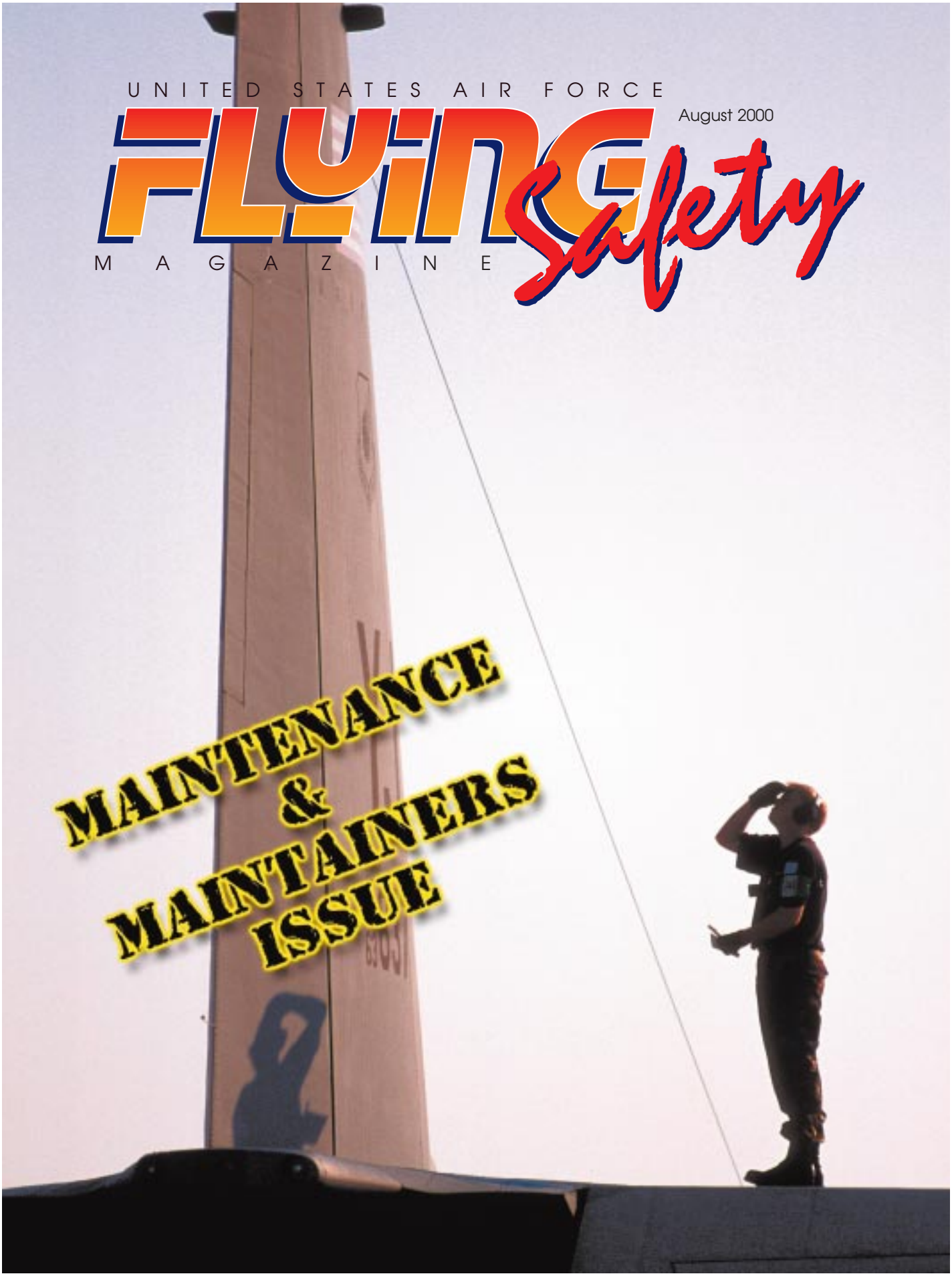
UNITED STATES AIR FORCE

FLYING Safety

MAGAZINE

August 2000



MAINTENANCE & MAINTAINERS ISSUE

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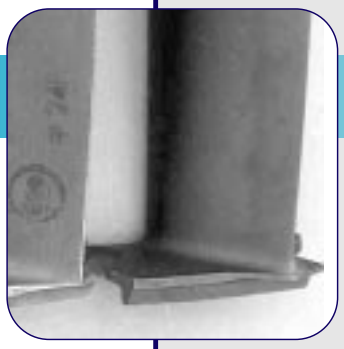
THE ISSUE:



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FSnotams

FLYING OUTSIDE THE BOOK

Courtesy ASRS *Callback* #243, Sep 99
NASA's Aviation Safety Reporting System

From a pilot who was persuaded by a company salesman to bend weight-and-balance rules to sew up a sale:

The salesman, myself, and the (new aircraft) owner were flying (on a long cross-country). With three people and full fuel, this aircraft is approximately 50 pounds over gross takeoff weight. We departed with an additional eight bags and one set of golf clubs, which clearly put us over gross weight. I know better, but rationalizing the salesman's statement, "I fly with five people and full fuel...and it is fine,"I proceeded. When I had the plane at approximately 400 ft AGL, I ran out of nose-down elevator trim. I called Tower and requested that we come around to land. That was my first experience out of the college training environment, which consists of good habit patterns and flying by the book. Unfortunately, I did not follow good judgment. Upon my return, I told the salesman he needed to get someone else.

(We believe it was Mark Twain who once said something like: "It's better to be careful a hundred times than to be dead once." Ed.)

IT'S IN THE BAG

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

A lost-communications incident that affected this air carrier flight crew may inspire other pilots to take a second look at where they place book bags containing flight charts and manuals.

About 30 NM out of (the) airport at 10,000 ft, I reviewed the approach and runway diagram and set my approach book back on top of my book bag. After about 4-5 minutes of silence on the radio and about ten miles from the airport, I asked the First Officer to query Approach Control about his intentions. The First Officer was unable to contact approach. I attempted to no avail, but the First Officer now told me he was getting feedback even when I was not transmitting. I looked down and realized that my approach book had shifted up to my comm panel and had toggled the transmission switch to "On." I removed the book, contacted and apologized to Approach and continued to landing. Approach was very understanding, even though I knew we had unintentionally disrupted his operation.

The comm panel on the (aircraft) on the Captain's side has been moved down and aft to make room for the steering wheel. This puts it right at the same level as the approach books, and the transmit switch is the first to be touched should the book shift.

MAINTENANCE CLOSEUP:

USAF Photo by MSgt Steven M. Turner

CAPT RICARDO HUERTA
CMSGT JOHN MULLEN
11th Reconnaissance Squadron

The Predator UAV system is, without a doubt, one of the most sought-after surveillance assets by Theater CINCs.

Dipping down to 14,000 ft, the aircraft banks right to allow the sensor operator a better image of the suspected Serb SAM site that has been harassing NATO aircraft in the Kosovo region. The sensor operator employs the aircraft's electro-optical sensor to perform a wide-area search, then uses a zoom lens to verify the presence and location of a SAM site. As the three-person aircrew—a pilot and two sensor operators—loiters the aircraft over the area awaiting Combined Area of Operations Center (CAOC) instructions, a small, white puff of smoke is detected in the imagery. Suddenly, the image freezes and all contact with the aircraft is lost. The CAOC uses other sources of information to confirm the combat loss...

Over 300 miles from the crash site, the downed aircraft's dedicated crew chief (DCC) gets the bad news and enters the Ground Control Station (GCS) to review video of the incident...and tease the pilot about getting knocked out of the sky. For you see, while it was flying in harm's way over Kosovo, the aircrew was safely operating the aircraft—an RQ-1K Predator Unmanned Aerial Vehicle (UAV)—from Tuzla, Bosnia, using dedicated satellite communication links. The DCC is saddened by the loss of his plane but, as usual, there's no loss of life. Welcome to the world of the Predator UAV.

Whether it's battle damage assessment, force protection, or monitoring civil unrest or troop movements, the Predator UAV system is, without a doubt, one of the most sought-after surveillance assets by Theater CINCs. It provides unmatched reconnaissance capabilities to commanders in the form of near-real-time video. It also presents new challenges for the maintainers who keep the system operational.

A Brief Predator Background

The Predator began its life as an Advanced Concept Technology Demonstration (ACTD) asset under control of the US Navy-led Joint Program Office. The system was tested and flown in Taszar, Hungary, in March 1996, in support of Operation JOINT ENDEAVOR peace efforts in Bosnia.

In July 1996, the Air Force took control of the program and assigned the Predator ACTD assets to the 11th Reconnaissance Squadron, which had been formed in 1995. The 11 RS undertook JOINT ENDEAVOR

operations in September 1996 and began training at Indian Springs AFAF in December 1996. The Predator UAV system was the first weapon system to go from ACTD to operationally capable, and it did so two years ahead of schedule.

An additional Predator squadron, the 15 RS, was activated in the summer of 1997. Their first deployment was to SWA in January 1999. In support of Operations JOINT FORGE, NOBLE ANVIL, and ALLIED FORCE, the 11 RS deployed to Tuzla AB, Bosnia, in March 1999. As the Kosovo air campaign escalated, a second Predator system deployed in April, followed by a third system in May. All systems returned to home station in October 1999.

The RQ-1A Predator System

A Predator system is comprised of four UAVs, a ground control station (GCS), and a Trojan SPIRIT (Special Purpose Integrated Remote Intelligence Terminal) satellite communications system. Crew chiefs, avionics specialists, computer maintainers, and satellite communications personnel all have a hand in maintaining the Predator system, and it's this hybrid of background and knowledge that makes the Predator the success it is today.

The RQ-1K Predator UAV

The Predator UAV uses a rear-mounted Rotax 912, four-stroke, four-cylinder engine for propulsion. Over the last two years we've converted from a fixed-pitch to a variable-pitch propeller, a major step forward. In addition to increasing performance and overall UAV capability, the variable-pitch propeller engine has tech data that enables military personnel to perform and sign off maintenance tasks. Previously, we had to rely on contractor personnel to supervise the maintenance and sign off work. As you might expect, this was both a morale-killer for our GIs and a significant "inconvenience" in a deployed environment.

