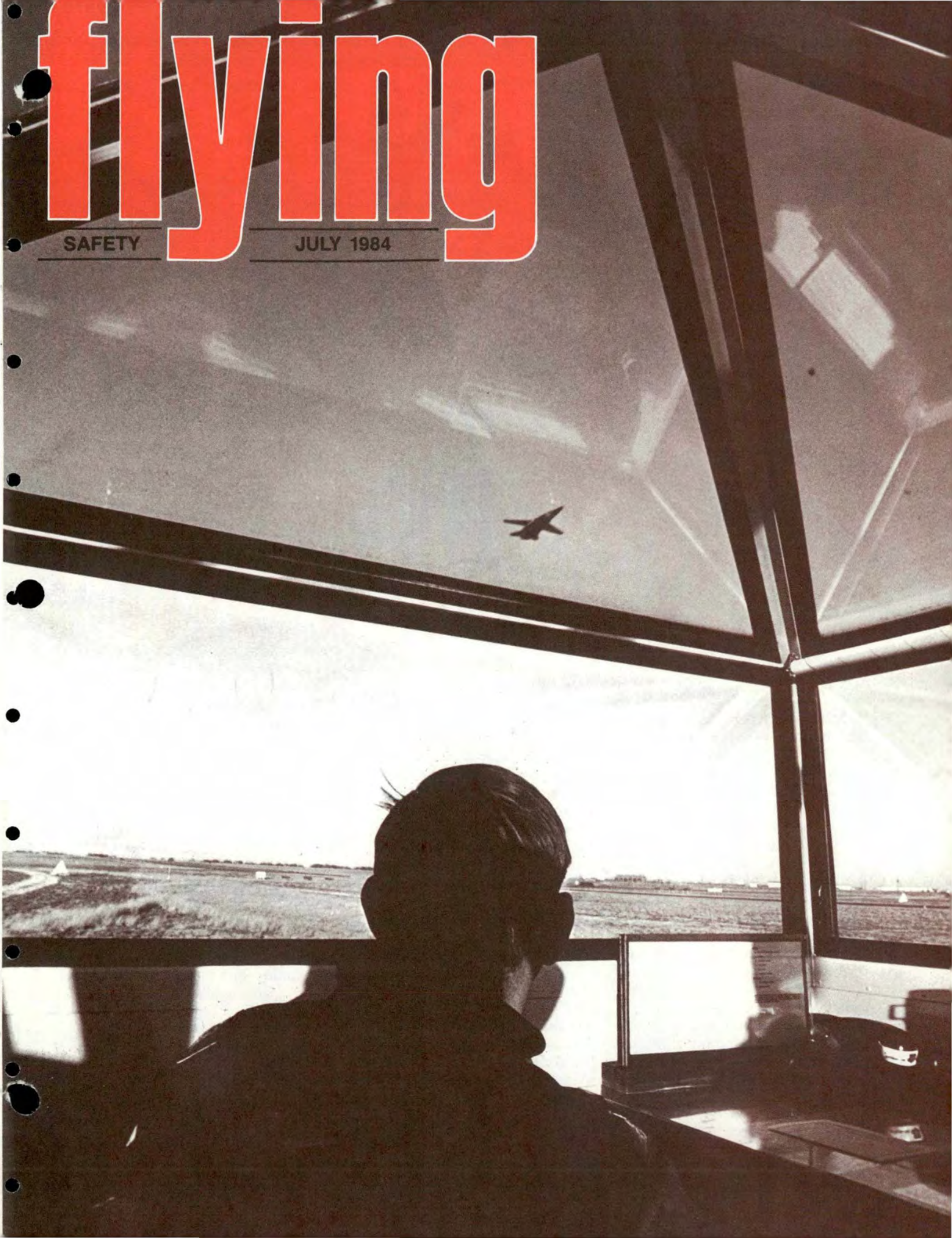
flying

SAFETY

JULY 1984



THERE I WAS

■ As I view my accident-free Air Force flying career from the twilight zone of a retiring 0-6, I realize that only once did I come close to "busting my . . ." That once, I should have bailed out — and didn't. I stayed with the aircraft because I failed to recognize how dangerous the situation really was.

