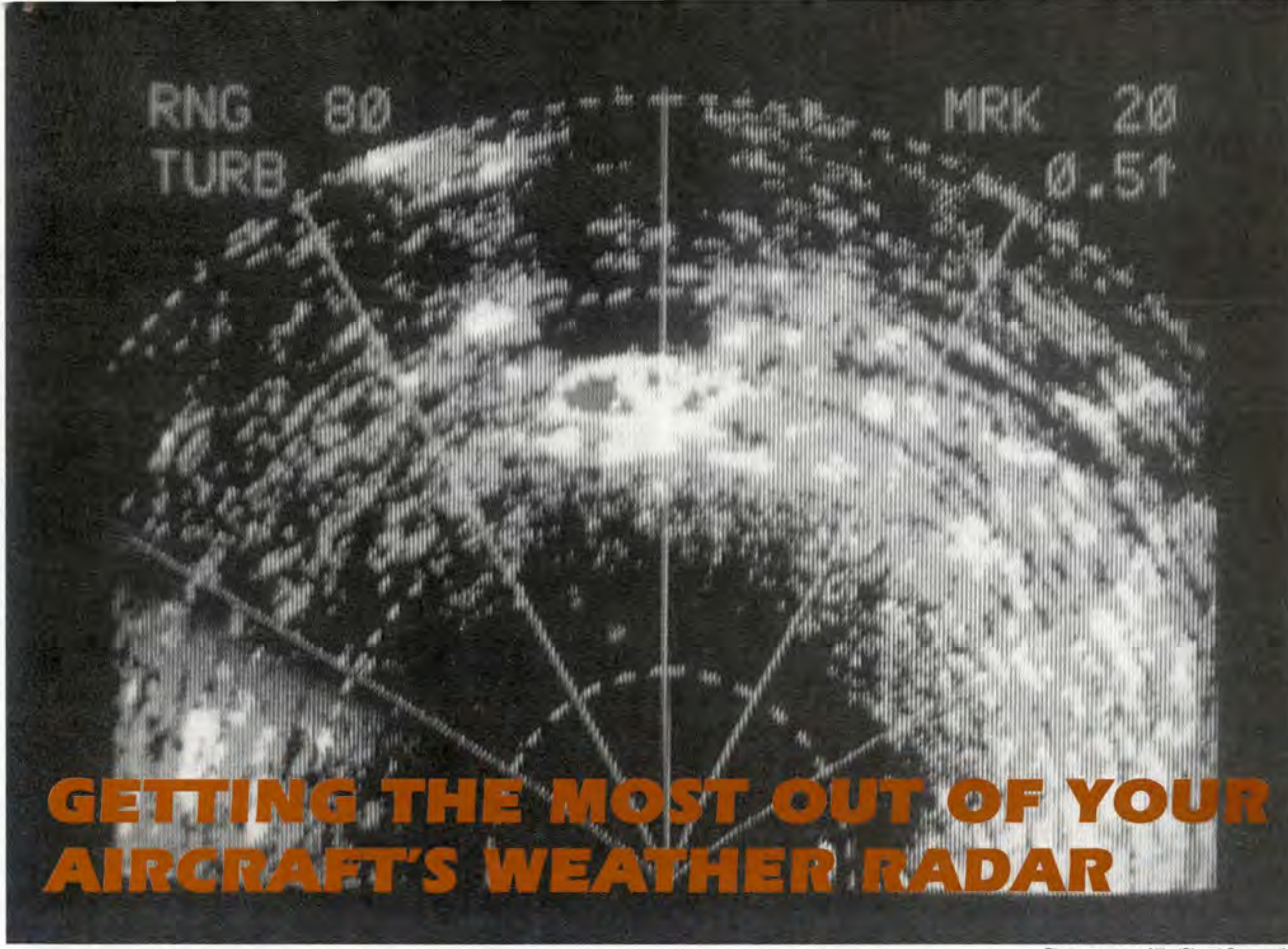
As the approach progressed, I couldn't help but review all the bonehead decisions I made on this trip — not challenging the destination while in the chocks, accepting his bogus fuel computations, accepting his "special" climb and descent as a way out, and not insisting on a timely divert to a civilian field. I began to wonder out loud about how the mishap report would read.

Feeling miserable, seeing occasional patches of green through the clouds below us, the situation looked very grim indeed. Fortunately, we found the runway through all the rain and fog, quickly configured, got "three-green" over the overrun, and landed with nothing left on the fuel gauge except the pointer — jabbing at the "ZERO."

After landing, we taxied to the chocks and shut down. Before I could take a breath, the old-head IP was jumping out of the jet, sprinting through the rain towards base ops, and telling me he was going to file our outbound flight plan. I was exhausted, beaten, and definitely disappointed in him.

However, my disappointment in the old-head IP was nothing compared to the disappointment I felt about myself. This feeling motivated me to walk into base ops and find the old-head IP. I found him in the weather shop frantically planning a route around the massive ink-blot radar summary chart. I told him that was it! I wasn't going anywhere. We were staying until the next day. We were going to stay put until the weather cleared. And *I* was going to do the flight planning!

Lesson learned: Judgment deferred is no judgment at all. ■



GETTING THE MOST OUT OF YOUR AIRCRAFT'S WEATHER RADAR

Photo courtesy AlliedSignal Corporation

CAPT PHIL CARMENA
Air Force Flight Standards Agency

■ Throughout the world, an average of 44,000 thunderstorms occur daily. They're a hazard aircrews often face in accomplishing their global missions. **While the best course of action is to stay well clear of severe weather and thunderstorm areas,** avoiding them is often a continuing challenge. To help us keep clear of CBs and other significant weather, most operational aircraft are equipped with radar systems that will help identify precipitation areas, and many aircraft have color weather radar.

While most flight manuals cover radar operations, weather identification, and radar switchology, many lack the specific "how to's" for using radar to avoid significant weather. Interpreting what you're looking at, knowing how to separate targets, and estimating the height of targets are some keys to avoiding severe weather and thunderstorms, along with their associated hazards. Understanding your radar's capabilities and limitations will increase its effectiveness as a weather avoidance tool.

Before we begin, a few definitions are helpful. ***Attenuation*** is the weakening of a radar signal caused primarily by precipitation, clouds, atmospheric particles, dust, and gases.

Beam width is the width of the aircraft's radar cone. Most military airborne weather radar sets have a 3° beam width.

Target resolution is the ability of a radar unit to display two closely spaced targets as separate returns on a radar screen. In order to resolve or separate two different targets at the same range, the targets need to be separated by at least one beam width.

Radar shadow is caused when an aircraft's radar beam can't penetrate through an intense area of precipitation. The radar signal is fully attenuated or absorbed by the precipitation, with nothing reflected back to the radar antenna.

Sensitivity Time Control (STC) is used to eliminate intensity variations caused by distance. Weather radar sets will only display accurate precipitation levels within their STC range. STC range varies between radar sets but generally ranges between 40 to 80 miles.

Tilt Management Techniques

Precise tilt management of your radar beam — knowing where your radar beam is looking — will give the most accurate picture of what is ahead of your aircraft. Knowing both what you're looking at and its altitude can help you avoid entering severe weather and also may prevent deviating unnecessarily for weather that is well below your altitude.

In Example 1, aircraft A is scanning too low. The weather depicted on the radar screen is below the aircraft's flight level. If it continues on its current path, the aircraft will enter the severe thunderstorm. The crew of aircraft B has determined where their radar beam is pointing and are scanning correctly. Their radar screen indicates the true intensity of the storm.

A key to proper tilt management is to determine where the bottom of your radar beam is looking. If you position your tilt so the bottom of your radar beam sweeps on a plane parallel to the earth's surface, the radar will display only targets that penetrate your flight level. This is easy if you're flying an aircraft with sophisticated targeting radar that provides accurate radar beam altitude readouts. For the rest of us without that feature, setting the radar tilt controller to zero is no guarantee the radar beam tilt is level. A calibration difference of 1 degree or less between the tilt controller and the radar antenna can easily degrade effectiveness.

To ensure your radar sweeps on a plane parallel to the earth's surface, Archie Trammell, a civil aviation radar expert, recommends the following method:

■ In level flight, set your tilt so ground returns paint from the 40-mile arc outward.

■ Drop the last three digits from your AGL altitude and divide by 4.

■ The result is the number of degrees you should raise your tilt to place the bottom of the radar beam at your flight level.

Example: Assume you're flying at FL390 over 3,000-foot terrain. Tilt down to make ground returns paint at the 40 NM arc. Your altitude AGL is 36,000, or 36, since we drop the zeros. Dividing 36 by 4 (from a 40-NM arc) equals 9. Raise the tilt 9 degrees to put the bottom of the radar beam at your flight level. Anything now painting on your radar is at your flight level or above.

A variation of this method is to tilt your radar down until ground returns paint at an arc (in nautical miles) corresponding to your altitude AGL (in thousands of feet), then raise the tilt 10 degrees. Using the previous example, you would use a 36-NM arc for 36,000 feet AGL. Raising the tilt 10 degrees will place the bottom of the beam at your flight level.

Once you've determined where the bottom of your radar beam is, you can work your beam up and down as needed to scan for significant weather.* En route, depending on the height of weather, you may need to scan by moving your tilt up and down in small increments to get a good look at radar returns. On low-level missions or in terminal areas, you'll need to scan up.

If you want to separate targets at the same range, or if you're considering climbing over weather instead of diverting around it (generally not a good idea for thunderstorms), the following steps will help you to use the bottom of your radar beam to determine the height of radar returns:

■ Starting from your level flight tilt setting calculated earlier, slowly raise the tilt to the point where the radar return just disappears from the screen.

■ Note the number of degrees you raised the tilt.

■ Multiply the distance to the target by 100.

■ Multiply that result by the number of degrees you raised your tilt.

Example: You're painting signifi-

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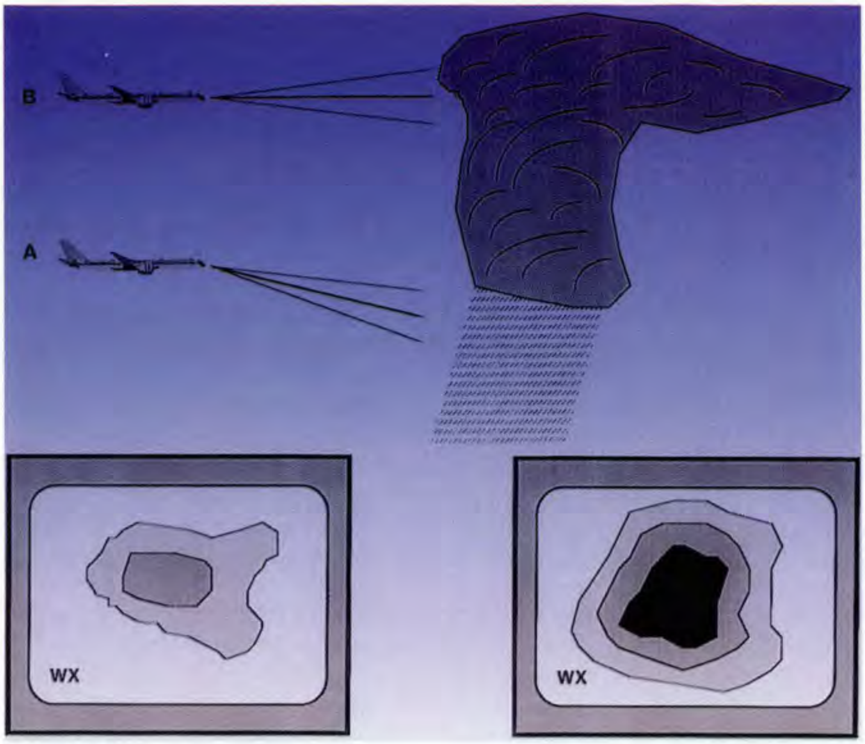
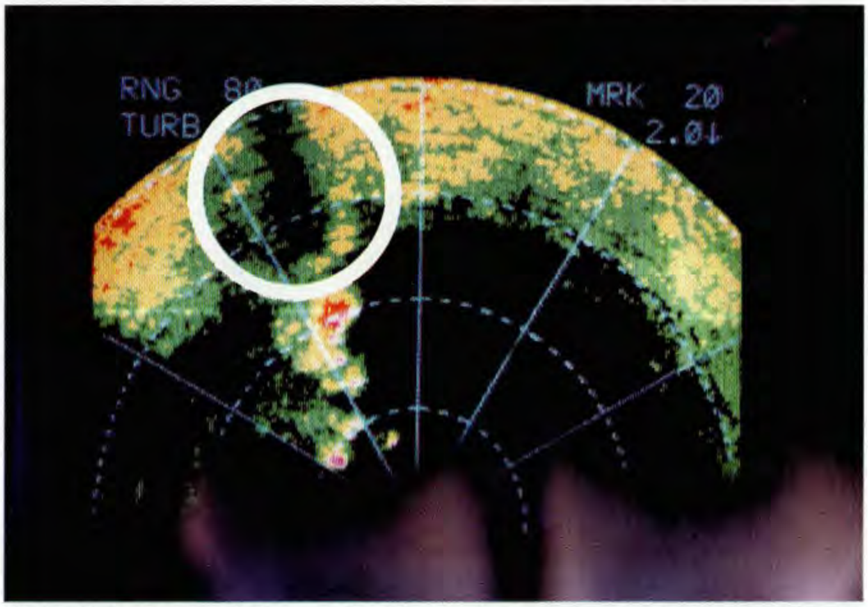


Example One

In this example, aircraft A is scanning too low. **(See Editor's note* on page 6.)** The weather depicted on the radar screen is below the aircraft's flight level. The crew of aircraft B has determined where their radar beam is pointing and are scanning correctly.