The Predator currently has a requirement for an inspection every 50 hours of engine time. Since the UAV typically flies 8-10 hour training sorties and 14-20 missions at deployed locations, this is the single most important factor our scheduler has to consider.

The 50-hour inspection is of major importance to all of us. Typically, four maintainers and one contractor perform the 50-hour. During this inspection, the DCC inspects the engine bay, changes the air filter, changes the oil and oil filter, performs compression and gearbox backlash checks, changes spark plugs and coolant and—most importantly for the Predator—replaces the rubber coupler (the "donut") and its radial bolts.

The donut connects and cushions the starter/alternator assembly to the engine. Because previous Predator mishaps have been linked to donut failures at around the 50-hour mark, the donut is the driving factor behind the 50-hour inspection.

R&R'ing the donut is a two-person job since it involves removing the engine and starter/alternator assembly from the aircraft

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The Predator UAV system was the first weapon system to go from Advanced Technology Concept Demonstration asset to operationally capable, and it did so two years ahead of schedule.

It's capable of detecting hot vehicles at 7-10 miles and cold vehicles at 2-3 miles.

to get to it. After replacing the donut and its radial bolts, a time-consuming, but critical, alternator plate alignment must be done to properly mate the engine and starter/alternator assembly back together. If this alignment isn't done properly, the engine will have unbalanced stress placed on it and the entire Predator vehicle will vibrate, causing loss of imagery capabilities. Improper balancing could even result in loss of the UAV itself. A propeller inspection is also done concurrently with the 50-hour inspection.

As you might expect, an engine run is required after the inspection is complete. In previous years, an FCF was flown, but numerous sorties and flight hours have proven a ground maintenance engine run will suffice. If everything runs smoothly, the entire 50-hour inspection process may only take six hours.

There are two other major inspections that occur every 300 and 900 hours of engine operating time. During the 300-hour inspection, the engine is stripped and cleaned and the manifold air pressure (MAP) sensor, throttle servo, and starter/alternator are R&R'd. During the 900-hour inspection, the engine is R&R'd. Despite being somewhat labor-intensive due to the length of a typical Predator sortie, the Rotax 912 engine has proven to be efficient and reliable.

Replacing the 912 engine with the Rotax 914 turbo-charged engine in the near future will give the Predator greater speed and decrease transit time to targets. It will also enable longer loiter times over targets or shorter sorties, which should decrease the frequency of inspections. Unlike the Rotax 912, where we took over an existing program from contractors, our crew chiefs will be in the initial training cadre for the 914. It'll be a challenge, but our crew chiefs are looking forward to it.

Most other maintenance practices and procedures for the Predator UAV are similar to those for manned aircraft. Maintainers perform R&R functions on items like the C-Band directional antenna, video processor, engine bay cooling fan and cowl flap servo, flight sensor unit, GPS antennas, KU-Band antenna and synthetic aperture radar (SAR) antenna and processor. One item of special interest is the electro-optical/infrared payload Versatron Skyball—the "v-ball"—and associated interface unit, and their removal and installation procedures.

The interface unit and v-ball are "married," and must be replaced as a single LRU. The v-ball contains the electro-optical sensor that allows the sensor operator to perform wide-area searches, zooming in on items of interest with the 900 mm spotter lens. This allows imagery analysts to identify specific target features. The sensor is capable of detecting vehicles at 15 miles.

The v-ball also contains an infrared sensor that allows imagery analysts to detect and identify a target in day or night operations. It's capable of detecting hot vehicles at 7-10 miles and cold vehicles at 2-3 miles.

The v-ball is the "eyes of the warrior" for the Predator UAV and it's often used for takeoffs and landings instead of the nose camera. Where the nose camera gives the pi-

lot a view from the front of the UAV, the picture from the v-ball allows pilots to view the ground and get a better feel for takeoffs and landings.

One final item that's unique for us in Predator maintenance is that when we first became operational, we did a lot of "hard landing" inspections. Understand that operating an aircraft by remote control is a one-of-a-kind experience for any pilot and you understand why hard landings weren't uncommon when our pilots were getting used to flying the Predator.

What constitutes a hard landing? Any touchdown where the landing gear contact the ground at a rate greater than eight feet-per-second. Hard landings require us to inspect the landing gear attachment bulkheads for structural damage and delamination in the composite material. Any bulkhead structure repairs are depot-level maintenance jobs. We also inspect landing gear struts and fittings for cracks, ensure gear retract servos are securely attached with no bent or broken parts and inspect the tires for cuts and abrasions. Finally, we'll inspect the nose landing gear assembly and tailplanes for cracks and damage. A landing gear retract test is required prior to releasing the UAV for its next flight.

Overall, the Predator is a reliable aircraft. Although the small number of UAVs assigned to a system causes MC rates to seem low, missions are rarely canceled except for weather. The Predator isn't an all-weather aircraft. We don't launch under high-wind or rain conditions, but if already airborne, it can loiter for extended periods until the weather blows over, a luxury that other weapon systems don't have.

The RQ-1P Ground Control Station (GCS)

The GCS has two main sections. The pilot (rated) and sensor operator (enlisted) work from the front of the GCS, while the Data Exploitation, Mission Planning, and Communications (DEMPC) operator's area is located in the back section.

From the front of the GCS, the pilot and sensor operator command and control the UAV, with the pilot flying the aircraft and the sensor operator controlling the v-ball and imagery. In essence, the front rack of the GCS is the cockpit of the aircraft, where the pilot has the typical throttle assembly and rudder pedals for UAV control. The pilot and payload operator basically use a computer monitoring station with a heads-up display function, where the video from the nose camera and v-ball are displayed. The video can be switched to either computer rack based on pilot wishes. Our avionics maintainers are responsible for this area of the GCS.

The second half of the GCS contains the DEMPC computer systems, SAR workstation and KU-Band link management assembly. This is the heart of the Predator system, as all reconnaissance imagery and information flows through this location. The enlisted DEMPC operator is also responsible for providing targeting coordinates and target heading to the pilot and sensor operator. Computer-electronics and satellite commu-

continued on next page

The Predator can loiter for extended periods until the weather blows over.

Eighteen maintainers are responsible for operating one Predator system 24 hours a day, seven days a week.

nications maintenance personnel maintain this portion of the GCS. A lot of the knowledge and skills acquired by maintainers in this area has been through OJT and prior UNIX computer system work.

RQ-1U Trojan SPIRIT

The last portion of the Predator system is the Trojan SPIRIT satellite system. This system was taken over from the US Army and has two main components. The first is a secure voice/data satellite communications spare equipment and maintenance shelter and associated 5.5 meter KU Tri-Band antenna used for UAV command and control. The second is a secure voice/data satellite communications primary heavy shelter and associated 2.4 meter mobile antenna platform. This second component is used primarily for establishing a wide-area network capability with access to the Secret Internet Protocol Router Network (SIPRNET) and the Joint Worldwide Intelligence Communications System (JWICS). Our intelligence function uses this feature for activities associated with reconnaissance missions.

While the US Army typically deploys only operators for their Trojan SPIRIT, and delegate maintenance activities to contractors, our workforce does both. Our personnel are responsible for setting up the antennas, grounding the equipment, establishing links with the satellite and connecting the Trojan SPIRIT to the GCS and operations cell.

One interesting aspect of satellite operations involves establishing the KU link with the satellite. The autotrack feature is often unreliable, so our maintainers acquire the satellite manually. They start from a known latitude and longitude and map the area with the antenna, attempting to acquire the expected signal. This can take anywhere from 20 minutes to two hours, depending on the satellites and different signals in the sector.

Upon acquiring the signal, they'll contact the bandwidth management office to verify that they've identified the correct satellite sector and then lock on to the signal. This information is then loaded into the Trojan SPIRIT satellite system, allowing its antenna to maintain signal lock in the auto mode.

Predator Maintainers

No description of the Predator system would be complete without discussing the maintainers who make it all work. Despite the complexity of the system, 18 maintainers—crew chiefs, avionics specialists, computer maintainers, and satellite communication maintainers—are responsible for operating one Predator system 24 hours a day, seven days a week.

Crew chiefs and avionics specialists have a diverse background and come from virtually all other weapon systems. We currently have "J"-shred crew chiefs, however, future Predator crew chiefs may come from any weapon system since the learning curve is the same, regardless of experience with previous aircraft. Those from heavies seem to grasp UAV requirements and expectations more quickly than fighter crew chiefs because the Predator operates much like a typ-

ical heavy aircraft.

It usually takes about six months experience to become a fully-qualified Predator maintainer. All new personnel attend a two-week general UAV FTD course to get familiar with the Predator. Specialized courses follow later, after they've become accustomed to UAV maintenance. Our maintainers are expected to know Predator launch and recovery procedures, PRE/BPO and thruflight inspections, refuel/defuel procedures and all of the other standard maintenance activities and inspections associated with traditional manned weapon systems. New maintainers must also have participated in the six-person team required to launch and recover the Predator to be considered qualified.

One factor that we impress throughout training is that the Predator must be maintained just like a manned aircraft. Flight safety requirements are the same, and UAV mishaps incur the same Safety Investigation and Accident Investigation Boards as manned aircraft. Quality-of-maintenance must be of the highest possible caliber.

The last step in overall training is augmenting the debrief section. Unlike other aircraft, our maintainers can walk into the GCS and actually view problems a pilot is having—live, or on tape. It's a luxury that other weapon systems don't have. This capability has even prevented some write-ups that we would later have attributed to "operator error."

The Predator system continues to evolve and mature. With new UAV features like wings that can deice themselves, the improved Rotax 914 engine, a UHF voice-relay radio for improved communications with ATC, improvements in software and hardware designs, and a new satellite communications antenna system, maintenance will continue to be a challenging and rewarding experience. ✈

(All information in this article is unclassified. Ed.)