The malfunction/emergency was an engine fire light in a two-engine high performance fighter while in a full landing configuration close in on final approach with weather right at minimums. The dangerous situation resulted from emergency procedures which when executed ("Affected Engine Off/Good Engine A/B/Gear up/flaps up/Go-Around"), resulted in a sink rate that almost exceeded my altitude. I recovered after going off the GCA scope, got back on the glide path and landed single engine in a clean configuration after relowering the gear.

I belive now that each aircraft has a vulnerable zone on final approach (reduced only by pilot proficiency). If you are in a full landing configuration and a malfunction occurs, you must trade altitude for the configuration change to clean the aircraft up. In the case of an "engine under load" malfunction (high drag, high thrust, high temp, high fuel flow, near max bleed air and bypass air, high lube requirements, and generous power changes), you must make the decision to retract/clean up. However, if a "hydraulic system under load" malfunctions (low feel operation, generous flight control movements, configuration change demands on the system, increased yaw/roll augmentation and by-pass actuators active), most flap systems fail to "trail" position and the configuration change, uncommanded, will occur in close proximity to the master caution light illumination.

Operations under circumstances involving high drag/sink rates, single-engine and close proximity to the ground, are hazardous to your health. In 25 years of flying, nothing — not even combat — has captured my attention like the day I fell out of the bottom of an overcast which I knew to be at minimums. I spent a major portion of my career practicing recoveries with an eye on the altimeter after that day.

For an uncommanded retraction, a 350′ loss is average (pull the flap C/B and see), and a 250′ loss is excellent. Engine and hydraulic sysems fail most frequently when operating, and maximum operation occurs during take off and landing. If the type of aircraft you're flying will not stay airborne in a full landing configuration on one engine with A/B, and, like me, you anticipate retiring, you had better practice your recoveries with emphasis on minimum altitude loss. ■

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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It's YOUR Privilege

MAJOR JOHN E. RICHARDSON
Editor

■ Captain Mark Stevens glanced at his watch for the sixth time in 5 minutes. He gazed around the small office in which he was waiting. A typical base office with an old desk, two ancient chairs, a telephone, and a faded print of an airplane on the wall. Opposite the airplane picture was a closed door. Mark stared at that door again as if trying to see through it.

Outside, an aircraft roared on the flightline, shaking the windows and filling the small room with noise. The noise covered the sound of the door opening, and so Mark was a bit startled when the major standing in the open doorway addressed him: "Captain Stevens, come in, please."

Mark stood up and nervously adjusted his blues. He felt much more comfortable in his flightsuit.

Walking through the door past the major, Mark found himself facing a long, grey, Air Force table. Behind the table were six chairs, five of them filled by officers of various ranks. The major who had called Mark into the room closed the door and returned to the empty chair behind the table.

As he took his seat, the colonel seated in the center chair spoke. "Good morning, Captain Stevens. I'm Colonel Brown, the mishap investigation board president. Please have a seat. We would like to ask you some questions about the aircraft mishap which happened last week. But, first, I want to assure you that anything you say will be kept confidential and will be used only for safety investigation purposes. Your statement will not be disseminated outside the Air Force or used as evidence in disciplinary actions or adverse administrative actions such as a Flying Evaluation Board. Nor will it be used to determine line of duty status, pecuniary liability, or elimination from the Air Force. We will use it only to determine all the factors relating to the mishap and to prevent recurrence. Do you have any questions?"

Mark nervously shook his head. "Fine. Now we have the statement you made and signed last week, but we would like to go over the mishap again. Would you please start at the beginning and tell us what happened?"

Later, Mark was sitting in the Officer's Club staring at his untouched glass of beer which was slowly going flat. Then he felt a hand on his shoulder, and his neighbor, Major Walt Allen, dropped into a chair beside him.

"Hi, Mark. Why so glum? You look like you've lost your best friend."