Radar shadow is caused when an aircraft's radar beam can't penetrate through an intense area of precipitation. The radar signal is fully attenuated or absorbed by the precipitation, with nothing reflected back to the radar antenna. **Note the shadow in the circled area.**

Weather Radar

continued

cant weather 50 NM in front of you. When you raise the tilt 3 degrees, the radar returns disappear. The bottom of your beam is now sweeping just above the target. 50 NM X 100 X 3° = 15,000. The top of the radar returns are 15,000 feet above your flight level.

Interpretation and Limitations

While weather radar is an excellent tool to help avoid severe weather, it's important to understand radar's weaknesses and limitations. When looking at your weather radar, be wary of shadows which look like clear areas but may invite disaster. Radar shadows are created when the radar beam cannot completely penetrate an intense area of precipitation. The precipitation attenuates or absorbs the radar signal, and little or no energy is reflected back to the antenna. Not even ground returns will be visible beyond the precipitation.

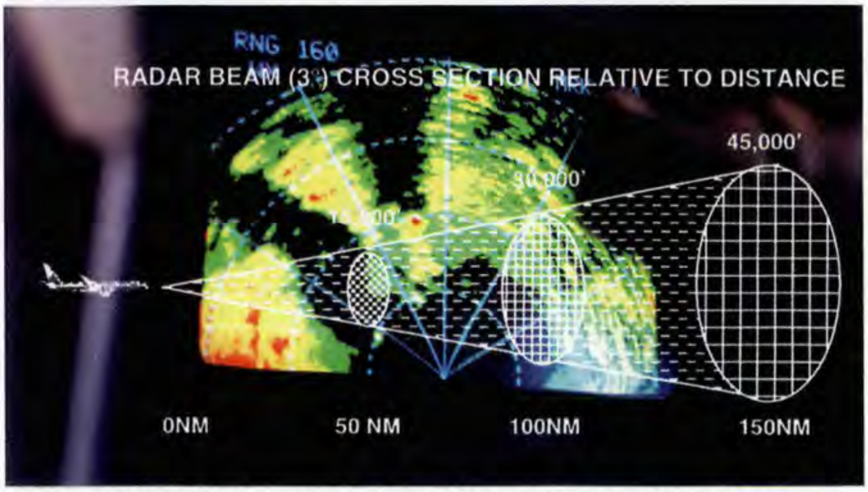
Along a line of thunderstorms, a thin band of solid precipitation with a "clear area" behind may look appealing to get through but, in fact, may mask the area of heaviest precipitation. Such was the case in 1977, when a Southern Airways DC-9 was lost after attempting to fly through what appeared on their radar screen as a gap between major storm cells. The "gap" actually masked one of the most severe parts of the storm system. The rule for radar shadows is *never* continue flying towards them. You simply can't tell what is lurking in the shadow, so play it safe and assume the worst.

As mentioned earlier, two targets at the same range can be resolved or separated on your screen if they're separated by at least one beam width. However, target resolution becomes more difficult the further away the targets are located. In addition to attenuation effects, as range increases, the radar beam grows in size and is looking at an increasingly bigger piece of sky. Two targets at the same range, but different altitudes, will often initially appear as one target on your screen. Example 2 shows what happens to a typical 3° beam as range increases.

Because of attenuation effects and decreased sensitivity at longer ranges, radar sets are equipped with features to help compensate and enhance accurate radar return displays. If your aircraft radar uses Sensitivity Time Control (STC), precipitation levels are accurate only within the STC range. Weather depicted beyond the STC range will normally be more severe than it looks on your radar screen. Your flight manual should list the STC range or identify a maximum range beyond which precipitation gradients or levels are no longer accurate.

Some radar sets use an ISO-echo mode to compensate for "blossoming" which occurs with close-in targets. In the ISO-echo mode, a portion of the echo, or radar return, is canceled if it exceeds a threshold level. This will cause a donut-shaped pattern on the radar screen. If your radar uses this mode, don't interpret the canceled area as an echo-free area with no significant weather.

Example Two



This example shows what happens to a typical 3° beam as range increases. Target resolution becomes more difficult the further away the targets are located.

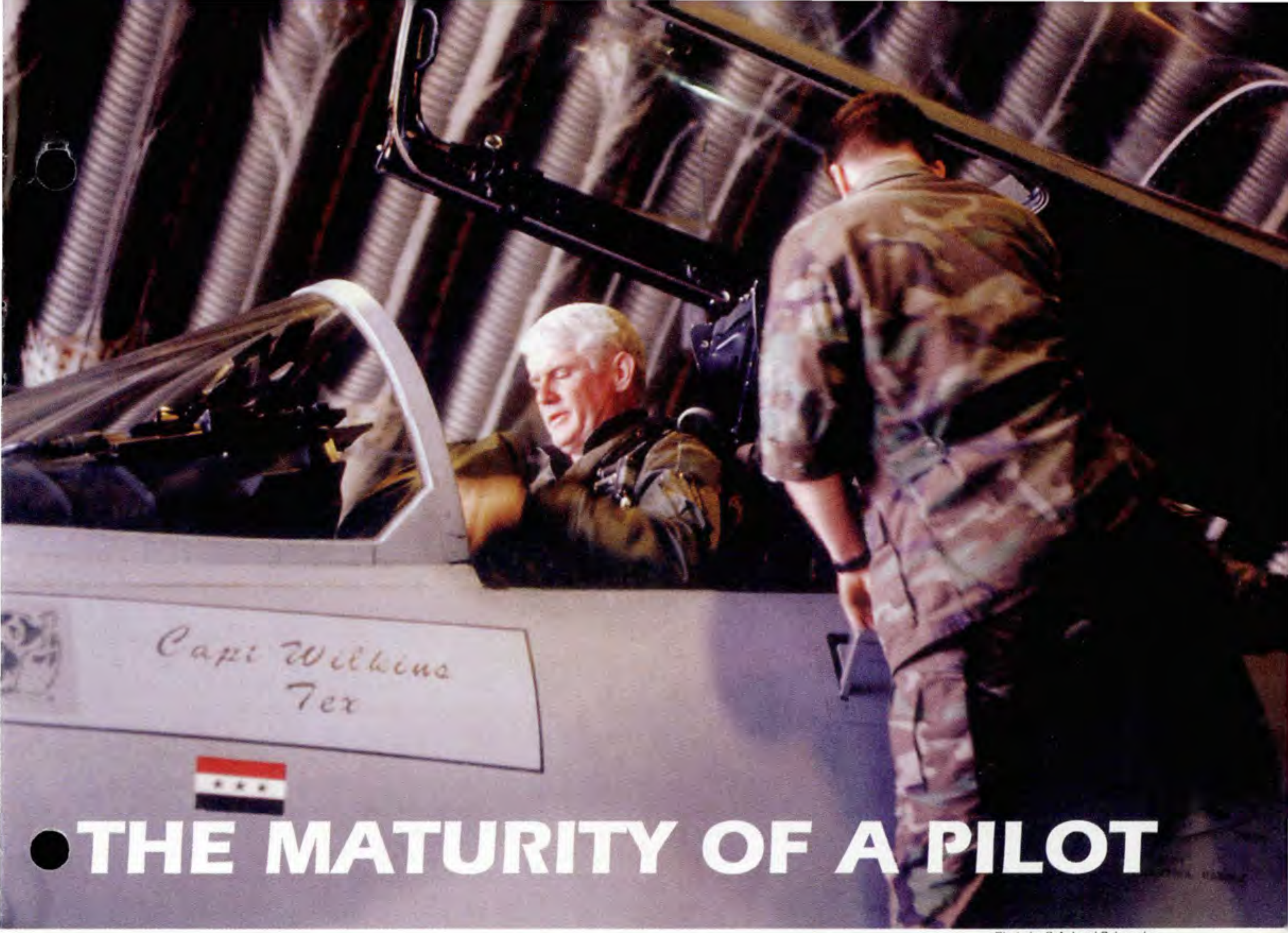
Application

Air Force and multicommand regulations tell us to avoid thunderstorms by at least 20 NM. It's smart guidance, but if you operate your aircraft in the southeast United States in the summer, or spend any amount of time flying in other areas where thunderstorms occur regularly, you'll find maintaining required clearances a continuing challenge. Widespread thunderstorms won't always give you that 40-mile-wide break to fly between cells. In some cases, flying 20 NM downwind from a mature storm won't be enough, while just a few miles upwind of a decaying storm might be sufficient.

If you're considering flying over a thunderstorm, keep in mind building thunderstorms have been recorded with growth rates at up to 5,000 feet per minute, and mature storms can produce turbulence and updrafts of 3,000 feet per minute or more above the cloud tops. Trying to outclimb a developing storm or flying over the top with minimum clearance is not recommended and usually isn't too smart an option.

Practice with your radar regularly, and you'll quickly master the tilt management techniques described earlier. Knowing your radar's capabilities and limitations will increase its effectiveness as a weather avoidance tool. But remember, it's only one of several tools available to you. Use weather forecasts, PIREPs, SIGMETs, ATC, and most importantly, your judgment and experience to keep yourself safe and clear of thunderstorms and severe weather. ■

*Editor's note: At higher altitudes where only ice may exist, a downward scan may be entirely appropriate. Consult your unit training flight for scanning techniques appropriate for your aircraft's radar and unit mission.



THE MATURITY OF A PILOT

Photo by SrA Janel Schroeder

COL RICHARD H. WOOD,*
USAF, Ret.

■ In the flying business, I've always felt there was a difference between a pilot and a *mature* pilot. Young UPT graduates, sporting new sets of wings on their blouses (shouldn't the plural of blouse be blice?), are very good pilots, but not *mature* pilots. I suspect they're something of a hazard to themselves and others until they cross that magic threshold called "maturity." My hope is that they live long enough to get there.

Yeah, well, that's nice, but how will we know when they've arrived? More important, how will they know?

This question has bothered a lot of people and spawned some research based on aircraft mishaps versus experience. So far, none of it has led to any absolute conclusions. If it had, we'd be sending all new UPT graduates to something called "Maturity School."

Some feel maturity results from the accumulation of total experience, and it's not definable as a specific point in a pilot's career. They are number crunchers who try to analyze total flying time. This hasn't worked well. I suspect it's because all flying time is not created equal. Some hours are better than others.

Many years ago, the fighter pilot fraternity argued (in all seriousness) that 1 hour in a fighter was worth at least 2 in anything else; therefore, fighter time should be multiplied by 2 when entered in the big record book. That proposal didn't make it past the first subcommittee. We've never figured out a way to factor in the quality of flying experience, and I don't think we ever will.

Others feel maturity isn't something that creeps up on you over a long time, like extra weight or gray hair. It results from one or two single events wherein the pilot, in a sudden blinding flash of insight, realizes that life isn't a rehearsal. This is it, buddy, and you get only one shot at it!