About the authors: Captain Huerta is Sortie Generation and Communications Flight commander for the 11 RS. Captain Huerta started his Air Force career in 1995 as a communications officer at Tyndall AFB. He was reassigned to the 11 RS at Indian Springs AFAF in 1997. He deployed to Taszar, Hungary, and Tuzla, Bosnia, to set up and operate Predator UAV systems in support of Operations JOINT GUARD, JOINT FORGE, NOBLE ANVIL and ALLIED FORCE. Captain Huerta has a bachelor's degree in Civil Engineering from Georgia Institute of Technology, and a master's degree in Business Administration from Idaho State University.

CMSgt Mullen is Maintenance Superintendent for the 11 RS. He enlisted in 1977, with a first assignment as an F-111E DCC at RAF Upper Heyford, United Kingdom. During his career, he has also worked the F-15 and F-16, and served at Luke AFB, Bitburg AB, Edwards AFB and Kunsan AB. Chief Mullen has earned a CCAF associate degree in Aircraft Maintenance Technology, and a bachelor's degree in Aviation Maintenance Management from Embry-Riddle University.

All photos by SMSgt Orival E. Greenfield, 11RS.

One factor that we impress throughout training is that the Predator must be maintained just like a manned aircraft.

USAF Photo by MSgt Perry J. Heimer

CMSGT JEFFERY A. MOENING
CAPT FRANK A. MCVAY
550th Special Operations Squadron

There was a loud, howling noise coming from the nose of the aircraft; and the cabin wouldn't pressurize.

You think it can't happen in your unit, but then it does. Failure to properly document an aircraft maintenance action that could very easily have proven deadly...

It started out as a normal MC-130H Combat Talon II training sortie, with the launch proceeding on time. Unfortunately, shortly after takeoff, the aircrew realized two things: There was a loud, howling noise coming from the nose of the aircraft; and the cabin wouldn't pressurize. They aborted the mission, landed uneventfully, and turned the aircraft over to our maintainers.

It didn't take long to locate the cause of their problems. Troubleshooters found the center kidney panel for the nose wheel well *lying near the throttle control cables on the flight deck. The kidney panel hadn't been installed securely.* What made things worse was the fact that some of the kidney panel hardware was found sitting in the forward nose landing gear door and some of it had fallen out during takeoff or in flight. Why? The kidney panel removal hadn't been documented in the aircraft forms.

As with any mishap, this one was preceded by a chain of events, and breaking any one of the links in that chain would have averted it. In this case, we had four chances to prevent it.

• The first chance was when a Crew Chief assisting an Electro/Environmental (E/E) troop in the search for a lost tool removed the kidney panel without documenting the action.

• The second chance occurred when the Crew Chief was pulled from the search to help recover another aircraft, and he assumed the E/E tech would document the panel.

• The third opportunity came and went when the E/E troop assumed the Crew Chief took care of documenting the kidney panel and reinstalling it.

• The final opportunity to prevent the mishap occurred when the Crew Chief performing the preflight and the Instructor Flight Engineer (FE) failed to notice the kidney panel wasn't secured properly. (In all fairness to them, the Dash-6 and Dash-1 checklists only state the nose wheel well area should be checked for leaks and general condition. Besides, the panel was never documented as having been removed.)

Lessons learned? You bet! Once again, it was proven that:

• *You must always* document what you do; and

• *You must never* assume someone else has taken care of your responsibilities.

It is every maintainer's responsibility to document what he or she accomplishes and make sure his or her integrity is never in question. If the Crew Chief had documented the panel, the E/E tech had performed a follow-up on the Crew Chief's work, or the preflight Crew Chief or Instructor FE had scrutinized the wheel well area a little more closely, this mishap wouldn't have occurred.

Bottom Line? This lapse in maintenance discipline resulted in an aircraft that wasn't safe for flight. Besides the dropped object incident (kidney panel hardware) and loss of a valuable training sortie, we dodged another bullet when the lost hardware didn't cause damage to our Talon or another aircraft. However, the solid reputation of our squadron maintenance professionals did take a hit.

Always remember: No matter what we do, no matter what the pressures, we must never compromise the safety of our aircrews and aircraft!

We aircraft maintainers are a proud and trusted group of professionals. We must always strive for perfection and quality. Integrity First! ✈

(At the time of this writing, Chief Moening and Captain McVay were the Maintenance Superintendent and Maintenance Supervisor, respectively, for the 550 SOS, part of AETC's 58th Special Operations Wing at Kirtland AFB, New Mexico. Editor.)

DEATH'S DOOR

MR. LAWRENCE SIMEK
Courtesy *Torch*, Apr 00

I remember reading an article that told of a sergeant crushing her head in a hangar door. The article said that her coworkers could do nothing but stand there and watch her die. It seemed unbelievable at the time. But almost a year later, I witnessed another sergeant do the same thing and fully understood how helpless her coworkers must have felt.

As with all mishaps, there's a chain of events that must occur to bring about tragedy. In this case, there were several. First, the door controls had been wired illogically. That is, the left switch moved the hangar door to the right, and the right switch moved the door to the left. The doors were being repainted, and tape and paper covered the outside switches. Also, the doors were open about one foot—a real no-no.

The sergeant needed to bring a crane into the hangar, so he asked the painters if he could open the door. When they said yes, he reached through the opened doors and hit the switch farthest from him.

He lived for another 15 agonizing minutes.

The human skull is stronger than you would think. Huge hangar doors won't crush the skull—nature made it strong, and it flexes quite a lot. Unfortunately, the tissue under the skull, like the sinus cavities and temples, can't take this kind of pressure. When the sinuses rupture, it's impossible to stop the blood from flowing. Even if this happened in an operating room with the best doctors, you're certain to bleed to death.

The Fire Department had to be called to wash away all the blood. I now understand when historians write: "The streets were as a river of blood after the battle."

Everything happened so fast, I didn't have time to mourn. That lasted until a few days later when I went to get a condolence card for his family. As I looked for the best card, all I could think about was his wife and kids without him, and his mother and father not being able to see their son any more. I'm sure I was a sight, biting down on my hand as hard as I could to keep from crying out in anguish.

As with most mishaps, this one would have been avoided had the rules been followed. Maintenance troops see the signs warning "Hangar doors must be fully closed or opened not less than ten feet." But many ignore the warning and open the doors just enough to get through—especially when cold weather sets in and they want to keep in the heat.

As with most warnings, events have occurred in the past that led to the logic behind the warning. Hangar doors are definitely no exception.

If you haven't applied the Operational Risk Management formula to hangar doors, the process is long overdue. Take the time to talk about scenarios with hangar doors that might lead to an unnecessary, hazardous risk. Formulate a plan that helps reduce these risks and, ultimately, may help prevent another mishap.

The bottom line is awareness and following the established safety guidelines.

The next time you see people opening hangar doors just enough to get their tool box through, tell them for their own safety to follow the warning. If you are a supervisor, keep alert to the actions of your people. It's the little, seemingly unimportant things that can cause a lot of heartache and end with having to explain to families why they are now widows and orphans.

Don't let complacency be in your epitaph. ✈

(Mr. Simek is with the 325th Logistics Support Squadron at Tyndall AFB, FL)

(AHFOSHSTD 91-100, Aircraft Flightline Ground Operations and Activities*, contains a section entitled "Hangar, Nose Dock, and Shelter Door Design Guidance and Operations." It provides basic Air Force policies for hangar door operation. It's also likely your unit has established local Operating Instructions to govern hangar door operations. If you're not sure what the local policies are, Quality Assurance should be able to help. Ed.)*

Don't let complacency be in your epitaph.

R2K, AND DON'T YOU FORGET IT!

MAJ ROB SHEPHERD
9th Airlift Squadron
Dover AFB

Crews that practice to such tight tolerances develop techniques also applicable to real world missions.

"Let's get ready to Rodeo!" The war cry rang out and the assembled masses responded, their voices and whistles reaching a feverish pitch. Welcome to Air Mobility Expeditionary Rodeo 2000.

Rodeo is the showcase for the world's mobility air forces. It features airdrop, aerial refueling, aeromedical evacuation, security forces, aerial port and maintenance teams in varied, challenging competitive events. These contests are designed to improve procedures and standardization, allow us to share techniques among our counterparts in allied forces, and demonstrate our many important capabilities. A nice side effect is the positive relations and espirit de corps among all the participants.

The "Rodeo" tag dates back to 1962, when CARP Rodeo was held at Scott AFB. Although the 23 Rodeos since then have been similar, the competition has evolved from a strictly airdrop affair to this year's wide-ranging show, with a variety of name changes to mark the major milestones in the progression. Many bases have played host to Rodeo, but none are as well versed as Pope AFB (which hosted from 1979 to 1992, and again in 2000). And Team Pope truly shined this year, as 79 aircraft and over 3000 team members descended on the North Carolina base from 64 active duty, reserve and Air National Guard units, as well as eight foreign countries. The largest Rodeo ever was a sight to see!

During the opening ceremonies, Gen. Charles T. "Tony" Robertson, Jr., Commander in Chief, U.S. Transportation Command, and AMC Commander, gave the competition four orders: 1) learn something new about air mobility, 2) teach something about air mobility, 3) be safe, and 4) have fun. As a veteran of three Air Force flying competitions, I can attest that all four directives can be complementary. However, the unwary aviator can easily lose sight of the big picture (read: safety) in pursuit of the other goals. Risk awareness and management techniques, formal and informal, are essential to the successful prosecution of such a massive and challenging event.

Learning more about air mobility is something I do nearly every time I fly, but the preparation and execution of Rodeo really took this continuing education to a new level. While the competition focuses on skills we routinely practice, the precision required to even remain in the running at Rodeo is much greater than that which will get the mission done in the real world.

Consider an aerial refueling (AR) sortie. The tanker is scored on an orbit exercise (cross the AR control point, orbit to cross the ARCP again at a specified time, and set up another orbit to cross the ARCP at the AR control time with the receiver in contact) and a toggle time exercise (offload 3000 pounds of fuel and achieve 24 minutes of contact with the receiver in a 24-minute period), worth a total of 1300 points. The crew would lose one point for every 100 feet of circular error from the ARCP at the specified orbit time (that's roughly fifteen-hundredths of a second error) or every second not in contact with the tanker. Each disconnect would cost 50 points in addition to toggle time lost. In the real world, being within 30 seconds at the required points and losing 5 minutes of available track time would generally yield an effective sortie, but would earn the crew exactly zero points at Rodeo.