"Hi, Major. I was just thinking about my session with the safety board this morning. They told me all about the confidentiality of my statement and how it won't be used for anything but safety purposes. Still, I'm just some captain fighter jock. I told the Board everything I knew about the crash. Do you really think that what I told them will be used just for safety?

Walt Allen took a sip of his beer and then started. "Well, Mark, I'm a lawyer, not a pilot, but I do know that the Air Force is dead serious

The Air Force is dead serious about maintaining the confidentiality of witness statements to a safety investigation board.

about this guarantee of confidentiality. They will not release witness statements under any circumstances, even to help the Air Force itself in a lawsuit. And they back it up all the way to the top, if necessary."

Mark looked at his friend rather skeptically.

Major Allen continued, "Perhaps the best way to make my point is to tell you about a case that was recently decided. I just read the brief this morning.

"Some years ago, an Air Force pilot was injured when he ejected from an F-106. The pilot sued Weber Aircraft who designed and manufactured the ejection equipment. To defend itself, Weber requested that the court (under what are known as pretrial discovery procedures) order the Air Force to give the confidential portions of the safety investigation report to Weber. When the court refused to do so, Weber requested the same information directly from the Air Force under the Freedom of Information Act. When the Air Force refused the request, Weber sued the Air Force.

"At the Federal District Court (for the Central District of California) the judge held that the Air Force was correct in withholding the mishap investigator's findings, conclusions, and recommendations, as well as the statements of witnesses given in confidence. The 9th Circuit Court of Appeals agreed about the investigator's findings, recommendations, and conclusions but disagreed on the confidential witness statements and ordered them released. The case was then appealed to the Supreme Court.

"The Supreme Court in a rare unanimous decision reversed the Court of Appeals and found in favor of the Air Force. The Court held that confidential witness statements are the type of information that Congress intended to be covered by the exemption to the Freedom of Information Act which allows the government to withhold certain kinds of intra- and interagency memoranda or letters."

Major Allen paused for another sip of beer and to nod to a grey-haired major in a slightly rumpled flightsuit who had just slid into the third chair at the table.

"The Court noted that Weber had been provided a copy of the accident or 'collateral' report — the one we in the JAG's office conduct under AFR 110-14. They had also been given the factual Part I of the safety report. The only thing withheld was the Part II — the one which contains the witness testimony and statements and the deliberations of the Board.

"You know, FederalCourts, with the exception of the 9th Circuit Court of Appeals, have upheld the Air Force's withholding of witness statements for over two decades. The real importance of this decision is that it affirms the Air Force's position that witness statements like yours do not have to be released."

The newest member of the party spoke up. "But that's not the whole story."

Mark and Walt turned their attention to Major Jack Crossman. Jack had been flying fighters for 13 years, and for the past two, had been the wing's Chief of Flight Safety.

Jack continued: "Mark, the Air Force is really serious about protecting safety information. The regs actually make it a court martial offense to release limited use safety information to unauthorized individuals. But what's more important is that the regs also absolutely prohibit the use of that safety material for any sort of disciplinary action. When you talked to the Board this morning they told you that, didn't they?"

"Yes, but . . ." Mark started.

"Well, believe it," Jack interjected. "You may hear a lot of rumors about guys getting hung by what they told the safety board. That's not the case. Remember, there are other investigations, the 110-14 board for example. They have access to the facts, but they can't use Part II of the safety report."

Mark was starting to look a bit relieved and was even thinking about a fresh beer as Jack Crossman continued.

"There was a lot of effort that went into preparing and winning the Weber case for the Air Force. Now we have to do everything we can to be sure that this effort isn't wasted. Many of us in the flying business routinely have access to privileged safety material. This is OK because we need the information to do our jobs. But if we don't use care or if we aren't absolutely sure that we're protecting that information properly, we're compromising the Air Force's position. If those who are not authorized gain access to privileged safety information — particularly if they get it because of our negligence — it will be a lot more difficult to protect despite our success in the Weber case."

Jack leaned back and waved at some pilots who had just come in and were heading toward the bar.