One proponent of this theory argued that maturity occurs about 1 hour after a pilot's successful recovery from the first really serious emergency. About then, the pilot is beginning to cool down slightly and realizes what a big mess that was and just how close he or she came to self-extinguishment. From then on, the pilot is different, and his or her attitude toward flying is forever changed. We might as well stamp a big "M" (for Mature) on the pilot's forehead. Promoting and upgrade to instructor would also be appropriate. Suddenly the pilot becomes too valuable a resource to waste as a mere wingman.

I must confess I subscribe to the single-event theory, and I can identify with the "serious emergency" as being the turning point. Looking back in my own career, that happened to me, and it definitely changed my outlook. Up to that

continued

Maturity continued

"Some feel maturity results from the accumulation of total experience, and it's not definable as a specific point in a pilot's career. They are number crunchers who try to analyze total flying time. This hasn't worked well. I suspect it's because all flying time is not created equal. Some hours are better than others."

Photo by SrA Andrew N. Dunaway, II

point, I thought I was immortal.

This, of course, isn't a very practical way to insure pilots achieve maturity. It would involve scheduling each pilot for a no-notice serious emergency and letting "survival of the fittest" cull out the pilots who are immature and plan on staying that way.

But I think there's another measure which is a little more controllable. In my view, a pilot achieves maturity the day he (she) learns to cope with extraneous pressures. It's relatively easy to swindle a young pilot into doing something that is either beyond the pilot's ability or that the pilot shouldn't do at all.

I can remember, as a young lieutenant, letting my squadron commander convince me I shouldn't pickle off the drop tanks merely because one of them was full and the other was empty — a situation the manufacturer strongly warned against. I damn near lost it on landing, and I can confirm the manufacturer's warnings were, if anything, understated.

Five years later, I can remember taking the controls away from my squadron commander (different commander) who was on board for landing recurrency. I initiated a go-around and wouldn't let him fly it again until I had him set up on downwind leg. I thought for a while I had just performed a CLM — career limiting maneuver — but after he cooled down a little (and made a fairly decent landing), he sort of agreed that maybe I was right.

The point is, sometime between the first and second event, I had matured. *There are a lot of dead pilots out there who didn't take control of the plane when they should have.* At one time in my career, I could've been one of them.

So far, I've talked about command pressure — that imposed by a senior officer. We all know that exists, but it's at least identifiable and manageable — somewhat.

There are two other types of pressures out there which are far more difficult to recognize but equally dangerous. The first of these is self-imposed pressure.

By their very nature and personality, pilots are achievers. They hate — absolutely hate — to not get the mission flown as scheduled. If no one else puts any pressure on them, they'll put plenty of it on themselves.

As an aviation safety consultant, I perform a lot of audits (inspections, actually) of aviation safety programs among corporate operators. I've looked at some of the best among the Fortune 500 companies. Because it's such an obvious problem, I always look for evidence that the corporate executives, the passengers, are putting the flightcrew under pressure to get them where they need to go.

I've flown jump seat on corporate flights and talked at length with the passengers — even, in one case, with the Chairman of the Board. I have yet to find one single case (in the corporations I've examined) where any passenger ever nudged a pilot toward a shaky decision on any aspect of flying. On the contrary, I've had executives tell me they wouldn't even think of influencing the pilot's decisions. "Getting someplace just isn't important enough to risk the airplane, the rest of the passengers and me — particularly me." (Obviously spoken by a mature executive.)

Yet the corporate fleet has a phenomenal performance record. Aborts and diversions are rare indeed.

Now, I didn't just fall off the turnip truck. I know nothing works all the time and the weather doesn't always cooperate. When I look at a record of near perfection, I just know someone is cutting a corner or two someplace. Since I know which rocks to look under, it's usually not hard to verify this.

What's happening? Where is the pressure to cut corners coming from? In almost all cases, it's coming from the pilots themselves. When they're carrying The Suits, The Big Guys, or The Heavy Breathers in the back, they feel absolutely compelled to meet the schedule.

Not all corporate pilots feel that way, of course. In my view, one measure of maturity is the pilot who accepts the occasional mission abort or diversion and doesn't allow his or her personal desire to succeed overrule his judgment.

Another type of subtle pressure is peer pressure. This, the psychologists tell us, is a very powerful force, and it may explain some of the aircraft mishaps we've had over the years.

Back in the mid-50s, I was flying B-47s when SAC decided to go into the low-level, high-speed bombing business. Learning to do this was something of a trial-and-error process as we had no terrain-following equipment or standard procedures on how to do it. The initial low-level routes were strictly VFR with one pilot watching out for the ground.

Our route started in the middle of New York State, wandered through Ohio, across Pennsylvania, back up to New York, and over to a target in Massachusetts. Anyone familiar with the weather patterns and major storm tracks of the United States could tell you that entire route would be VFR maybe 6 or 7 days a year. You could absolutely count on IFR conditions.

We flew this thing with a gaggle of five or six planes spaced 15 minutes apart. This generated an interesting peer pressure phenomenon. No matter how bad the weather, if the first plane entered the route and didn't abort, the rest would follow right along. Once in the route, the first plane never aborted because of the peer pressure applied by the following planes. It was sort of a Catch-22 thing.

We even developed a set of code words to describe the weather. If the plane ahead of you said it was excellent, that meant it was mostly VFR. If he said it was "not too bad," that meant it was bad — IFR. If he said it was "marginal," that meant anyone in their right mind ought to get out of there and go home — but no one ever did. I don't know why we bothered to ask.

Once we were down and in the soup, there weren't many options. We were too low to talk to anybody useful as ATC did not have its present remote transceiver setup. Climbing to establish radio contact and get an IFR clearance meant climbing through a few airways. We generally agreed the safest thing to do was to stay where we were and press on. Nobody else would be stupid enough to be down that low in that weather. Thus we developed a low-level IFR capability long before SAC thought we had it.

Another example. In corporate and airline operations, it's common practice for the captain and first officer (FO) to split legs. The FO flies every other leg or segment. This procedure is almost chiseled in concrete, and the captain is under enormous peer pressure to let the FO fly his leg regardless of the situation. Obviously, there are combinations of weather and flightcrew experience where the captain ought to take the leg himself and maybe give the FO the next two. This rarely happens. I am convinced I can identify the mature captains by identifying the ones who are immune to this type of pressure. They fly the legs that they obviously should fly and make the landings they should make regardless of whose turn it is. How do I find these people? I ask. The FOs will tell me which captains split legs regardless of the situation and which don't.

I really believe we can measure the maturity of a pilot by noting his reactions to extraneous pressures. When we find one with unsatisfactory reactions, we can send him to Pressure Reaction School, or something like that. We can actually teach him what's important in this business and what can be ignored. In a way, that's part of CRM training.

Aside from my first emergency, when did I really mature? I think it was the night three of us bombers were trying unsuccessfully to land at the home base in grungy weather. The command post (CP) finally directed all of us to divert to a base whose weather wasn't much of an improvement and would put me well below fuel minimums. There was another base much closer with beautiful weather, but it was notoriously unfriendly to transients, particularly SAC bombers.

The other two bombers headed off as directed. Hoo boy! Peer pressure on top of command pressure! I remember telling the nav to give me a heading for the other base as we weren't going with them. I pulled the old frequency change trick. That's where you begin to acknowledge the CP's instructions, but change frequency right in the middle of a word. It takes a little practice, but done right, the CP thinks the problem is with their radio.

The next day I learned the other two bombers landed with fuel emergencies and had a very sporty time of it. The question of why I didn't participate was never asked. The next time I looked in a mirror, I'm not absolutely sure, but I think I saw a faint letter "M" on my forehead. ■

"I can remember, as a young lieutenant, letting my squadron commander convince me I shouldn't pickle off the drop tanks merely because one of them was full and the other was empty — a situation the manufacturer strongly warned against. I damn near lost it on landing, and I can confirm the manufacturer's warnings were, if anything, understated."

Photo by SrA Andrew N. Dunaway, II

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ENVIRONMENTAL HAZARDS AND MISHAP INVESTIGATION

Official USAF Photo

MAJ JOHN E. RICHARDSON
USAF, Ret.
Southern California Safety Institute

■ There has been an aircraft crash. You are designated as a member of the aircraft mishap investigation board. You assemble at the designated point and, with the other board members, get ready to proceed to the mishap site.

But wait. Before you go, there are some things that you may not have thought about. The crash site of a modern aircraft is a very dangerous place. You will be faced with a variety of hazardous materials and hazardous situations. But with some preparation, you will be able to cope with these hazards and successfully complete the investigation.

First, let's define some of these hazards and then discuss ways to cope. What is an environmental hazard? We can define it as:

The various environmental factors or stresses that may cause sickness, impaired health, or significant discomfort or inefficiency.

Notice the focus of this definition is on your health and safety. You cannot perform your job as an investigator if you are sick or injured. Adding a second mishap to the one you are investigating is not an idea that will endear you to the commander.

Environmental hazards and stresses can be divided into four categories: chemical, physical, biological, and ergonomic. Each variety will probably be present in some form at every mishap site. And there are specific precautions an investigator should take for these hazards. Let's now briefly look at each of these categories and discuss what you can do to protect yourself.

Chemical Hazards

Chemicals make up the bulk of the environmental hazards in the workplace. There are metals, liquids, and gases, all of which have well-known toxic properties and which require specific protective and control actions. Yet there are significant differences between the standard industrial workplace and an aircraft crash site. At a mishap site, you will encounter excessive concentrations of mists, vapors, gases, or dusts. The primary problem is dust.

There are a few exceptions. The first and most obvious is hydrazine. Any investigation involving an F-16 must consider the presence of hydrazine until the hydrazine tank is identified and controlled. Dust hazards are less obvious.

Beryllium is a metal commonly used in electronic components. When it is heated, beryllium oxidizes into a gray, powdery dust. Beryllium is one of the most toxic elements we currently know of. Inhalation of beryllium oxide dust may produce an acute form of pneumonitis with cough, pain, difficulty with breathing, and other symptoms. Relatively small concentrations of beryllium compounds may cause reactions in sensitive individuals.

There are other metals often found

in aircraft that can produce toxic dusts in a crash. Two commonly found are cadmium and uranium. Cadmium, when heated, can produce cadmium oxide, a compound that has caused cases of poisoning in firefighters. Uranium is used by aircraft manufacturers for its high weight-per-volume ratio. Its dust can cause toxic effects in humans which are more serious than any radiation hazard.

Note that for all the metals discussed, the problem is dust. As you work with the wreckage, you may disturb these metal dusts and then inhale them. As an example, beryllium oxide would most likely be present inside an electronic component. If an investigator were to closely examine an electronic component by blowing away the gray dust and dirt to see specific circuits, there is a real possibility for exposure to beryllium.