There is a silver lining here: Crews that practice to such tight tolerances develop techniques also applicable to real world missions, such as efficient use of the airplane's navigation systems to control arrival times accurately. They also build strong aircrew teams, something we can always use. The other ops competitions—timed arrival, engines-running on/off-loading, cargo loading, airdrop and short field landings—provide some of the same opportunities to hone mobility skills.

You can probably envision the additional flying hazards that came along with trying to perform at such a high level. Crews are under competitive pressure and are generally more aggressive than during day-to-day operations. This focus can mitigate some risks, but the loss of "peripheral vision" can allow other factors to creep into our path.

Commanders take this into account when selecting their teams, with fairly experienced crewmembers who will mesh as a team. By the time the competition takes place, most teams have flown together for a while and have developed a division of duties that will restore a good deal of each member's lost situational awareness. The bottom line is *awareness*; if you pay attention to what's happening all the time, you'll be better prepared to deal with unexpected situations despite the added pressures.

The flightline presents another host of dangers. During the arrival of the U.S. teams, 60 airplanes were scheduled to land with only 5 minutes of separation. This timetable continued for over 6 hours. Mix in some unfamiliar taxi routes and unforgiving parking plans and you've got some real ramp congestion issues. We can all tip our hats to the Rodeo Ambassadors for minimizing the impact of this situation. Those red-shirted troops, all volunteers from Team Pope, did a masterful job positioning the airplanes without incident, a testament to solid planning and deliberate execution. Competition days also set challenges for the teams. Maintenance and aerial port teams were competing on the ramp while aircrews were launching and recovering their sorties. Once again, smart scheduling and diligence on the part of team members and Rodeo staff kept the accident demon at bay.

Scheduling that location and season for Rodeo is always challenging. McChord provided beautiful weather for part of Rodeo '98, but the thunderstorms and low ceilings we experienced there were typical for June. Heat and humidity were on the menu at Pope, though we actually didn't have too much of the combination. Nevertheless, it could have been a very negative factor during the competition. The Rodeo safety staff, composed of members from HQ AMC, Pope and other units, stepped up to the task of lessening the potential impact. Coolers with bottled water were stationed everywhere and were kept full during the whole week, the Chuck Wagon was continually roaming the grounds passing out water to anyone who asked, and shade was available nearly everywhere for a brief respite from the brutal sun.

The ground safety folks had to work with congestion around Pope and Fort Bragg, with over 3000 competitors sharing the roads with thousands of permanent party members. What kept it under control? Of course, prior planning by the diligent staff (see a trend developing here?). Lots of signs were all over Pope and Fort Bragg directing people to the various gates, events and competition venues. Safety reps gave the aircrew members, as well as other competitors, a very detailed safety briefing at the outset, so we were all aware of areas requiring special caution.

Remember the orders from Gen. Robertson? Most folks took the last one to heart and carried it out with zeal. Dodge City—the traditional Rodeo hangout—offered a wonderful setting for competition and staff to unwind, share stories (factual or otherwise), and generally improve relations. Long days, late nights, warm weather and some adult beverages could have led to problems, even among such professional airmen. The town "mayor," along with his numerous marshals and deputies, roamed the premises relentlessly, preserving a relaxed environment while keeping good order and discipline. I can personally attest to the positive impact these folks had on the whole competition, even though most of us spent only a small percentage of our time in Dodge City.

I'll again ask you this question. Do you see a trend? It's people! All of our safety programs are designed by people to be implemented by people and serve to keep our people out of harm's way. I've already described some obvious "mission makers" at the Rodeo: safety staff, marshals, ambassadors to name just a few. But we all took Gen. Robertson seriously when he said, "Be safe." Everyone took an active role in the risk management that goes on every day around our Air Force…and you see it was effective. This was one of the safest Rodeos on record.

Those of you who shared the experience with me can pat yourselves on the back for stepping up to the plate, taking your best swing and making R2K the biggest and best Rodeo ever. It was, in the words of Maj. Gen. "Si" Johnson, Rodeo commander, "a home run for each person involved." ✈

Note: The author is a C-5 evaluator pilot at Dover AFB. He was part of the Best C-5 Air Refueling Crew at Rodeo 2000, adding to his Top T-37 Aircrew award from Torchlight '89.

Crews are under competitive pressure and are generally more aggressive than during day-to-day operations.

AIR MOBILITY RODEO 2000:
A MAINTENANCE PERSPECTIVE ON "R2K"

USAF Photo by SSgt Steven Pearsall

CMSGT MIKE BAKER
Maintenance/Technical Editor

Rodeo is, first and foremost, a* combat *competition.

You think the 2000 Olympic Games are being held in the Land-Down-Under, don't you? Uh-uh. Not for the thousands of folks wearing Air Force Blue in the air mobility profession. They'll tell you the 2000 Olympics already took place May 6-13, at Pope Air Force Base, North Carolina, under the "Air Mobility Rodeo 2000" ("R2K") banner.

"Rodeo" is an Air Mobility Command-sponsored biennial competition that provides a setting for US Air Force and allied nation air mobility forces to showcase their core capabilities and war-fighting skills. Rodeo is—dare we say? (Dare! Dare!)—the world's premier air mobility competition, and a golden opportunity for maintenance, aircrew, aerial port, special tactics, security forces and aeromedical evacuation (medevac) personnel to show off their combat skills in friendly competition.

Dozens of teams from organizations around the world come together at Rodeo to vie for the distinction of being recognized "Best of the Best." This is where individual units are recognized with—and get the bragging rights to—the prestige that accompanies selection as Best Air Refueling Wing, Best Airdrop Wing or the top honor, Best Air Mobility Wing. For maintainers, this is their shot at earning a spot in the Rodeo history books as Best Preflight, Postflight or all-around Maintenance Team for their particular airframe.

A Little Rodeo History

The granddaddy of today's Air Mobility Rodeo was 1962's "CARP Rodeo." In that first "Computed Air Release Point" Rodeo, C-124 Globemaster II crews competed to see who was best at airdropping cargo on target, on time. Since that first Rodeo competition, Rodeo has grown. For instance, in 1979, maintenance competition became an integral part of Rodeo, and the first international teams participated. In 1990, cargo loading was added as a competition category. Air refueling events became permanent parts of the competition in 1993. Finally, the inclusion of security forces, special tactics and medevac personnel in Rodeo events, and formal recognition for those both in the air and on the ground who make the mission, accurately reflects the teamwork that has enabled the evolution in the worldwide air mobility mission.

One of the products of Rodeo's evolution is that even though much of the public focus


USAF Photo by SSgt Lisa M. Zunzanyika

still tends to be on Rodeo's most obvious aspect—flight operations—every single competitor knows that success in the air isn't possible without a total team effort. I was awed at how closely each of the unit teams functioned. From beginning to end, they acted like family and treated each other like family, regardless of rank or specialty.

Rodeo's moniker has changed over the years, from CARP Rodeo, to Airlift Rodeo, to today's Air Mobility Rodeo, but then, as now, the ultimate goal of competition is to improve current and future air mobility operations.

The Ground Rules

In the 1980s, it was common for a select group of highly experienced maintainers to be assigned exclusively to primary and backup Rodeo aircraft months in advance of the competition. Sometimes aircraft and crews were even exempted from flying channel missions and did nothing but get ready for Rodeo. And while a lot of emphasis was put on aircraft "go"—how well aircraft systems worked—there was also a lot of emphasis placed on "show." Replacing otherwise functional items that were merely scratched, worn or blemished became the norm, and Rodeo aircraft were often recipients of new parts, floor coverings, paint, polished items and, in some cases, "custom accessories," all to enhance appearance and impress umpires. In a large Air Force with few apparent budget constraints, infrequent deployments and a sizable pool of experienced personnel, it was okay to be a little extravagant. No more. Beauty is a good thing, but it's "go," and not "show," that matters most. The last several competitions have made it clear Rodeo is, first and foremost, a *combat* competition.

Maintenance Teams, Maintenance Umpires and Scoring

Rodeo preparation and competition are incredibly demanding. Workdays and nights routinely average 12 and 14 hours or more, with no letup until the return trip home. So, as you would expect, Rodeo Maintenance Team members—in addition to being crackerjack mechanics in their own AFSCs and proficient in a few other specialties—are dedicated *and* tough. Only small degrees of difference in attitude, ability, cohesiveness and motivation separate individual teams from one another, but it's their performance, both individually and collectively, that determines how well their aircrews will fare in the flying phases of the

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USAF Photos by (Left to Right) TSgt James E. Lotz, Lotz, SSgt Jerry Morrison, SSgt Lisa M. Zunzanyika, and SrA Lee E. Rogers

Umpire slots are filled by some of the most experienced senior NCO maintainers in the mobility air force.

competition.

Maintenance Umpire slots are filled by some of the most experienced senior NCO maintainers in the mobility air force. The Maintenance Umpire's task is straightforward, if not always easy: Use standard inspection and observation criteria to perform a series of impartial, graded evaluations on each aircraft and observe how well Maintenance Teams comply with tech data and safety requirements. Because of the number of aircraft and teams present for R2K, there were 15 Maintenance Umpire teams this year—three more than for Rodeo 98—with eight members assigned to each team.

Every Maintenance Team is graded in four primary areas, with maximum attainable scores shown for each:

• An Aircraft Preflight (PRE) Inspection. A "zero defect" evaluation is worth 600 points;

• An Aircraft Basic Postflight/Home Station Check (BPO/HSC) Inspection, 600 points available;

• An Aircraft Refueling Evaluation, 100 points available; and

• Daily observations of launch, recovery and maintenance activities, as well as adherence to safety practices. 100 points for each day of competition, 500 points available.