"You know, Mark, the concept of privilege is a cornerstone of our aircraft mishap investigation and prevention programs. The Air Force will go to the wall to protect it, but those of us in the Air Force must give our support, too. Now, if you will excuse me, I see a certain lieutenant colonel over there who needs to pay up for his lack of proficiency on the range today. See you later."

Jack rose and headed toward the other side of the room in search of the latest victim of his unerring skill on the bombing range. Mark, feeling much more relieved about his experiences of the day opted for a steak dinner downtown rather than another beer. He thanked the JAG and then, with a smile on his face, walked briskly out of the club. ■

COCKPIT COMMUNICATION

CAPTAIN BRUCE GOLSON
93 BMW
Castle AFB, CA

■ Cockpit communication in the KC-135 can make or break a mission. In 8 years of experience as a copilot, aircraft commander, and instructor pilot in the tanker, I have had the opportunity to observe and train many crews — some successful, some not so successful. The element that seems to make the difference between levels of success is called "crew coordination." The essential ingredient in crew coordination is *cockpit communication.*

You've probably heard the story of the pilot who looked over at his copilot, who appeared to be a little "down in the dumps." As they started their take off roll, he said to the copilot, "cheer up." The copilot was prompt to comply with his bosses wishes, and as the engineers would say, "the airplane's coefficient of friction with the runway went off scale at the top end." In other words, the crew discovered their error when they couldn't taxi, even with military power!

That's a story we can all laugh over, and I'm sure we can all think of other cockpit communication scenarios that have been just as disastrous or have had the potential for disaster. I can think of several of my own experiences that might help us understand how lines of communication get crossed. Then we will attack the problem of how to improve cockpit communication in the interest of safety.

One event that comes to mind is a technique I had for landing in a stiff crosswind. I was a young aircraft commander, and on this particular day our landing was to be in the stiffest crosswinds I had ever faced. I was somewhat apprehensive about the landing, naturally. I was concerned about the lateral and directional control combination. This is tricky in the KC-135, since you can't land in a crab, or with much bank. Also, the sweepback angle on the wings intensifies the aerodynamic effects of crosswind sideslip. So, I arranged to have my copilot work the power. In fact, that is how I said it. "I'm going to have

Cockpit communication can make or break a mission.

my hands full of yoke, so you handle the throttles."

To make a long story short, with much perspiration I got the airplane in a good position to land and yelled across the cockpit "Power!" You guessed it, we went around! Because of my lack of clarity in briefing my copilot, and because he had probably never seen the control gyrations required in a stiff crosswind, "power" meant something completely different to him. We were fortunate that all turned out well, once my mind was set for a go-around. All I had to do was another approach in those nasty winds — and guess who handled the throttles?

Think for a moment of the consequences if I had decided to land anyway. I might have released a bunch of aileron crosswind control getting to the throttles, and I surely would have left a lot of runway behind me where it's no good to anyone. Or worse yet, what if I were having trouble with the controls in the landing flare and had decided to take it around, yelling "power" to my copilot. If he had interpreted my command as "power back," and pulled the throttles to idle, we would have been on the ground, quite possibly out of control, and with no option but to ride it out. Incidentally, that second "what if" did occur in a KC-135 recently — minor damage — a dented engine pod.

Instructors are in a more vulnerable position than crew commanders for having their commands misunderstood, because the new guys are not familiar with the various mission terminology, flight profiles, and control nomenclature. I have some of my own examples of communications breakdowns between instructors and students.

The first one occurred during the student's first flight in the KC-135 as a new copilot. We had discussed all aspects of the mission, including touch and go landings, as thoroughly as possible — so I thought. I told him that I would handle the throttles for the first few approaches and landings (my normal technique). Once he got the feel for the control responses, I would allow him to handle both aerodynamic controls and throttles. We had briefed throttle techniques, and he had practiced them in the simulator. He was also aware of what configuration changes were to be made on the runway during the touch and go, and the fact that I, the IP, would make them.