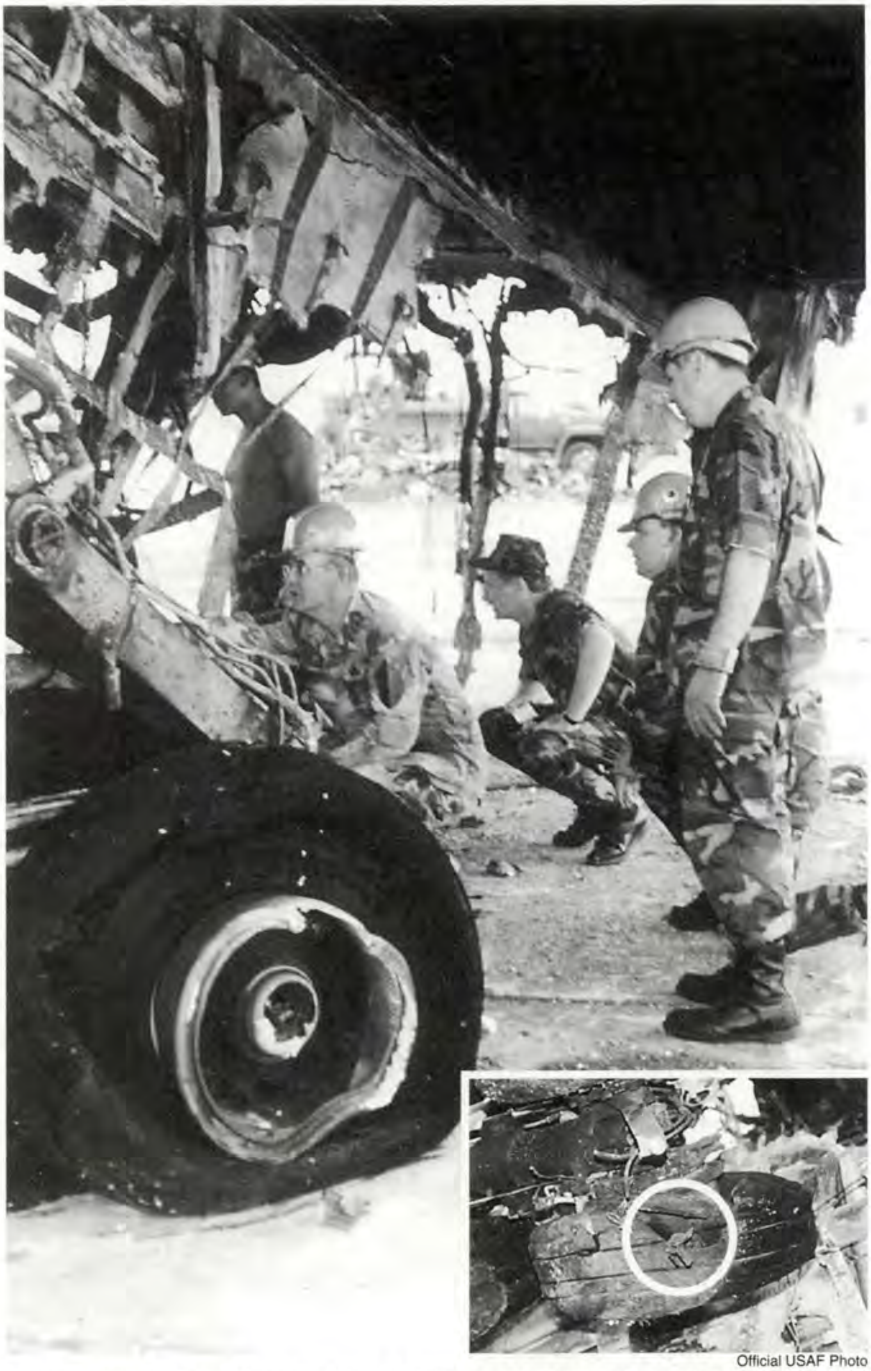
Despite the descriptions of the hazards of metal dusts, your chances of exposure as an investigator are not significant if you follow a few precautions.

Avoid raising dust, and do not work in dusty environments whenever possible. When you are going to be exposed to dust of any kind, wear a protective mask. If you suspect that a dust inhalation hazard exists, consult your bioenvironmental engineer for guidance on respiratory protection.

Physical Hazards

These hazards include excessive levels of electromagnetic or ionizing radiation, noise, or extremes of temperature and pressure. Of all of these, the most likely are extremes of temperature or pressure. Here we are not referring to the temperature of the aircraft parts but rather the air temperature.

Two examples: In a recent USAF mishap, the temperature at the site was in excess of 100°F every day. There were some cases of heat exhaustion and several serious cases of sunburn. On the other hand, in another mishap the weather was cool, and the wreckage was in a cold river. Hypothermia was a problem. The best protection from temperature extremes is good planning. Before leaving for the mishap site, know what the weather potential is and have proper clothing. Be prepared for situations like cold water wreckage recovery or high altitude and hot weather.



Official USAF Photo

You must always expect the unexpected at a mishap site. This is a C-141 fuselage, but notice the inset. The object inside the circle is a BDU-33. It was embedded in the C-141 tire during the mishap.

Pressure is another likely hazard. Actuators and other pressure vessels are a common part of every modern aircraft. These components are usually pressurized, and under stress, physical or thermal, they can rupture violently. Like protection from temperature extremes, the solution here is planning and common sense. Knowing that actuators and pressure vessels have the potential to rupture and avoiding rough handling of these components provide the best protection.

There is one other hazard that can be classified as a pressure hazard — explosives. There are many explosive devices on modern military aircraft

continued

Official USAF Photo

beyond the obvious one of munitions. These include initiators, ejection seat components, and explosives for emergency egress. Even practice munitions can be dangerous. Always attempt to identify the weapons configuration of the mishap aircraft. Even a 7.62mm round can cause severe injury if it explodes.

While excess electromagnetic radiation should not be a problem for the mishap investigator, you will face the problem of ionizing radiation and radioactive materials. There are many uses for radioactive materials on aircraft, from nucleonic oil gauges containing Krypton-85 to Americium-241 in F-16 LANTIRN pods, magnesium-thorium alloys in engines, and depleted uranium counterweights in the C-141.

The hazard from radioactive materials is very low. Yet radioactive materials are still a problem for the mishap investigator because these materials are very stringently controlled by the Nuclear Regulatory Commission (NRC). The USAF must account to the NRC for these materials. In the event of an aircraft mishap, the investigators should work closely with the base radiation safety officer (RSO) to identify items of special concern. These include, in descending order of potential hazard:

- Licensed radioactive materials or items with such materials in cargo.
- Depleted uranium munitions.
- Nucleonic oil gauge sources on engines.
- Depleted uranium ballast and counterweights on the airframe and in target designators.
- Magnesium-thorium in the airframe and engine parts.
- Thorium coated lenses and static elimination sources in target designators.
- Radioluminescent exit markers, dials, and gauges.

Each of these sources must be identified and properly controlled. Normally, the RSO has the proper training and equipment to identify and handle these radioactive materials. And the RSO can contact other radiological health experts for assistance. The point for the mishap investigator is that there are potential radiological hazards present in an aircraft mishap site. The proper procedure in such cases is to work closely with the RSO to ensure adequate control of radioactive material.

Official USAF Photo


Personnel searching a wreckage path must be briefed on potential hazards before starting their search.

Biological Hazards

These include mists, molds, fungi, and bacteriological hazards. We will also include indigenous plants and animals. Currently, the area receiving most public attention is exposure to bloodborne pathogens. The two most likely are hepatitis and HIV and are transmitted through contact with infected tissues or body fluids. The Occupational Safety and Health Administration has published a standard for control of occupational exposure to blood or other potentially infectious materials.[1] The FAA provides special bloodborne pathogen training for all aircraft accident investigators.

For the USAF, control of this hazard rests with the Surgeon General. However, the risk for investigators is low if certain basic precautions are followed. The most likely method of transmission would be through a cut or through the mucous membranes — nose, eyes, mouth. Therefore, investigators should take precautions to protect these areas. Proper gloves, boots, and durable clothing will reduce the chance of cuts and scrapes. Masks and safety goggles will protect the eyes, nose, and mouth. In addition, there should be no smoking, eating, or drinking in the actual mishap site, and you should make provisions for proper control of waste products. These same precautions will protect you from most of the other biological hazards.

One special caution regarding indigenous "critters." At a recent mishap site, the investigators encountered more than a dozen rattlesnakes in the first day at the site. One investigator was bitten and required hospitalization. The folklore of mishap investigation is filled with stories of encounters with everything from alligators to elephants. I even have a friend who, when arriving at a mishap site in Africa, encountered some decidedly unfriendly natives with spears.

Ergonomic Hazards

These are hazards directly related to the work environment, in particular lifting, reaching, visibility, and the physical location of the wreckage. Injuries from improper lifting are the most common mishap category. In the press to find the answer, an investigator may attempt to move a piece of wreckage that is far too large or heavy.

Official USAF Photo

A word about back supports: Although they are commonly used, the National Institute of Occupational Safety and Health has published a position stating that there is no evidence that the standard back belts provide any significant protection from back injury. The only sure protection is prevention — don't lift anything you don't have to, and if you do lift something, use proper technique.

Other problems in mishap sites are uneven terrain, sharp objects, and poor visibility. This combination can lead to slips, falls, various wounds, and other injuries. Some of these hazards cannot be avoided. The mishap site cannot be moved, but visibility can be controlled. In most cases, you should not need to operate in the mishap site at night. There is little that you can accomplish in the dark other than hurt yourself or destroy evidence. Wait until daylight.

Summary

There are three main environmental hazards for a mishap investigator:

(1) Ingestion or absorption of toxics or pathogens.

(2) Physical injury from sharp objects or shrapnel.

(3) Physical injury from improper lifting or movement.

To properly protect yourself from these hazards, follow the following procedures:

- Ensure the mishap site is safe. This includes munitions, radioactive sources, pressure vessels, and toxics. If you are in doubt about a component or area, get an expert to evaluate the situation before you proceed.
- Always wear proper protective equipment. You should never enter a mishap site without gloves. These should not be flying gloves but instead heavy, leather work gloves. If there is risk of bloodborne pathogen contamination, latex undergloves may also be worn. Dust respirators and eye protection are also essential. Depending on the weather, protection from sun or wind may be necessary. This includes anticipating weather changes.
- Always use common sense in approaching the site. Be sure of your footing and where you are reaching. Don't rush into a situation until you have thoroughly evaluated the potential hazards.

Air Force Pamphlet 127-1 sums this entire subject up in four steps.

EXPECT!

Expect hazardous materials in any mishap until such presence has been ruled out.

WAIT!

Wait until potential hazardous energy transfers (fires, explosions, vapors, radioactive materials, etc.) have been controlled before proceeding to the site.

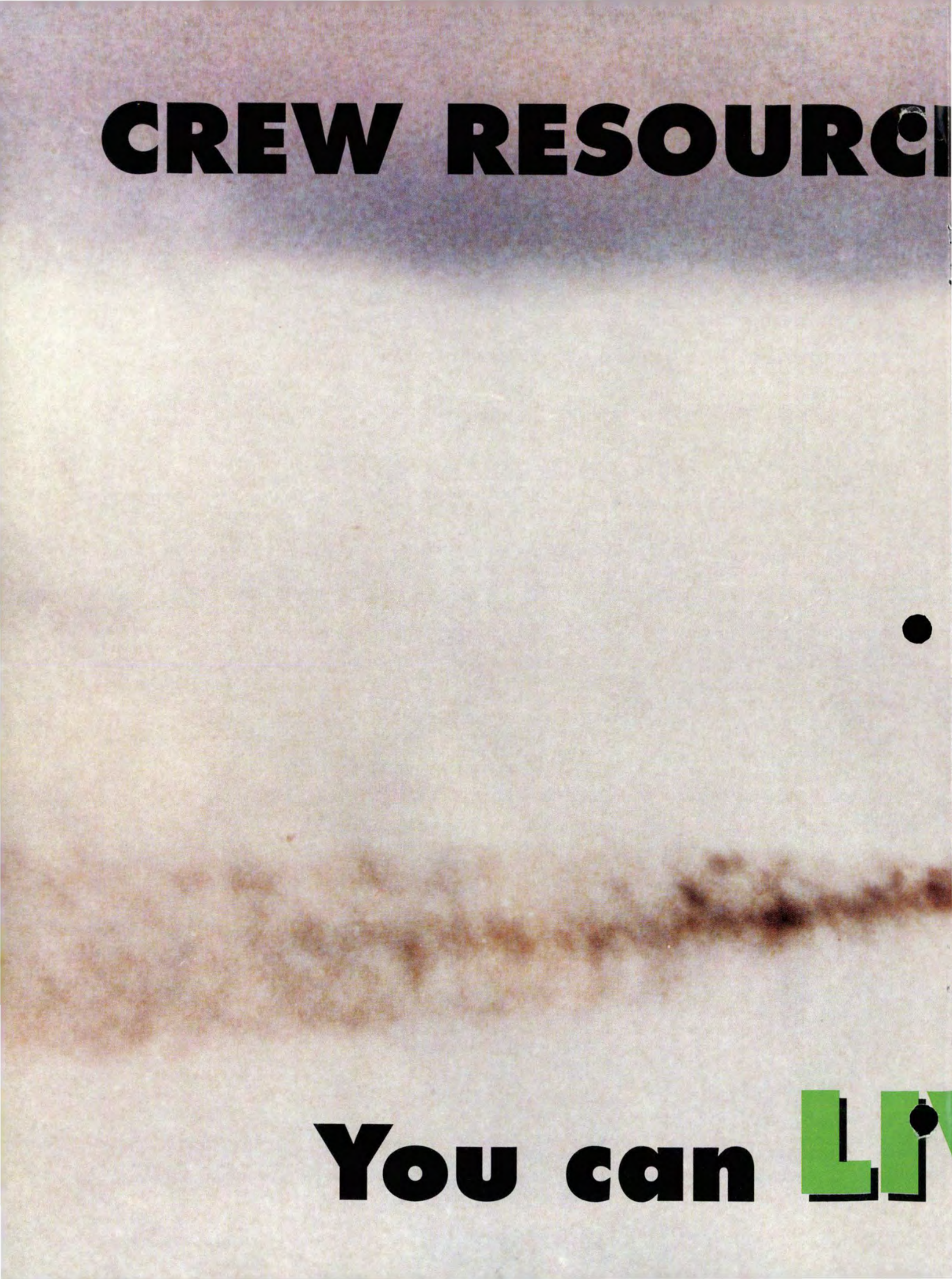
FOLLOW!