Upon arrival, Maintenance Teams receive a schedule informing them when, during the five days of competition, they'll be receiving their PRE, BPO/HSC and Refueling evaluations. Even though these tasks are performed several times during Rodeo, each of them is formally graded only once. The PRE and BPO/HSC evaluations are done after Maintenance Teams have completed their own inspections. Using the same inspection workcards the Maintenance Teams use, Maintenance Umpires evaluate how well the teams followed workcard requirements, so attention to detail is vital. Aircraft Refueling Evaluations are assessed "live," as they're being performed, again using the same checklists the Maintenance Teams use. Safety, reliability and working within the prescribed time limits determine score here.

Daily observations are just that: Umpires observe Maintenance Team members as

they conduct day-to-day launch, recovery and maintenance activities. Teams can lose points here in one of two ways: Small point deductions for minor infractions, like not using the right tools, or deviating from tech data or other directives; and big point deductions for commission of safety violations that could result in injury (or worse).

All of this may sound pretty simple, but there are plenty of opportunities throughout the competition for teams to *lose* points. Arriving with "awaiting maintenance" discrepancies, transcribing aircraft forms during the competition and failing to sign (acknowledge) Daily Observation Score sheets no later than 0700 each competition day result in point deductions. Bringing a backup aircraft, having a late takeoff (or abort) charged to maintenance, or bringing a team with too many Rodeo 98 "veterans" are other point killers.

Sure, quality of maintenance and safety in each of the four major areas earn high scores and determine, to a large extent, which Maintenance Teams will take home Gold Medals. But a careful reading of the Rodeo Operations Order and *knowing* the competition rules (hint, hint) can sometimes mean the difference between a Gold Medal and a Silver Medal. By the way: There is no trophy for second place.

Safety *Is* the Word (Again! Really!)

Was there potential for an aircraft mishap or personal injury at Pope AFB? Absolutely! Consider the following: Thousands of people, new to the area, who were unfamiliar with the parking ramp, base layout and surrounding community areas. Large numbers of diverse types of big aircraft all sharing the same ramp space at the same time. Language barriers for international teams (no, I'm not talking about dealing with "Southern" here). Workdays (seemingly) without end. Ongoing ramp construction projects. Unfamiliar airspace. Record heat and humidity. Et cetera, et cetera, et cetera. You get the picture. Even without throwing in an ever-changing cast of 10 to 15 transient aircraft that seemed to be present all the time, it would be a huge understatement to say Pope's ramp was ripe for a mishap to

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It would be a huge understatement to say Pope's ramp was ripe for a mishap.

USAF Photos by (Left to Right) SSgt Jeffrey Allen, MSgt P.J. Heimer, SSgt Lisa M. Zunzanyika, SrA Lee E. Rogers, Rogers, and MSgt James D. Mossman

Three Air Force flag officers made it clear that "Be safe" was one rule not to be violated.

occur. But the thought and effort put into making R2K safe were incredible!

Dozens of safety professionals from AMC's Directorate of Safety, 43d Airlift Wing Safety (Pope's host unit) and safety personnel from several other units worked closely for months in advance, doing "a little" R2K risk management. They recognized Rodeo risks, considered ways to eliminate or minimize the hazards and got proactive. Immediately after arrival, the Rodeo competitors went through a Rodeo Safety in-processing, where they received a safety briefing, welcome packages with flightline and surrounding community safety guidance and a quick familiarization with on- and off-base hazards.

It also didn't hurt that during opening ceremonies, no less than three Air Force flag officers made it clear that "Be safe" was one rule *not* to be violated. General Charles T. Robertson, Jr., AMC and USTRANSCOM Commander, gave the teams four Rules of Engagement for R2K: "Learn something new about air mobility, teach someone something new about air mobility, be safe, and have a helluva lot of fun." Major General Silas R. Johnson, Jr., Command, Air Mobility Warfare Center, and R2K Commander, reminded participants the emphasis was on "team"—from the smallest to the largest—and looking out for each other was crucial. He also endorsed use of ORM throughout the competition. Finally, Brigadier General Richard J. Casey, 43 AW Commander, encouraged the teams to have fun, but, above all, to be safe. When three generals tell you to be safe and have fun, it leaves a lasting impression. And you know what? Rodeo participants followed their orders to the letter.

When I asked Maintenance Umpires and Maintenance Team members what kind of emphasis they'd perceived when it came to "safety," without exception, they all echoed what seemed to be the universal credo of "Work hard, play hard, be safe." Not a single one of them felt like all the talk about safety was just "eyewash."

Here's a sampling of Umpire comments.

Chief Jim Phillips, of the 19 ARG at Robins, Rodeo's KC-135 Maintenance Umpire Superintendent: "Safety is the Number One issue. It's briefed to competitors before anything else." Chief (S) Chris Aitken, of the 437 AGS at Charleston, a C-141 Maintenance Umpire said, "Safety is briefed to arriving competitors, first by AMC Safety, then by Pope Safety. The briefs are thorough and everyone leaves with the understanding that safety is absolutely paramount."

Captain Bryan Boggs and MSgt Gary Brewster, both stationed at McChord, and heading the 62 AW's C-141 Maintenance Team, said nearly in unison, "Safety is paramount." Mr. Rick Curiel, WS-10, the 97 AMW C-5 Maintenance Team Chief, from Altus, told me, "The safety briefs were as thorough as I've ever seen. We were all told to have fun during the competition, but to place safety above all else."

The comments that best summarized overall impressions I got from everybody I spoke with at Rodeo came from Chief Jim Eagle, a member of the AFRC IG Team at Robins, and a C-141 Maintenance Umpire Team Chief. "Just like throughout the Air Force, the Number One issue here at Rodeo is safety. We have difficult, dangerous stuff to do and we must do it as safely as possible. We have to use Operational Risk Management to minimize hazards, and it's up to everybody—the individual and the supervisor—to get the mission done safely."

R2K: The Competition

Competing in this year's Rodeo at Pope AFB were 58 U.S. and seven international units, with 65 aircraft representing seven major weapon systems, crewed, supported and maintained by upwards of 3000 personnel. Major weapon systems vying for honors this year were the C-5, KC-10, C-17, KC-135, C-141, and the C-130/C-160 turboprop family. The Total Force concept—active, guard and reserve units working together—has made implementing the Expeditionary Air Force vision possible, so it was no surprise to see that nearly half of the 58 USAF competitors were Air National Guard and Air

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We have difficult, dangerous stuff to do and we must do it as safely as possible.

The greatest margin of difference between those awarded overall "Best Maintenance" title for an airframe and their nearest competitor was only 56 points.

Force Reserve Command units. Units from ACC, AETC, PACAF and USAFE sent competition teams as did allied nations, including Belgium, Brazil, Canada, Egypt, France, South Korea and Turkey.

Maintenance competition immediately swung into high gear on Sunday, 7 May, with Preflight Inspection Evaluations, and as competition days rolled on, the pace for Maintenance Teams accelerated. As each PRE, BPO/HSC, and Refueling Evaluation was completed, Maintenance Team Chiefs were given a copy of the score sheet to review for discrepancies, and given the opportunity to appeal the score if he/she felt points had been deducted in error. Likewise, Maintenance Team Chiefs acknowledged Daily Observation score sheets and, again, had the opportunity to appeal. But remember what I said earlier about all the ways there were to lose points? Here was another. Maintenance appeals that couldn't be backed up with hard evidence within one hour of the event conclusion meant loss of an additional 100 points from the event score. Ouch!

Cumulative maintenance scores are posted throughout the competition, but in order to preserve confidentiality of the "Best Maintenance Team" for each weapon system until the conclusion of Rodeo competition, some scores are masked. Rodeo's Maintenance Staff tallies overall maintenance results to determine best-in-category winners. These scores are also forwarded to Rodeo Central, where they're incorporated with the other competition scores derived from flying, security forces, aerial port and other events to help determine overall Rodeo award winners.

R2K Final Results

Was the competition close? Let me put it this way. I was afforded the privilege of seeing Maintenance Teams' raw scores. In one case, a mere two points—remember, now, this is out of a maximum possible score of 1800 points—separated the winner of the overall "Best Maintenance" title for an airframe from the second place competitor. That was no fluke. The greatest margin of difference between those awarded overall "Best Maintenance" title for an airframe and their nearest competitor was only 56 points. Yes, you could say that competition was close.

As you look over the list of Maintenance Teams who can proclaim themselves title holders (at least until Rodeo '02) in a "Best" category, note that just as was true at Rodeo 98, they come from active, guard, reserve and allied unit organizations. Doesn't it just prove what we knew all along, that our Total Force is greater than the sum of its individual parts?

A Few Closing Observations

First things first. AMC's 43d Airlift Wing and Pope AFB, host to R2K, did, hands down, a magnificent job! When it came to providing the atmosphere, the facilities and all the other necessities to make for a fun, safe, unforgettable Rodeo competition, General Casey and his Command Chief, Chief Ron Carter, made it world class all the way. Special "Kudos" to them and everyone else at Team Pope, who treated their Rodeo guests to a huge helping of hospitality, Pope-style!

Constant, positive encouragement from all levels to "work safe, play safe" paid off. Based on the fact that there was some kind of R2K activity going on around the clock, it's nothing short of miraculous that there were no—that's "zero"—serious injuries or equipment losses during Rodeo. Sound application of Risk Management reaped huge dividends by keeping people and resources safe. So more "Kudos," first to the Safety cadre, and then to everyone else—from the most junior ranking airman to the commanders who provided the leadership—that made R2K a real success story.

Pride and professionalism were evident in every person I had the pleasure of meeting. Everyone, from the security forces charged with defending the airfield, to the aerial port-types that make cargo movement happen, to the maintainers who provide safe, reliable aircraft to the aircrews, knew they were part of the same team. It was incredibly gratifying to see how well competitors understood that teamwork and safety are the keys to assuring victory in any contest.