Follow, don't lead into the wreckage site. Ask the experts to clear the area first.

DON'T TAKE CHANCES!

If you are not sure the area is safe, get help to determine the risk. Your job is to determine what happened, not to become part of what is happening.[2] ■

[1] 29CFR1930.1030, Bloodborne Pathogens Standard
[2] AFP 127-1, US Air Force Guide to Mishap Investigation, Dept of the Air Force, Washington DC, 1987, pg 3-5.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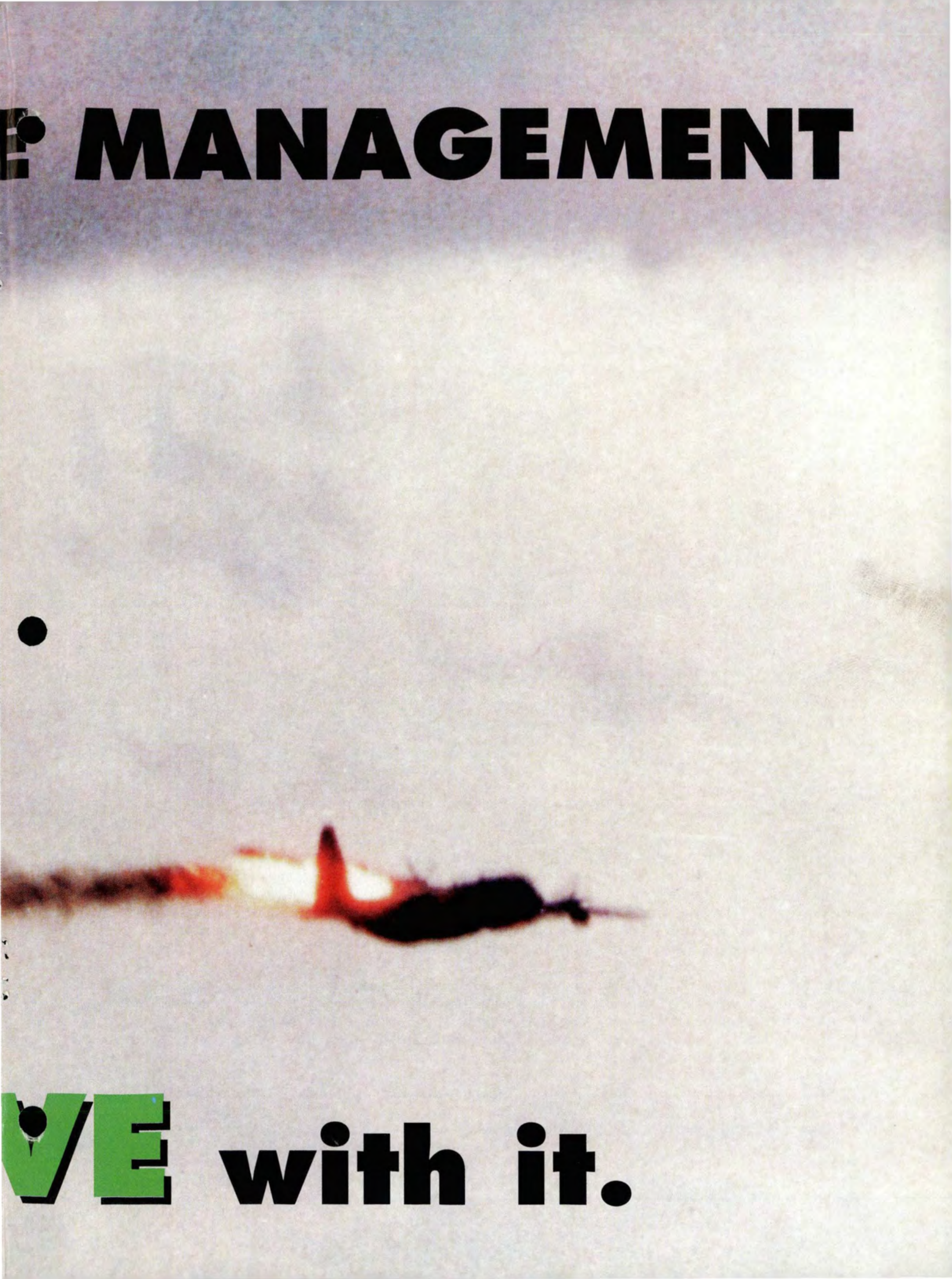

MANAGEMENT
VE with it.

MY FIRST WAKEUP CALL!!

CMSGT DON A. BENNETT
Technical Editor

■ I was a young Staff Sergeant crew chief, assigned to an airlift wing during the "Operation Linebacker" era of Vietnam. The mission tempo was incredible. There was a seemingly never-ending airlift effort to keep the Southeast Asia Theater supplied. Aircraft were coming and going 24 hours a day, 7 days a week. Many were gone weeks at a time and would return to home station only long enough to catch up on some scheduled inspections and deferred maintenance, then go back out again. The pace was extremely hectic and exhausting for all the maintainers, but they were "cuttin' the mustard."

One morning I was tasked to tow a very broke C-141A. Spare parts were scarce, and it had been the cann bird for quite some time. It was almost reduced to "skin and bones." Luckily, the jet was finally scheduled for a periodic inspection and had to be towed to the docks. There it would be fleshed back out again.

The hydraulic systems had numerous parts canned which rendered the brakes inoperative. Missing AC/DC components required a power-off tow job. Both conditions combined called for chock walkers on each main gear. No sweat for a can-do cat like me! That day I was an invincible seven-level crew chief, using the checklist! How could anything go wrong?

Well, it did — big time!

When I came to some parts of the checklist which required me, as the towing supervisor, to ensure certain things were accomplished properly, I asked my ole buddy, ole pal Timmy, to do some of them for me. It was his job as a tow team member to do those tasks in the first place. He was someone I always trusted, so why not ask him to do portions of my job as the supervisor and allow him to verify some of his own work?

The tow route required us to travel between a row of hangars on one side and a row of transient aircraft on the other. Before we came out of this gauntlet, we had to start our turn in order to back the aircraft into the docks. It was a tight spot to maneuver in, and the tow tug driver had to really crank the jet around to line up the aircraft's tail end with the dock hangar centerline.

Well, there I was … towing an aircraft with no brakes, on a downhill slope, in a tight turn, between obstacles, when the tow bar snapped like a dry twig!

I frantically waved off the tow tug driver before the jet pushed him out of its way. It was still moving at a pretty good clip, so instinctively I yelled up to the bored tow brake operator in the cockpit for "BRAKES"! He looked indignantly at me and yelled back "(expletive)!! Ain't got any!"

I called out to the left and right chock walkers, "CHOCKS!" while at the same time giving a pleading hand signal for "CHOCKS." They must've immediately responded to the urgency of the situation when they saw the aircraft was obviously still moving — on its own — towards a row of parked vehicles!

But the two chock walkers were so excited they *both* overshot the main gear tires, and the chocks settled underneath the jet's belly. Of course, to me, it seemed like an hour waiting for the aircraft to roll forward enough to clear both of those chocks. There just had to be at least one more attempt at stopping the big, runaway jet!

Well, sir, this just wasn't my day, 'cause again, helplessly, I watched as *both*, yes sir, *both* overshot their respective main tires for the second time! The jet just kept on surging towards our employee parking lot (with at least a million cars parked there)! I remember at that point I had had enough fun with normal emergency actions — drastic "Super Sarge" reactions were now in order. Besides I couldn't stand the suspense any longer.

So I hastily stepped in front of the aircraft's nose, straddled the broken tow bar and, like Superman stopping that train in the movies, I leaned forward with both hands against the aircraft's nose radome!!!! (For you impressionable young troops out there, *never* attempt this yourselves. It should only be done by trained, professional idiots.) Anyway, with my boots slippin' and slidin' on the ramp pavement, and still yelling for "CHOCKS," I just knew the jet would never stop. I was a hog's breath away from giving the parking lot an unscheduled mow job!

At that moment, I wasn't sweatin' bullets anymore — they had turned into cannon balls. But I was totally convinced my unwritten, and probably unheard of, emergency reaction was the only option available to me. That is, 'til the grille of a building-

sized Oldsmobile loomed over my shoulders. The extreme pucker-power factor demanded more action. It was then my overcreative mind thought of the next, and certainly last, heroic (probably then, but stupid now) action to stop that ungrateful beast. ***So as I was about to lay my shaky-breaky body down to use as nosewheel chocks,* IT STOPPED!**

Well, ladies and gentlemen, the two chock walkers, plus both wing walkers, and I just stood there awhile, dazed, shocked, quiet, looking at each other with golf ball-sized eyes with pinhead pupils. We undoubtedly would still be there, frozen in time, 'cept my ole buddy, ole pal Timmy, came rushing up to us. (He, by the way, had been the tail walker during the ordeal.)

"What the hell did ya do, Don?" he asked nastily.

After experiencing something similar to a natural birth, I slowly absorbed Timmy's question and began to speak through highly torqued, clenched teeth. I was the perfect ventriloquist as my salty words filled the air.

"I bet if I were to go into the (expletive) nose gear wheel well, I betcha I'd find the (expletive) nose gear scissors weren't (expletive) disconnected like I asked ya to do and double (expletive) check for me. Ya sorry (long string of expletives that questioned his class of species and method of birth)!!!" I shouted back in an ever-increasing high shrill.

Ole Timmy knew I was 'bout to have a meltdown right there, and half-stepping on his part would only aggravate the situation. Besides, he knew he didn't perform his job, as well as *my job*, like he was tasked to do. So he bravely stepped up to the plate and faced his fire-breathing,

continued

MY FIRST WAKEUP CALL!! continued

meat-eating buddy for a bawling out he wouldn't forget. As I look back, he must've been facing a frightful mob!

After snacking on Timmy's heart and finishing off a gigantic meal of his rump, I felt my working day was over — time to quit. As I was walking off the ramp, going to the hangar, I radioed my expeditor, told him what happened, and told him I needed a replacement towing supervisor. Also, he could find me in the men's room if he needed me.

Well, we all survived the experience, but, more importantly, I learned an extremely valuable lesson that morning. I made a critical correction in my judgment and maturity development. And years later, I can finally tell you **who really was at fault**. Me!

Poor ole Timmy. I wonder if he knows. ■

MISTAKES IN MATURITY

Making mistakes is an inherent part of life!

All of us have, and will continue, to make mistakes — that's human. No one's immune, on or off duty, in our private life or during our professional career. And while most of our mistakes are minor in nature, others have been, **or will be**, major ones with costly or grievous consequences.

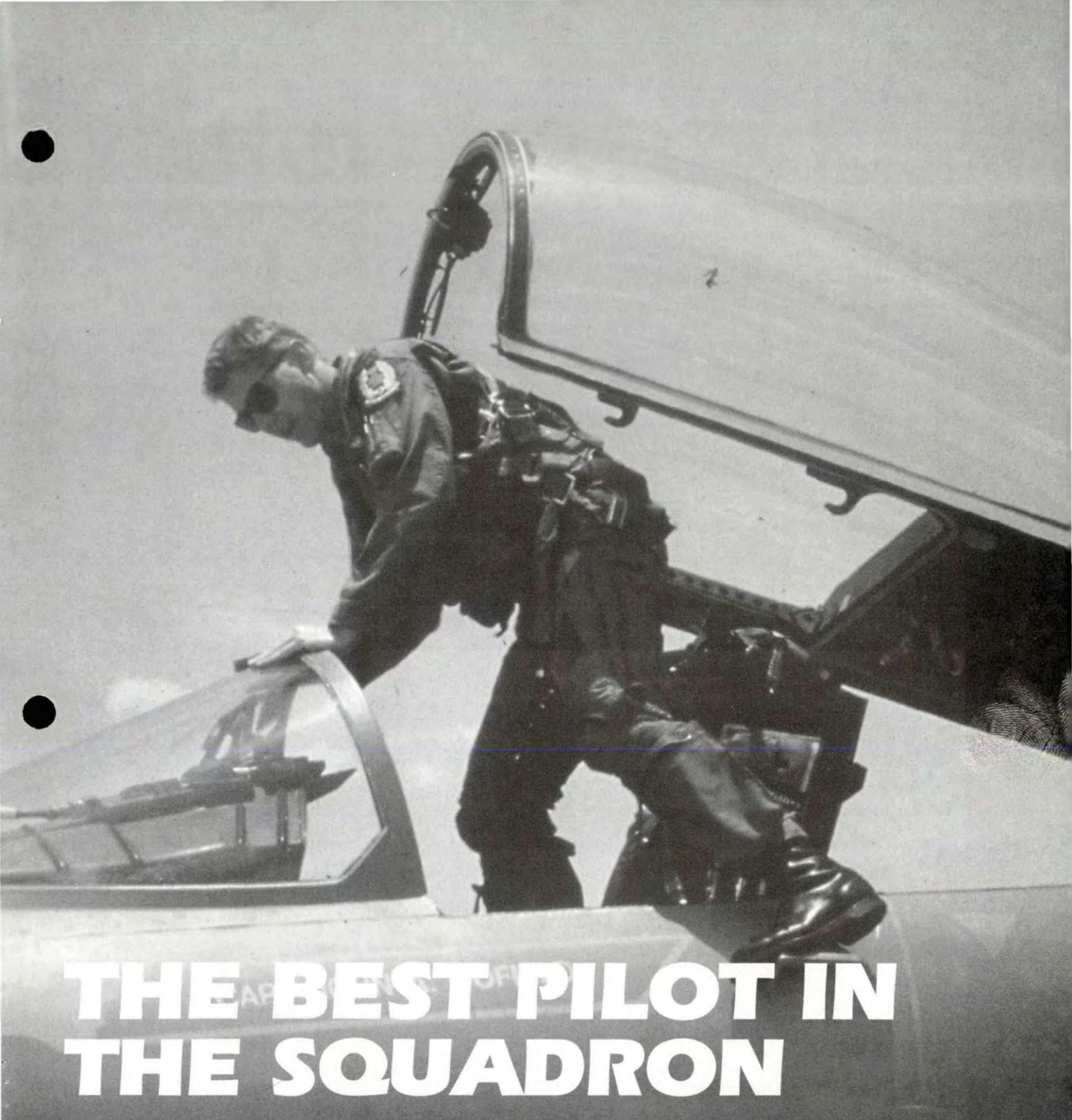
You might say making mistakes is also a prerequisite for our personal growth, development, and maturing process. Education and training are necessary, too, but real-life learn-by-burnin' experiences will nurture and perpetuate the maturing process a lot faster. Nobody has reached the pinnacle of success without taking some risks which backfired. Successful people learned from their mistakes. They eventually developed a "situational wisdom" that can't be gained from reading a book or taught in a classroom.

Unfortunately, some people *never* learn a blasted thing from their mistakes or change an undesirable habit or behavior. Instead, they go on to repeat their mistakes, 'til one day, they get a "bolt out of the blue" wakeup call. Many are finally forced to face their private or professional responsibilities with "enforced" maturity, but only at the expense of someone's injury or costly damage to an aircraft or equipment. Many times civil or military disciplinary action is taken. But the bottom line is something drastic had to happen to get their attention and make them own up to their responsibilities — hence, enforced maturity.

There are also those who prematurely meet their death after carrying out their last fatal mistake. For whatever reason, they failed to heed the warnings and continued their stupidity, carelessness, or immaturity. Sadly, sometimes their coworkers, friends, or loved ones are severely injured or killed due to their selfish, immature actions or poor judgment calls. To these dearly departed, the final wakeup call came too late, and they will *never* be given a second chance.

But that can't happen to me, can it? For as the accompanying article relates, I got a forgiving wakeup call and learned from the experience. I started paying closer attention to my duties and responsibilities. I *never* let someone else perform my vested duties, unless it was absolutely necessary, and I was positively sure of their qualifications and integrity. Oh sure, I'm still susceptible to making mistakes. Even though I'm an ole gray-headed Chief with 26 years under my belt, I'm still human. I still have to work at *not* repeating past mistakes and making sure I'm careful *not* to invent new ones.

No sweat for a can-do cat like me. Today I'm an invincible nine-level Chief Master Sergeant, using the checklist! How could anything go wrong?



THE BEST PILOT IN THE SQUADRON

MAJ MICHAEL T. FAGAN

Major Fagan wrote this article while assigned to the Air Force Inspection and Safety Center, Norton AFB, California. We reprint it from the **Aerospace Safety** *magazine, June 1980. Its lessons are still very valuable.*

■ Not long ago, as an unproductive happy hour wound to a close, several of my flying colleagues and I were gathered around the dregs of the last pitcher which was rapidly approaching being too flat to drink. As is often the case when aircrew members "stand to their glasses," the conversation drifted from war stories through "Where is old so-and-so?" to memories of those no longer with us.

Some had been recruited by the airlines, and some had gone to rated sup, but the talk centered on one of our number who had met an

continued

untimely end on a desert gunnery range. If there is a special eulogy for pilots, it is not delivered by a chaplain from a pulpit — it is spoken by his messmates in the bar as the happy hour crowd thins out and the beer gets warm.

No congregation could be more sad-faced. No higher praise could be given. The ceremony is as predictable as any formal funeral. Sometimes there are even hymns of a sort, and green Nomex is a kind of vestment. Unfortunately, it was a familiar scene to most of us who had been around for a few years.

Inevitably, someone said, "Yeah, he was the best pilot in the squadron." All who knew him nodded their heads in silent accord.

He certainly had been a memorable figure. He had been assigned to standboard as a lieutenant. An academy graduate, his bearing and conduct were exemplary. He knew the Dash One down to the publisher's initials and was an authority on all the "non-BOLD FACE bold face" published by the MAJCOM on down. Though he got to SEA too late for the hot part of the conflict, he extended until the very end and played a highly decorated part in the evacuations and the Mayaguez affair.

He was always chosen to lead the tough missions and earned the total respect of his superiors at all levels. His exploits were legendary. He was the one who went to the development conferences and flew the test program. His physical appearance was striking. He was well ahead in his PME. He was always available when the schedule changed at the last minute, and he more than pulled his weight in the additional duty department. Besides that, he was a nice guy. No one was surprised when he was selected for major below the zone.

He was the best pilot in the squadron.

It does not pay to speak ill of the dead, but wait a minute! If he was so good, why is he dead? At the risk of asking a sacrilegious question, how about those other well-remembered colleagues who have been honored with the posthumous title of "best pilot in the squadron"? Is there something about being the best which is fatal? What good is being the best if it kills you? What good is having the best in the squadron end up in a box when he is needed in the cockpit? Let's take another look at this paragon of pilot virtues.

The investigators found nothing wrong with the aircraft. It appears he simply flew into the ground after pulling off the target. He either didn't hear the "knock it off" call or it came too late. In any case, he got low enough to prompt a call and apparently did not react prior to impact.

He was aggressive, ambitious, and confident. These are admirable qualities — in fact, they are requirements for the job. There is, however, an important distinction between confidence and overconfidence, aggressiveness and overaggressiveness — even achievement may be overdone, or done too fast.

He had required a little command assistance to transition into a new weapons system when he did, and no one was surprised when he got it. That he was killed on a range *was* a surprise. He had a lot of low level experience. He liked being down in the weeds, and he was good at it.

The investigators found nothing wrong with the aircraft. It appears he simply flew into the ground after pulling off the target. He either didn't hear the "knock it off" call or it came too late. In any case, he got low enough to prompt a call and apparently did not react prior to impact.

Could there have been a malfunction? He had previously demonstrated exceptional ability to bring the aircraft home when another pilot might have landed at an intermediate point, even though maintenance would have been inconvenient and the squadron would have bought a bunch more down time. He was good enough (and mission oriented enough) to take a bird with minor discrepancies, work around them, and get the job done. He was a mission hacker. "Ya gotta be tough," he had said more than once.

It probably wasn't a malfunction. He could have handled any malfunction small enough to be missed by the investigators.

The flight was a late afternoon launch, but there is no reason to believe he had been fatigued. He was not a heavy drinking man, and he had had no duties which would have conflicted with crew rest. Besides, during the Mayaguez mission he had demonstrated he could perform when tired. He had flown sortie after sortie, on his own adamant insistence, even though there were more rested pilots available. He kept getting an airplane despite fatigue. After all, he was the best pilot in the squadron, and that was one tough mission. A little fatigue wouldn't have bothered him.

He bought the farm on a check ride, but stress couldn't have been a factor — he always did well on check rides. In fact, stress may actually have improved his performance. At Kho Tang Island he earned a medal for going in on the hottest objectives. In one case, he went in a third time after being shot at twice. Now, that's stress! No, he was not one to choke under pressure.

In the final analysis, the report concluded the cause of the mishap was "pilot distraction" or "disorientation" — in other words, what used to be called pilot error.

But errors are not something one would expect from the best pilot in the squadron.

On the other hand, if he had not "gotten caught," no one would have ever suspected he had been disoriented or distracted. He had exhibited no such tendencies, or at least none had been recognized.

But it only takes once, and it's hard to make a habit out of having fatal mishaps. The diagnosis has to come before the fact in order to do any good, and it's no easy task.

The distinction between the spirit of attack and dangerous lack of caution is not always readily apparent. What passes for aggressiveness may be found to be (or at least labeled) recklessness after a mishap. Spirit, however, is a prerequisite, and an excess of caution is self-defeating. A force of timid pilots, reluctant to take any risks, is not acceptable. Neither is a corps with a disdain for death like kamikazes (especially if training flights are required).

What is required are pilots with the will to accomplish the task at hand but the sense to recognize a given result is not worth the loss of an aircraft and crew. This is especially true in a training environment.

During the early '70s, when Vietnamese aviation cadets were receiving primary training in the United States, one Vietnamese training officer would address each arriving class of cadets with the following safety philosophy:

- Each student must become the best possible pilot. This requires both nerve and skill. Since the mission doesn't end with a single sortie, a good pilot must be available to fight tomorrow.
- Good pilots bring both themselves and their airplanes home.
- Dead pilots are bad pilots. The loss of an airplane in training is as detrimental to the war effort as a direct hit from an SA-7.
- Sometimes it takes nerve to refuse an aircraft or abort a mission. That's part of what it takes to be a good pilot — nerve.

So what does this have to do with the pilot who is the subject of this tale? Little or nothing. Flying safety lectures will do him no good now and apparently didn't do him enough good when he was alive.

Photo by SrA Jerry D. Morrison

All those monthly meetings, special briefings, and bulletin boards weren't enough to keep him alive. Neither were his skilled, highly trained hands and feet, vast knowledge of regulations and procedures, or extensive experience. For all his education, ability, and desirable attributes, his final professional act was costly and wasteful. He destroyed a valuable aircraft and killed its pilot. At the very best, he did not prevent the loss, and he was the last person who could have done so.

The best pilot in the squadron? He's still *in* the squadron. He, too, knows the books, has the skills of a brain surgeon, and reeks of moxie, but he comes home with his airplane intact. Maybe it's that little bit of extra for Mom and the safety officer. Who knows? One thing is certain though: The best pilot in the squadron will get the job done without unnecessary losses. While he's there to fly and fight, he knows broken birds stay on the ground, and dead pilots don't defeat anybody.

The pilot's epitaph will, unfortunately, be occasionally intoned in the bar while the ice melts and the happy hour crowd drifts out the door with the smoke. It's a traditional way to honor our dead.

But in the meantime, let's be honest. Here's to the real best pilot in the squadron — the one who's still with us. ■

YOU WERE THERE

BOB KERR
OC-ALC/TILO(MAAF)
Tinker AFB, Oklahoma

■ The USAF has a new facility, located at Tinker AFB, Oklahoma, to animate data recovered from aircraft mishaps and incidents. Named Mishap Analysis and Animation Facility (MAAF), the MAAF significantly enhances the Air Force's ability to recreate an aircraft's flight profile. Viewing an animation or simulation of a mishap at MAAF from the cockpit, with mishap data being displayed on an instrument panel, can really give you the sensation YOU WERE THERE. The visual lessons learned will stay with you for some time, and you will say to yourself, "I'm not going to let myself get into that situation!"

Mishap animation is quite useful for presenting a large amount of time-correlated data. In the real flight world, many things are happening at once. To get the proper perspective for a mishap investigation, we need to display everything at once with the ability to slow or reverse events as needed to study detail.