As always, the challenge—and the acid test—for all maintainers was to prepare and care for their aircraft in the safest, most effective manner possible and give aircrews the safest, most reliable, FMC aircraft on time. Sure, there were a couple of maintenance cancellations and a late takeoff or two, but Rodeo Maintainers, you did one helluva fine job of providing aircraft that were ready to execute their wartime mission and bring their crews back home safely. Well done! ✈

R2K Maintenance Award Winners

Best C-5 Maintenance Team	**60 AMW (AMC), Travis AFB, CA**
Best C-5 Preflight Team	**439 AW (AFRC), Westover ARB, MA**
Best C-5 BPO/HSC	**349 AMW (AFRC), Travis AFB, CA**
Best KC-10 Maintenance Team	**305 AMW (AMC), McGuire AFB, NJ**
Best KC-10 Preflight Team	**305 AMW (AMC), McGuire AFB, NJ**
Best KC-10 BPO/HSC Team	**60 AMW (AMC), Travis AFB, CA**
Best C-17 Maintenance Team	**315 AW (AFRC), Charleston AFB, SC**
Best C-17 Preflight Team	***315 AW (AFRC), Charleston AFB, SC***
Best C-17 BPO/HSC Team	**315 AW (AFRC), Charleston AFB, SC**
Best C-130/C-160 Maintenance Team	***France***
Best C-130/C-160 Preflight Team	**167 AW (ANG), Martinsburg, WV**
Best C-130/C-160 BPO/HSC Team	**3 AW (PACAF), Elmendorf AFB, AK**
Best KC-135 Maintenance Team	**19 ARG (AMC), Robins AFB GA**
Best KC-135 Preflight Team	**19 ARG (AMC), Robins AFB, GA**
Best KC-135 BPO/HSC Team	**22 ARW (AMC), McConnell AFB, KS**
Best C-141 Maintenance Team	**452 AMW (AFRC), March ARB, CA**
Best C-141 Preflight Team	**97 AMW (AETC), Altus AFB, OK**
Best C-141 BPO/HSC Team	**452 AMW (AFRC), March ARB, CA**

Won the same category at Air Mobility Rodeo 98.

USAF Photo by MSgt Anderson Allamby

USAF Photo

MR RICH GREENWOOD
P&W Flight Safety
HQ AFSC/SEFE

Excessive tip curl could lead to liberation of the tip.

(Note: This article is for informational purposes only. Nothing contained herein is to be used in place of current Technical Order guidance. Remember: Always use and adhere to current tech data! Ed.)

The Pratt & Whitney F100 series of engines has been in service with the USAF since the mid-1970s, logging over 11 million engine flight hours in the F-15 and F-16 aircraft. Over this time it has proven to be one of the most reliable fighter engines ever produced.

Throughout those years, many changes have been made in the F100 engine family, as have the missions of the aircraft in which they're installed. The most significant engine change has been the introduction of the Digital Electronic Engine Control (DEEC) in the PW220/E model, which, among other things, allows the engine to run at peak performance throughout its life.

The Issue

Recently, 3rd stage low pressure turbine (LPT) blade tip shroud curling has surfaced as an area of concern in the F100-PW-100/200/220/220E series of engines. What is tip curl? The 3rd stage LPT blades on these engines are of a "shrouded" configuration, meaning they have a "T" shape with the cross-piece (shroud) at the tip. The shrouds of each blade interlock with the shrouds of the adjacent ones, helping to dampen out vibrations. Curl refers to the tendency of the shrouds of the blades to stretch or "curl" in service when exposed to high temperatures for extended periods of time. Although not readily apparent from the blade shown in Figure 1, there is curling present at the blade tip. If allowed to continue undetected, excessive tip curl could lead to liberation of the tip and damage to the turbine.

What causes 3rd stage LPT blade tip curling? There are a few reasons. Changes in aircraft missions—such as when the F-16 force went from a pure air-to-air role to

Figure 1. PW 100/200 3rd Stage LPT Blade Tip.

include air-to-ground attack—have sometimes resulted in operational usage exceeding original engine design specifications, subjecting the engines to higher temperatures for longer periods of time. Also, as the engine fleet has continued to age, more refurbished parts are used during overhaul. When compared to brand new engines, engines with refurbished parts can run at slightly higher temperatures. These are the major factors behind tip curling in F100 3rd stage LPT blades.

Reducing the Risk

Pratt & Whitney and the Air Force have been working closely on this problem and have taken several actions to mitigate the risk associated with 3rd stage LPT blade tip curl. The most significant action is a complete redesign of the blade and disk assembly as part of the new Reliability Enhancement Program (REP) 4000 cycle fan drive turbine assembly. Installation of the REP turbine Air Force-wide is ongoing and eliminates the need for borescope inspections for tip shroud curl. However, based on the schedule that's current as of this writing, the majority of the fleet won't be retrofitted for at least another 2 years.

Another action being taken to reduce the incidences of 3rd stage blade tip curl is measuring 2nd stage HPT blade tip clearance whenever the low pressure turbine is removed. Excessive clearance between 2nd stage HPT blade tips and their surrounding airseal allows the bypass of more hot gases, which raises the temperature of the 3rd stage LPT blade tips and can accelerate tip curling. If 2nd stage HPT blade clearance is too great, the entire high pressure turbine must be replaced.

Finally—and this is where you, the flightline and JEIM mechanic, come in—non-REP turbines require a focused periodic borescope inspection for signs of tip curl. Because of the repetitive nature of the inspection and personnel turnover, it is important to periodically review proper inspection techniques to be sure the full benefit of the inspection is being realized. You flightline and JEIM mechanics are the front line of defense for this important inspection. Let's review some of the basics.

As the engine fleet has continued to age, more refurbished parts are used during overhaul.

First Steps

The first thing you need to do before inspecting is to determine what type of aircraft/engine combination you are dealing with and what part number blade is in the engine. The engine/airframe combination determines the inspection interval, and the blade part number/type determines the inspection method. A caution here: Engine

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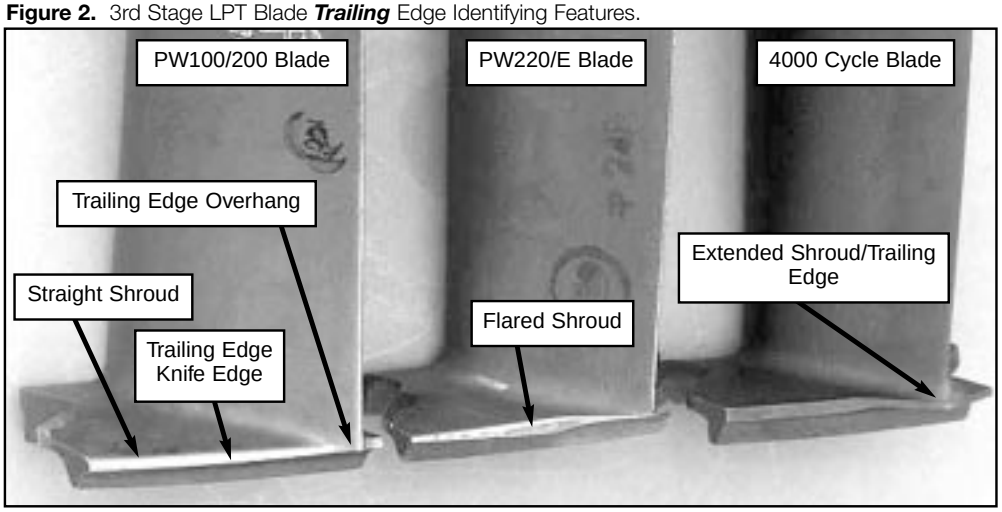
Figure 2. 3rd Stage LPT Blade ***Trailing*** Edge Identifying Features.



are inspected at the leading edge through the AP6 borescope port. This is because the prime indicator of tip curl on PW100/200 blades is wear of the rear knife edge, while for the PW220/E blades, it's mismatch between adjacent blade shrouds.

Why the differences in inspection intervals? In the older PW100/200 engines, a hydro-mechanical fuel control is primarily responsible for fuel scheduling, while the DEEC takes care of it in the PW220/E engines. Whereas a hydro-mechanically-controlled engine must be manually up-trimmed periodically to regain lost performance as the engine "wears" over its life cycle, a DEEC-controlled engine is always being trimmed for peak performance, every moment of its life. This means that DEEC-controlled engines run at higher, "up-trimmed" temperature levels for more of their lives than hydro-mechanically-controlled engines. As mentioned earlier, it is *time at temperature*, not just peak temperature, that induces tip curl.

You'll notice that there's a shorter inspection interval for the F-16 outfitted with the PW220/E engine than for the F-15 outfitted with the same engine. That's because single-engine failure in an F-16, where you only have one engine, can have a radically different outcome than single-engine failure in an F-15, where you have two engines.

You probably also noticed that the inspection intervals on PW100/200 engines are given in terms of "EFH," or "Engine Flight Hours," while PW220/E inspection intervals are given in "HS3" hours, or "Hot Section 3" hours. EFH is just that: The number of hours the engine is flown. The first inspection for these PW100/200 engines isn't due until the LPT has accumulated 800 calculated cycles (Ccy) of operation. "HS3 hours" requires a bit more explanation.

The PW220/E engines have an Engine Diagnostic Unit (EDU), and one of its many functions is to keep track of "hot time" hours, or the number of hours the engine has operated above a certain temperature. The PW100/200 engines don't have an EDU. HS3 time is the number of hours the engine has operated above a fan turbine inlet temperature (FTIT) of 915 degrees Centigrade. Different missions will generate different amounts of HS3 time per EFH. Again, it's *time at temperature* that is the driver for blade tip curl. Analysis has shown that HS3 time is the best parameter to use to track blade tip curl inspection times.

It is time at temperature, not just peak temperature, that induces tip curl.

What To Look For

OK. Now you can identify the different blade types and you understand why inspection intervals vary for different engine configurations. Now it's time to inspect. But what are you inspecting for?