Once the recorder data and terrain information is loaded in the computer, animations of any portion of the flight can be viewed in real-time, fast or slow motion, forward or reverse. Shown above are four freeze-frame views of the same point in a flight: a ground view from the runway, chase plane views from line abreast and right echelon, and a view from the cockpit. A variety of information, taken from data recorders or derived from other sources, can be displayed on screen as text, on simulated instruments, or as any desired type of indicator. The lower photo shows sparks coming from the wingtip as an indication of ground impact.

Photos courtesy MAAF, Tinker AFB OK

A Little History

MAAF is part of Oklahoma City Air Logistics Center, Technology and Industrial Support Division (OC-ALC/TILO), and is an outgrowth of the Aircraft Structural Integrity Management Information System (ASIMIS) which has processed flight data for over 20 years. In the past, only noncrash-hardened MXU-553 tape cartridge structural data recorders were installed in some Air Force aircraft. In most Class A mishaps, that data did not survive. As modern digital recorders are installed on new aircraft, recoverable flight data is becoming more common.

Air Force policy on flight data recorders (FDR) was established in 1973 by the USAF Chief of Staff, General John Ryan, and reemphasized by the Vice Chief of Staff, Jerome O'Malley in 1982. It requires FDRs on all new aircraft unless a specific waiver is obtained. Since 1982, there has not been any written change to Air Force policy.

In 1982, a crash-protected memory module was developed for the B-1B aircraft. Mishap data was stored in wrap-around memory so the most recent data would survive the mishap. In 1984, a crash survivable memory unit was designed for the F-16C/D aircraft, and, in 1988, it was added to some other aircraft weapon systems which have the standard flight data recorder (SFDR).

The Air Force mishap investigation instruction, AFI 91-204, states that "OC-ALC/TILO is the central Air Force activity for recovery, transcription, and analysis of FDR data in support of US Air Force mishap boards." All mishap investigation boards are expected to contact TILO for assistance with data recovery.

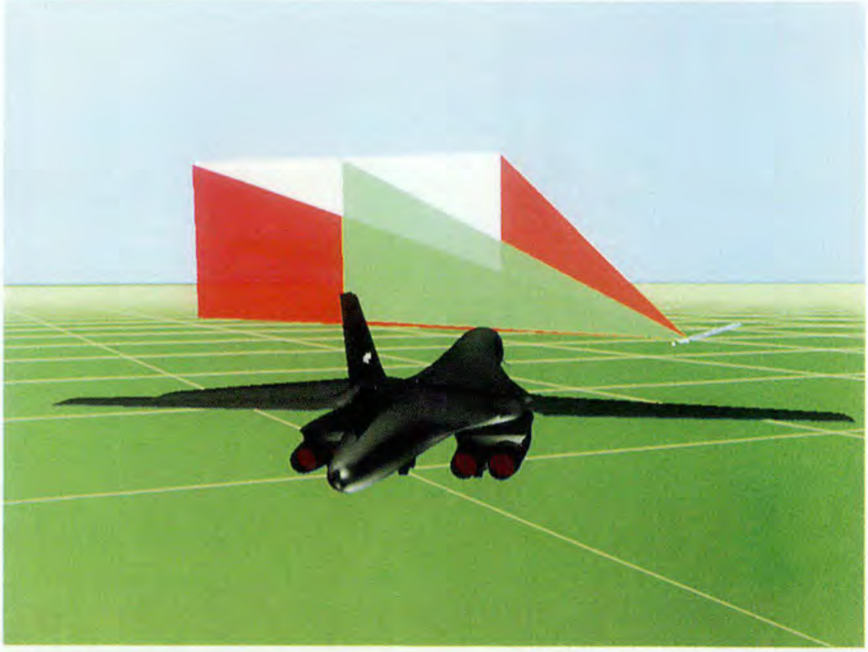
Beginning and Accomplishments

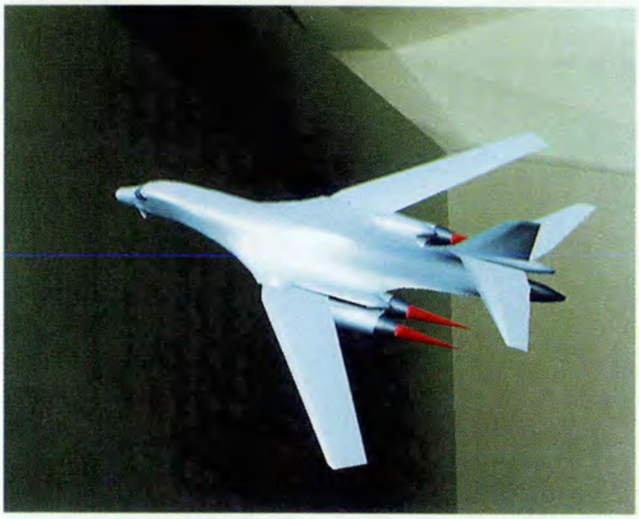
MAAF development really began following a B-1B mishap. In 1993, TILO received funds from the B-1B System Program Manager to develop an animation capability for future B-1B mishaps. Development began on a system to support all the "non" SFDR-equipped aircraft including the B-1B.

In February 1994, Recovery Analysis and Presentation System (RAPS) software was installed on a Hewlett Packard computer system in the Mishap Analysis and Animation Facility. Developed by the Canadian Transportation Safety Board, it's currently being utilized by the US National Transportation Safety Board (NTSB) and equivalent agencies worldwide. Since installation, two past B-1B mishaps have been animated. The system is capable of presenting the mishap from a cockpit, chase plane, or ground view. Selected parameter data can be displayed at the same time in the form of a simulated instrument panel.

A knob box allows viewing of the model from any angle. The action can progress at normal speed or be manually controlled in forward or reverse from the knob box. Up to

continued



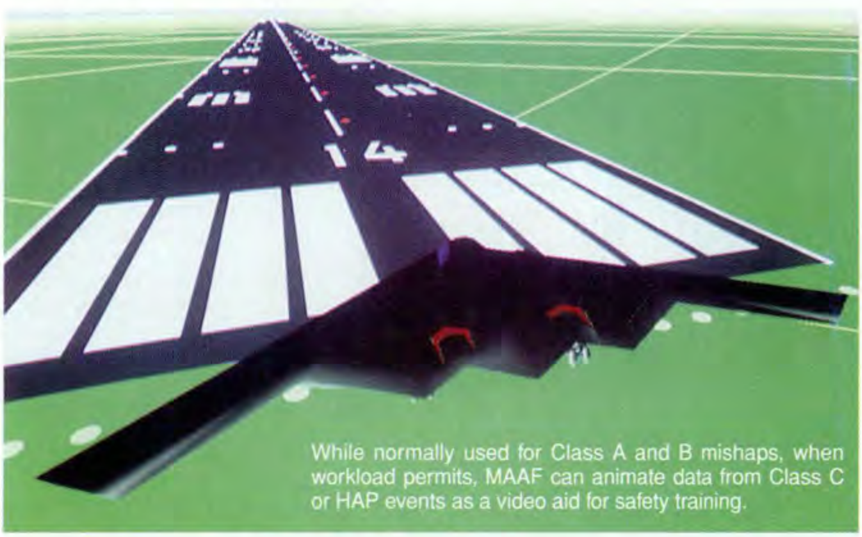


Glide slope features can be depicted when desired. Another useful tool is a flightpath line trailing the aircraft like a smoke trail to help visualize motion changes, with tick marks for time increments (not shown). Ground can be displayed as a featureless grid or with actual topographic data.

The B-1B model shows wing sweep and landing gear position and has flame plumes to indicate afterburner operation.

Up to four different aircraft flightpaths can be shown simultaneously. Viewing angle can be instantly changed to enhance mishap understanding: Compare the lower image with the cover photo of this magazine.

Mishap video animation allows investigators to quickly assimilate large volumes of time-correlated data. In comparison to the long pages of numbers previously studied, it is equivalent to moving from newspapers to television.



While normally used for Class A and B mishaps, when workload permits, MAAF can animate data from Class C or HAP events as a video aid for safety training.

four separate flight paths with four separate models can be "flown" simultaneously. Flight paths are generated from recorded data such as airspeed, altitude, attitude, and heading. Global positioning parameters can be used if accurate enough. Cockpit or ground audio transcripts can also be synchronized into the video and superimposed as subtitles.

In 1993, Smiths Industries was awarded a contract to provide a Silicon Graphics computer to support mishap animation for all SFDR-equipped aircraft. The Smiths System became operational in September 1994 for the F-16C/D, F-15E, and C-17 aircraft.

Per MAAF requirements, this system was delivered with the ability to process and display mishap flight data and Defense Mapping Agency (DMA) terrain data (both elevation and features). A HUD display is available from the cockpit view.

Data can be retrieved from a single computer chip if data recorders are damaged and can't provide any information. In a "smoking hole" accident, the memory chips will be removed from the protective housing "nutshell" and installed on special boards so that data can be extracted from each of the chips. The data is then assembled, converted to engineering units, and processed through 2 dimensional and 3 dimensional analysis.

Future Planned Enhancements

The MAAF plans to acquire tape decks to input E-3 FDR data and voice recorder data into the Hewlett Packard system. This equipment should also allow MAAF to process C-130 and C-141 data recorded on the older Lockheed commercial-type flight data recorders.

In addition, a conference room with a high resolution projector will be installed to "brainstorm" mishaps with members of the Safety Investigation Board and other system experts. A choice of parameters can be selected by mishap investigation teams such as type of display, viewing angle, and supplemental data. VHS tapes of the final product can be made and sent back to the Air Force Safety Agency at Kirtland for instructional purposes.

Advantages of Animation

Animation of mishaps can speed up the process of finding the cause of a mishap, thus improving military readiness.

Fast resolution of mishaps can reduce or eliminate costs for system tests which might otherwise be required in a search for mishap causes.

To contact MAAF, send correspondence to OC-ALC/TILO (MAAF), Attn: Bob Kerr, 7851 2nd Street, Room 125, Tinker AFB OK 73145-9145; or call DSN 336-3373, or commercial (405) 736-3373; FAX 336-3086; E-Mail: bkerr@OCDIS01.tinker.AF.mil. ■

LANTIRN OPERATIONS — LIVING LOW IN THE DARK

Official USAF Photo

CAPT MERRICK E. KRAUSE
57 OG/OGV
Nellis AFB, Nevada

Preface

■ Twenty-one hundred local time, a quarter moon and no clouds, and the mission is going well. The B-1s are in a good trail position behind your F-15E flight, so you can provide them with mutual support. The terrain following radar (TFR) is working fine as you ingress at 500 feet and 550 knots. The visibility is great through the forward looking infrared (FLIR) image in the head-up display (HUD), and it looks quiet in the target area. Suddenly, the weapons system officer (WSO) shouts, "Break right, missile launch right four o'clock ..."

Introduction

Flying low in the dark is an unnatural act for most fighter crews — or it was. The introduction of the low altitude navigation and targeting infrared for night (LANTIRN) system on the F-15E (and certain modified F-16Cs), first operationally employed during Desert Shield and Storm, allowed night TFR flight to progress from the exclusive realm of the F-111 and B-1 into a mainstream fighter activity. As a result, many aircrews now regularly fly in the high-speed, low-altitude night employment regime.

Mission Planning

Flying against surface to air missiles (SAM), anti-aircraft artillery (AAA), and enemy fighters was challenging enough. Adding the element of "darkness" not only exacerbates some old problems, it creates many new concerns. There are several factors that can increase aircraft survivability during a low-altitude night TFR mission. Some critical mission planning factors include route planning, weather, threats, formations, crew coordination, and training rules (TR).

This article will briefly look at each of these areas and their significance to operating low and fast at night. Hopefully, it will spark some discussion within your organization which will enhance your unit's survivability. Non-TFR trained USAF members should note the concerns low, fast night fliers operating the LANTIRN system must consider. After reading this article, they will be better prepared to discuss these planning factors when involved in any night composite force operation.

Route Planning

All published low-level routes have altitude and airspace restrictions. Most prevent full defensive reaction practice since they restrict 180-degree turns. Additionally, many fighter units practice at either 500- or 1,000-foot set clearance levels when operating TFR. In peacetime or in combat, transition levels (TLvs), or other altitude restrictions and air tasking order (ATO) defined low-level transit corridors, will affect your desired routing. Terrain and the location and type of threat require the flight lead to find a path of least resistance and optimize terrain masking (direct or indirect).

In all cases, calculation of minimum safe altitudes is a necessity for each leg or segments of each leg. These altitudes provide safe airspace — typically 1,000 feet above the

continued

LANTIRN OPERATIONS — LIVING LOW IN THE DARK continued

To fully realize the potential of the LANTIRN system, intensive mission planning must consider route planning, weather, threats, formations, crew coordination, and TRs review. The factors provided in this article are not the only considerations but, hopefully, they provide some food for thought.

highest obstacle within 5 nautical miles of the course centerline (see local and MAJCOM regulations for specifics). This obstacle-free airspace is then available for maneuvering when the LANTIRN fails or when reacting aggressively to threats.

Weather

It is extremely important to incorporate ingress, target area, and egress weather into the mission-planning process. Precision guided munitions (PGM) employment adds the necessity for more detail, but any LANTIRN sortie requires additional environmental information beyond ceiling, visibility, and winds.

Moon illumination provides an indication of the enemy's ability to see the fighter and the crew's chance of seeing ground features. Thermal crossover and ground/target temperature may assist in LANTIRN navigation pod and targeting pod tuning and polarity selection. The absolute humidity also gives an indication of the range at which the FLIR can effectively identify ground or target features.

Threats

Threats en route and in the target area typically affect the tactics used to ingress and attack a target. If threats can be avoided by changing the route of flight, the route should be altered as much as practical. When threat reactions do occur, timeliness, training, and aggressiveness are keys to survival.

To ensure the proper maneuver is accomplished at the appropriate time, the reactions attempted and how they are performed must be discussed on the ground. These maneuvers must also be practiced in peacetime before they can be confidently applied in battle.

A threat reaction frequently involves flowing to the rear of a formation, a climbing break-turn, or pushing-it-up-and-taking-it-down. LANTIRN operations require special attention to terrain, weather, and crew coordination to acquire an inbound missile or stream of cannon fire. All maneuvers exceeding TFR limits must occur above the minimum safe altitude (MSA), and knowledge of the terrain and obstacles on the low-level route is paramount.

Formations

Depending upon the size of an attack package, a midair collision is nearly as much a threat to survival as a SAM or the ground. Trail formation, timing deconfliction, and parallel low-level routes are techniques to separate LANTIRN fighters. Unfortunately, once threat reactions begin, the formation becomes more fluid and, consequently, more dangerous. FLIR, air-to-air TACAN, radar, IFF, and timing all contribute to improve situation awareness (SA). Timely radio calls for defensive maneuvers allow all flight members to redirect their attention to a changing formation and possibly to changing roles between crewmembers within a jet.

Crew Coordination

In the F-15E, as in the F-111 or F-4, crew coordination is the force multiplier that makes an excellent fighter into an outstanding weapons platform. It is critical to brief crew duties in detail on the ground to minimize confusion in the air. Some LANTIRN-specific crew coordination items include who operates the radar and the targeting pod during each phase of flight, crew-specific code words, and how to effectively change crew duties.

For example: Frequently, on a LANTIRN non-PGM mission ingress, the WSO operates the radar and visually scans for bandits and surface threats. Simultaneously, the pilot flies and navigates in automatic terrain-following (ATF) mode with control stick steering. As the WSO selects the targeting pod to attack the target, the pilot takes command of the radar to sanitize the target area while monitoring the TFR to avoid obstacles.

The WSO, when finished targeting, uses a crew-specific code word such as "designated" to inform the pilot the target is acquired and stored in the navigation system. New steering is now available in the pilot's HUD. The pilot selects a manual TFR mode for the attack-run to allow a climb to a specific delivery altitude. The pilot then directs 100 percent of his or her attention to flying planned attack parameters to accurately deliver the weapon and avoid the ground during the escape maneuver. The WSO operates the radar, monitors the radar warning

Official USAF Photo

receiver for threats, and checks six (looks out the back of the jet) for AAA tracers or missile plumes.

Single-Seat

Single-seat fighters do not have the capability to share the workload in flight and are typically restricted to operating one piece of equipment at a time during TFR operations. ATF is a primary mode, so routes are planned requiring minimal aircrew correction to maintain course. The radar enhances SA, but operating the radar, TFR, and targeting pod simultaneously can be extremely task intensive.

Premission planning of what duties to perform, and when in the mission to execute them, decreases the opportunity for task saturation. When dropping laser-guided bombs from low altitude, single-seat fighters must restrict tactics due to safety considerations and overtasking, or use the point-tracking capability of the targeting pod to track a specific target. In this case, the targeting pod computer tries to keep the laser on the selected target while the pilot concentrates on flying a recovery maneuver.

Training Rules

TRs are a contract "written in blood." LANTIRN TRs are tools to enhance survivability. Crews must make sure their TFR and FLIR systems are operational and must turn on the systems before descending. They must follow the flight director or couple the automatic system and monitor it.

When maneuvering below the MSA, it is imperative that crews always fly in limits. In the fog of war, or even during a night range ride, an emergency or break in a habit pattern may reduce SA and can lull a pilot into maneuvering outside TFR limits below a safe altitude. Responding to a "Break right!" call while operating on LANTIRN might involve a climbing TFR turn to the MSA, followed by an aggressive break turn to defend against a threat while avoiding the ground.

Conclusion

Although flying low in the dark is neither comfortable nor particularly easy, there are hundreds of techniques available to increase survivability. With the introduction of the LANTIRN system, F-15Es and modified F-16s can now enjoy the luxury of flying TFR missions with a FLIR to provide some visual access to obstacles and targets previously unavailable to older generation aircraft.

To fully realize the potential of the LANTIRN system, intensive mission planning must consider route planning, weather, threats, formations, crew coordination, and TRs review. The factors provided in this article are not the only considerations but, hopefully, they provide some food for thought.

Postlog

Suddenly, the WSO shouts, "Break right, missile launch right four o'clock." As you begin a hard pull to the MSA, you call on the radio, "Bat 1, missile launch north." While the WSO calls, "Chaff," you see the flashes as the chaff bundles dispense. Reaching the briefed MSA, you begin a 6-G break to the right. The missile passes under your jet, and you see the flash of a detonation behind and beneath you. Regaining TFR parameters, you descend while answering on the radio, "Bat 1, back to course." Now, off to complete the mission: Bombs On Target! ■

UNITED STATES AIR FORCE

Well Done Award

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

■ The 41st and 71st Rescue Squadrons were notified by the USCG Station Mayport of an injured seaman aboard the 67-foot fishing vessel *St. Elmo*, located approximately 200 nautical miles due east of Patrick AFB, Florida. The injured fisherman, a 39-year old male, had fallen from the roof of the wheel house onto a metal rail fracturing several ribs, puncturing his lung, and seriously injuring his back. The vessel had a ruptured fuel line and no longer had the fuel to make it back to the Florida coast.

The crew of Air Force Rescue 811 (HH-3E helicopter) quickly departed Patrick AFB for the *St. Elmo*. At approximately 50 miles offshore, Air Force Rescue 853 (HC-130 Tanker) rendezvoused with the helicopter, where they air refueled to make sure each aircraft's air refueling equipment was operating properly prior to committing the helicopter outside its normal, unrefueled range. The crew also performed health checks on both engines to assure engine performance was not compromised.

Once on scene, the HH-3E made an approach over the water, next to the vessel, and deployed pararescuemen TSgt Lowdermilk and SSgt Hehir using swimmer deployment procedures. Their HH-3E made a second approach and deployed a stokes litter. After TSgt Lowdermilk and SSgt Hehir prepared the patient for a hoist recovery, Capt Coffindaffer, the aircraft commander, conferred with his crew and decided the safest means of recovery was to have the vessel maintain a course 30 degrees off the wind line at approximately 5 knots. This would provide a stable platform for the helicopter, from which a hoist pickup could be performed over a clear section at the stern of the vessel.

Capt Coffindaffer held a steady 75-80 foot hover over the vessel for a stokes litter hoist extraction. While the stokes litter was being hoisted up, the vessel was caught by a large wave causing it to pitch up and to the right. As a result, the vessel was then 30 degrees off course from its original heading and moving away from the helicopter. The stokes litter, with the survivor in it, began to move with a pendulum motion to the left, proceeded to go in between the deck and a rail, and then entered the water — jamming the hoist cable against the vessel's rail. This situation, combined with the forward motion of the vessel, caused the stokes litter to be dragged under the water (like a sea anchor), placing the survivor in close proximity with the vessel's propeller.

With total disregard for his personal safety, SSgt Hehir jumped into the water, swam to the survivor, got the survivor to the surface where he could breathe again, and ensured the litter stayed clear of the boat's propeller. At the same time, pararescueman MSgt Mayfield, who was still on board the helicopter, called for the hoist cable to be sheared. Flight engineer SrA Riddell immediately sheared the cable, which then entangled itself within the hoist drum and rendered it useless. MSgt Mayfield began improvising a device from rappel ropes and carabiners, utilizing his knowledge of litter evacuation procedures used in mountain rescue situations. He envisioned a rescue by clipping the ropes to the stokes litter and pulling in the survivor while the helicopter was in a low hover or landing in the water.

After a successful approach to a 1-foot hover over rough sea, TSgt Lowdermilk and SSgt Hehir were able to clip the ropes to the stokes litter which enabled MSgt Mayfield, SrA Riddell, and Capt Hurwitz to manually pull the survivor aboard the helicopter. Once on board, flight surgeon Capt Hurwitz began administering medical treatment to the patient. Capt Coffindaffer then flew an approach back to pick up TSgt Lowdermilk and SSgt Hehir, where they climbed into the helicopter using a rope ladder. Upon takeoff, Capt Coffindaffer made smooth power adjustments because he knew the jet turbine engines had ingested excessive salt spray which could severely degrade the engine's performance.

At approximately 200 feet off the water and 50 knots forward airspeed, the helicopter experienced a compressor stall on one of its engines. The loud bangs of this failure alerted the aircrew of an emergency situation. The aircrew, following procedures outlined in the current H-3 Dash One Technical Order, were able to stabilize the engine, avoiding a highly probable engine failure. However, after a health check was performed on the engines, the helicopter aircrew became aware they did not have normal power due to jet engine performance deterioration. By this time, the helicopter needed fuel to make it back to Patrick AFB.

With a power critical situation, Capt Coffindaffer requested that the

*U.S. GOVERNMENT PRINTING OFFICE 1995-679-016/03007

From top, counterclockwise: Official USAF Photo

SrA	MSgt	Captain
Dave Riddell,	**Wiley Mayfield,**	**Gary L. Hurwitz,**
Flight Engineer	Pararescueman	Flight Surgeon (not pictured)

Captain	Captain	TSgt	SSgt
Steven W. Kelly,	**John Coffindaffer,**	**Greg Lowdermilk,**	**Greg Hehir,**
Copilot	Aircraft Commander	Pararescueman	Pararescueman

41st Rescue Squadron, Patrick AFB, Florida

HC-130 fly underneath them at 1,000 feet to set up air refueling operations. As the tanker came into view, Capt Coffindaffer entered a shallow controlled descent, engaged the drogue of the HC-130, and obtained 1,200 pounds of fuel — enough fuel for the helicopter to make it back on its own. The air refueling took place at 1,000 feet and 105 knots airspeed over the ocean. At approximately 90 miles east of Patrick AFB, copilot Capt Kelly noticed the cyclic stick was beginning to drive forward. Capt Kelly passed the controls to Capt Coffindaffer, and they determined the helicopter's automatic flight control system (AFCS) was malfunctioning and should be turned off. The HH-3E is safe to fly when the AFCS is turned off, but flies unsteady.

Meanwhile, Capt Hurwitz and the pararescuemen were providing life-saving medical attention to the patient. After conferring with his crew, Capt Coffindaffer elected to make a minimum power running landing to Runway 11 and landed without incident. The helicopter ground taxied to base operations where an ambulance was waiting to take the patient to the hospital.

If not for the gallant efforts and teamwork of the helicopter and HC-130 aircrews, the patient would not have lived from the injuries sustained during his fall. In addition, Air Force Rescue 811 crew's superior airmanship, along with their expeditious and accurate assessment of multiple emergencies, resulted in the successful recovery of a valuable Air Force aircraft and the saving of all lives on board.

WELL DONE! ■

Photo courtesy U.S. Navy

Not following aircraft oven T.O. procedures will ruin more than your lunch!