Let's start with the PW100/200 engines. Per current tech data, you are going to crawl up the tailpipe with your trusty borescope, snake it through the 4th stage blades and vanes, and start looking at the trailing edge knife-edge seals on the 3rd stage blade tips. You must carefully examine all blades,

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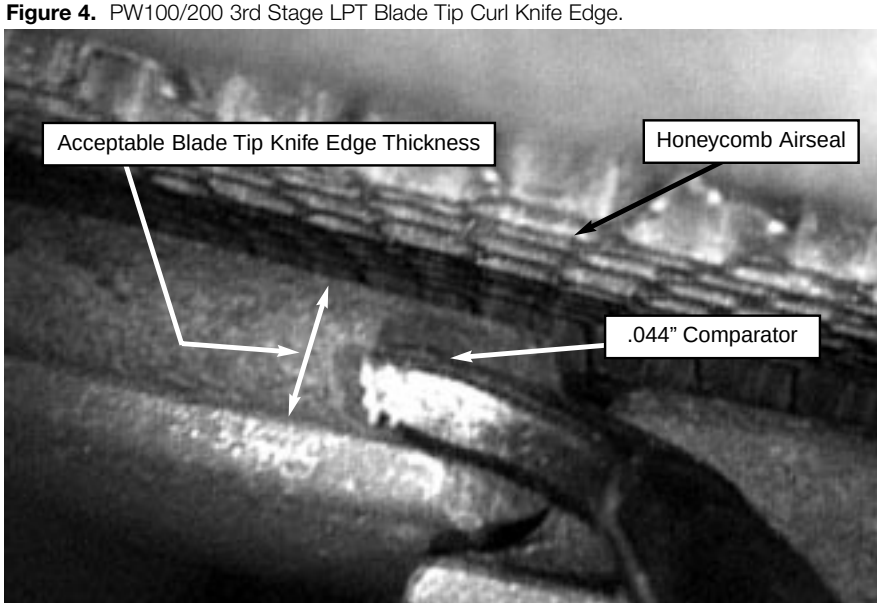
Figure 4. PW100/200 3rd Stage LPT Blade Tip Curl Knife Edge.



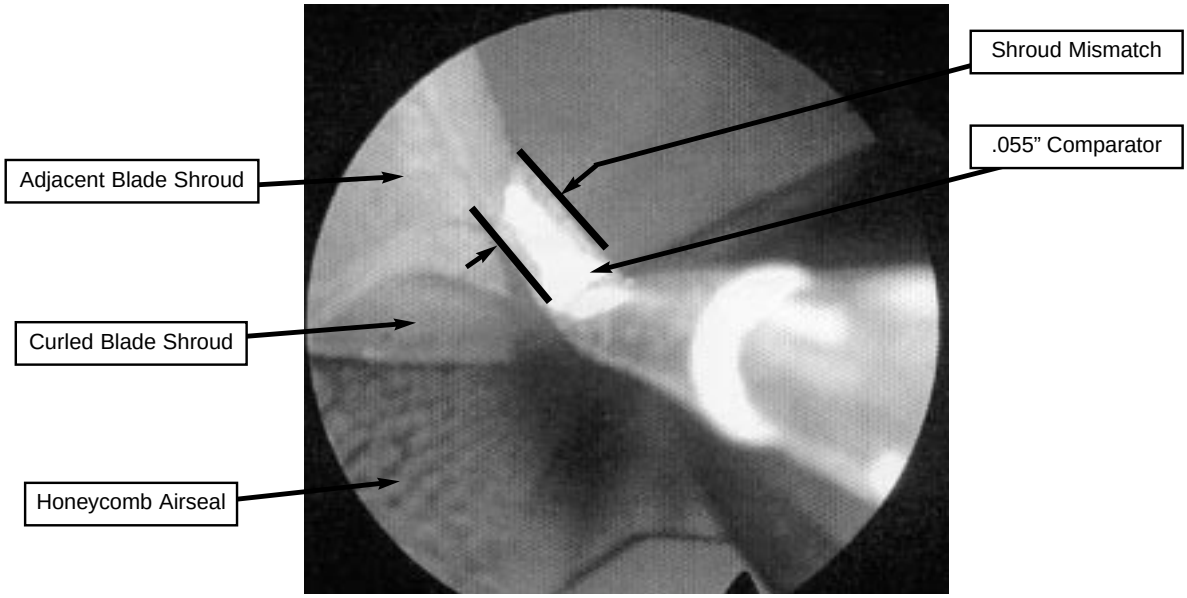


Figure 5. PW220/E 3rd Stage LPT Blade Tip Curl Inspection Using .055" Comparator.

Different blades may have slightly different material properties and curl at different rates.

because different blades may have slightly different material properties and curl at different rates. If you find a knife edge that is worn down to the platform, congratulations! You've found rejectable curl! That being said, please be aware that as of the writing of this article, there is a proposed T.O. revision to this inspection which is scheduled to come out in June 2000. Remember what I said about using *current* tech data? This proposed change will require use of a comparator to actually measure the knife-edge thickness. The comparator is just a calibrated piece of wire (in this case, it is 0.044 inches thick) that goes through the borescope. You'll lay the wire up against the backside of the knife edge, and compare the thickness of the wire to the thickness of the knife edge. A knife edge that's thicker than the comparator means the blade is okay; thinner than the comparator and the blade is a reject. If this T.O. revision is approved and accepted for use in the field, Figure 4 shows how an acceptable knife edge would appear when viewed through the borescope.

For PW220/E-powered aircraft, the inspection is performed on the front side, or leading edge, of the blade through the AP6 borescope port. What you're looking for as an indicator of curl here is mismatch between adjacent blade tip shrouds. Per the inspection instructions, you will need a 0.055-inch comparator to gauge the rejectable mismatch. Lay the comparator gauge on the inner diameter of a blade shroud and compare the thickness of the comparator to the difference in height between the tip shroud of the blade being measured and the adjacent blade tip shroud. See Figure 5. Is the difference in shroud heights greater than comparator thickness? If so, you have a reject. Slowly, with someone turning the low pressure turbine, measure each and every blade with the comparator. It is very important that you do not try to "eyeball" this inspection, as different viewing angles can give the impression that all blades are OK when they aren't.

You're the Last Line of Defense

Experience has shown that repeated awareness training for this important inspection is required for inspectors to maintain their proficiency. Pratt & Whitney representatives periodically travel to Air Force bases to give Maintenance Awareness Briefings. When a Maintenance Awareness Briefing comes to your base, please make every effort to attend the session. It will give you updates and maintenance tips on 3rd stage tip curl inspections, as well as many other issues. Your diligence in performing these inspections will help keep the engines running smoothly until retrofit of the REP turbine is completed. ✈

Photos courtesy of author.

"It was a dark and stormy night…"

No, we're not looking for budding novelists, but we would be interested in some good, solid "There I Was" style accounts which teach a good, solid safety lesson. If your story is published in *Flying Safety*, we'll send you one of our new coffee mugs or computer pads*, your choice, in appreciation for your efforts.

We'll even sign you as "anonymous," if you like.

Send your story to:

roodj@kafb.saia.af.mil or

Flying Safety Magazine
AFSC/SEMM
9700 G Avenue SE
Kirtland AFB NM 87117-5670

******Coffee and mouse not included.*

Maintenan

Maintenance Matters Presents...

Eagles and Falcons and Warthogs—Oh My!

Caught in the Eagle's Talons

For every mishap, there's a whole sequence of discrete events that lead up to it. Each of these events is like the links in a chain: Break one of them and you break the chain, preventing the mishap from occurring. This near-deadly mishap was no exception. See if you can spot the links here.

A Pneudraulics tech and three Electro/Environmental (E&E) techs were checking out the anti-skid system on an F-15 Eagle. The Pneudraulics tech was reading out each step in the Job Guide (JG) via interphone and operating/monitoring the hydraulic mule. When the E&E techs got a bad indication during one of the anti-skid checks, they needed to dig into schematics to find the cause of the problem. Since the Pneudraulics tech wasn't needed for troubleshooting, he shut down the mule and left to work another aircraft.

One of the troubleshooting steps required checking wiring, starting with a plug in one of the MLG wheel wells. E&E tech No. 1 went there and manually opened the doors to gain access to the plug, but didn't install safety pins on the doors. During the course of troubleshooting, several actions were taken, and the original problem was fixed, but only one member of the team—E&E tech No. 1—knew of *every* action taken.

Once the Pneudraulics tech rejoined the team, the series of op checks resumed, with him running the mule and reading out steps from the JG over the interphone. Things proceeded normally until an indicator light in the cockpit that should have gone out remained illuminated. E&E tech No. 1 in the cockpit remembered he may not have reconnected the MLG wheel well plug he disconnected earlier and asked E&E tech No. 2 to check it out. When the plug was reconnected, the MLG doors closed on E&E tech No. 2's head and shoulders almost immediately, causing severe injuries.

Each of these techs was trained and certified, with more than 5 years' experience on the F-15. How did they drop their guard like this? Over-confidence? Complacency? Preoccupation? Something else? We don't know. But for all of you with less experience than these techs, this near-fatal mishap is a chilling reminder why we are *required* to follow tech data step-by-step. Tech data "Warnings" and "Cautions" are useless if they're ignored.

For all of you with just as much or more experience than these techs, this near-fatal mishap illustrates why you, too, are required to follow the book. Remember: New maintainers look to you to set the standard for performing safe, quality aircraft maintenance. Do it by the book and they'll follow your example. Do it wrong, and it's difficult to "untrain" a poor work habit out of a troop.

Follow tech data. Communicate. Work smart. Work safe.

Clipped-Wing Falcon

It should have been just another ordinary night on the F-16 flightline. One of the troops was sick, though. He'd been experiencing stomach upset, vomiting, and was physically run-down, but still reported for duty. When asked the usual "Anybody unprepared or unable to perform their regular duties tonight?" question at roll call, he decided he could hack it, and didn't let on he was under the weather.

Nevertheless, while cruising the flightline during his shift, the troop started feeling worse and worse and began missing radio calls. Yup, another wave of nausea was running its course. When the boss caught up to see if there was a problem, he observed his troop "talking to Ralph." Even though the supervisor offered to relieve him so that he could go to sick call, the troop shook him off and communicated that he was still able to hack it.

While cruising the flightline a little while later, this plucky troop became disoriented (a micro-sleep episode, perhaps?) and regained lucidity just in time to see that he

was about to collide with one of his own jets. He reacted to avoid the collision but stomped on the accelerator instead of the brake pedal, and quickly attained ramming speed.

The collision moved the nose of the Falcon 16 feet, resulting in damage to the total temp probe, AOA vane, and radome. The vehicle was totaled, but the driver suffered only minor injuries (another seat belt save!).

Toughness, courage and carrying your own weight are traits we all admire. But don't jeopardize your safety or that of those around you. Know when to call "Time out" or "Knock it off."

Forms Documentation Isn't "Optional"

Know what's worse than asking someone to document your work in the aircraft forms and not following up to ensure it was done properly? Yourself being the one guilty of poorly documenting the aircraft forms—or not documenting the work at all.

If you're ever tempted to skip documenting the 781s (or CAMS/GO81), and the thoughts "*Because it's required*" or "*It's the right thing to do*" don't motivate you, then consider the harm that could result.

Your failure to properly document could lead to equipment damage. It could also do serious damage to your otherwise sterling reputation. However, in a worst case scenario, that momentary lapse in good judgment could lead to someone being seriously injured or killed. Which means you'll *still* have paperwork to fill out: Accident reports, witness statements, stuff like that.

USAF Photo by SSgt Andrew N. Dunaway, II

If the temptation to blow off documenting your work lingers, then think about the following new, fun and exciting things you could experience if you hit the jackpot and your willful neglect causes a serious mishap.

- You'll get to spend lots of quality time with the officers presiding over the Accident Investigation Board who, before beginning the questioning, will first politely ask you to acknowledge in writing that you understand your rights as they've been read to you under Article 31 of the UCMJ.
- You'll get to spend more quality time with the local Area Defense Counsel learning the meaning of terms like "self-incrimination," "willful dereliction of duty" and "pretrial restraint." You'll also attend the course, "How to Write An Effective Personal Memorandum Asking the Court for Leniency in Sentencing, 101."
- In addition to losing sleep and wondering what's going to happen to your career, you'll have to deal with the reproachful looks of the man in the mirror every day for the rest of your life.

'Nuff said?

Crippled Warthog

Now, having thrown in our two cents worth about forms documentation, here's a real-life mishap that should give you additional pause to think twice about documenting your work in the forms.

The troop showed up in the Phase Dock to do a rig check on the A-10's right MLG door. A quick survey of the right MLG door area revealed the door rods were connected but not safety-wired. Also, the outboard pushrod and jam nut were nearly bottomed out. The aircraft forms made no mention of the gear door being out of rig, and the Phase Dock chief stated the rods had been disconnected FOM for re-torquing of the MLG trunions. Based on this information, and per tech data, a rig check—but not a complete re-rigging of the door—was required.

Whether or not the troop had nagging doubts about the door being properly rigged, we don't know, but absent any documentation or information to the contrary, he pressed on with a gear retraction and rig check. All it took was one landing gear "Up" and "Down" cycle to do $20,000 damage to the structure.

Once again: 'Nuff said? ✈

USAF Class A Mishaps

FY00 Flight Mishaps (Oct 99 - Jun 00)	FY99 Flight Mishaps (Oct 98 - Jun 99)
13 Class A Mishaps	26 Class A Mishaps
5 Fatalities	8 Fatalities
8 Aircraft Destroyed	20 Aircraft Destroyed

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

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

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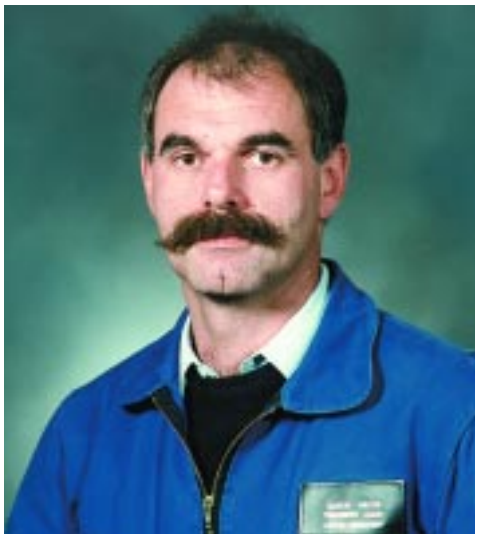
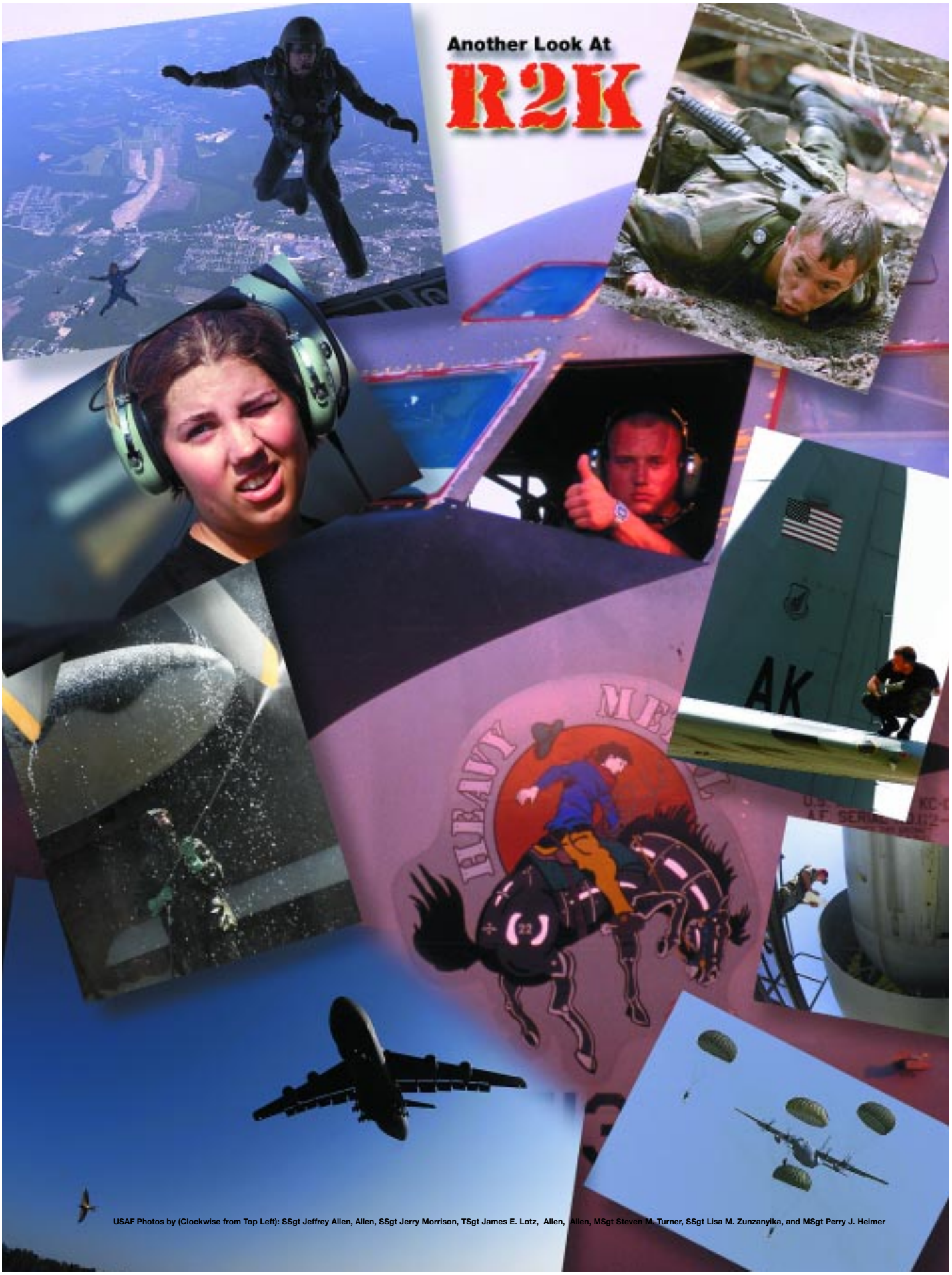


HERR ULRICH MEYER

86th Airlift Wing
Ramstein Air Base, Germany

On 16 July 1998, Transient Maintenance crews were in the process of servicing several aircraft which had been diverted to Ramstein AB because of bad weather at Spangdahlem AB. At 1150 local time, the Transient Maintenance board room operator was notified that an additional diverted A-10 would be landing in a few minutes. Due to maintenance actions being performed on the initially diverted aircraft, the board room operator was unable to make radio contact with the maintenance crews. So, Herr Meyer was dispatched to inform the technicians that another A-10 would be arriving soon. After informing his teammates about the additional aircraft, he proceeded back to the shop.

At the junction between taxiways Alpha and Charlie, he observed a contractor delivery truck on taxiway Charlie heading towards the runway. At this time he noted an A-10 on short final. He did not hear any radio traffic from the vehicle or the tower. It appeared that the vehicle was not cleared into the east Controlled Movement Area. Due to his complete comprehension of this area from his constant vigilance in day-to-day activities, he knew this area on Taxiway Charlie was not in sight of the tower. He accelerated towards the vehicle in hopes of intercepting it before it made its way to the Controlled Movement Area. The driver failed to act on the rotating beacon and flashing of the headlights from Herr Meyer's vehicle, entered the Controlled Movement Area, and continued driving towards the runway. At this point Herr Meyer understood the possible catastrophic situation at hand if he did not act fast, so he immediately radioed the tower to inform the air traffic controllers about the runway incursion. At this time the A-10 was about one mile out. The vehicle continued driving towards the runway and within a couple of seconds after the radio transmission, the A-10 received the message from the tower and executed a go around. The A-10 overflew the vehicle at a safe altitude and came around for an uneventful landing. Herr Meyer's attentiveness to his surroundings prevented a potential catastrophe, but most importantly may have saved human lives. ✈



USAF Photos by (Clockwise from Top Left): SSgt Jeffrey Allen, Allen, SSgt Jerry Morrison, TSgt James E. Lotz, Allen, Allen, MSgt Steven M. Turner, SSgt Lisa M. Zunzanyika, and MSgt Perry J. Heimer