Perhaps I should explain the touch and go procedures before we continue. We normally land with 40° or 50° of flaps and lower the nose wheel after touchdown on the main gear. The copilot, who is flying the airplane in this instance, "stands up" the power — about half open throttles — to allow the jets to spool up. The IP raises the flaps to 30° and resets the stabilizer trim. He then checks the engine instruments to make sure they have all spooled up together and there is no asymmetric thrust. If the engines have all accelerated, the IP tells the copilot to "push them up." The copilot sets a previously calculated touch and go power setting. The IP then calls "rotate" once the aircraft is stable and has reached minimum rotation speed.

Now the stage is set. My young jet jock in the copilot's seat was doing well on his first couple of approaches and landings with me handling the power. So I gave him the throttles for his next approach and landing. He was a little behind on his throttle movements, but with some verbal coaching he was getting the hang of it. He touched down and did well working the throttles on the runway, until he "pushed them up." He went too far — towards the point of *overboost*. So I said, "That's plenty." You guessed it. My young copilot grabbed the flap handle and raised the *flaps* to 20°! I didn't even notice until after we were airborne, since I was busy with the power and had previously

Any successful mission requires crew coordination. The essential ingredient in crew coordination is cockpit communication.

COCKPIT COMMUNICATION continued

set and checked flaps at 30°. Fortunately, we were light enough to fly out of it, but it sure taught me a lesson in communication.

Another instance occurred later on in the training program with a different copilot. This guy was pretty strong as a student also. His landings had been consistently good, but I felt he was using up too much runway by being a little slow lowering the nosewheel to the runway. So, I critiqued him on this minor point as we briefed the next approach. I was pretty relaxed with this copilot, even in the landing phase, since he'd been doing so well. I was taken completely off guard when he dumped the nose forward just before we touched down. He wasn't going to be late lowering the nosewheel! I took the airplane, pushed in power, and pulled back on the yoke at the same time, but I wasn't able to keep the nosewheel from touching first. It bounced back and hit on the main gear, then the nose gear again, etc., etc.

We were in a porpoise and the magnitude of each successive runway contact became greater. That had to be the longest 8 seconds of my life, waiting for the engines to spool up and fly us out of that jam; and it was because I chose the wrong time to critique my student.

I found out later he thought he was making a "gross" error in lowering the nosewheel, when, in fact, the error was a very minor point of technique. I chose the wrong time by mentioning this to him in the cockpit during flight. It would have been much better to discuss it with him after our final landing and explain my reasoning — that keeping the nosewheel up in the air after the mains touch down uses up runway, because he can't use speed brakes or wheel brakes until the nosewheel is down.

One last scenario. This did not happen to me, but certainly could have because I have used the same imprecise terminology. The instructor watched his student get low on glide path for landing. He was also hot on airspeed. So the instructor said, "raise your nose a little bit." Nothing happened — same glide path, still hot. "Come on, raise your nose up." Still no change in the aircraft attitude. "OK, Bill, can't you see you're low; let's get that nose up." The instructor looked over at his student just as he began to complain, "But, sir, I can't even see my instruments with my nose up so high!" The instructor finally saw whose nose he had caused to raise with his unsuccessful verbal instructions!

The KC-135 requires a four-man crew to fly a tactical (air refueling) mission. There are two pilots, a navigator, and a boom operator. Our communication inputs and outputs are the intercockpit interphone and two radios, one for ATC communications, and one for tactical communications. Communication on the radios is beyond the scope of this article, but it certainly is relevant when it interferes with cockpit communication, or cockpit communication interferes with radio communication.

While instructing at CCTS I compiled data on three student crews at the same point, two flights prior to their checkrides. I counted missed radio calls. There was an average of 12 missed radio calls per sortie with an average flying time of approximately 6 hours. That's about two missed calls each hour. Although I didn't keep records, most of these missed calls were because interphone calls or calls on the other radio were covering them up.

At this point, I'd like to delineate some phases of the tanker mission where cockpit communication becomes critical. The first is take off. It's a complicated maneuver at a low airspeed and angle of attack with limited thrust. It requires close to 2 miles of runway with a heavy airplane. To complicate matters, about 20 percent of that thrust will be lost in about 2 minutes after initial power application for take off. This is because water injection will run out. Therefore, configuration changes must be made according to a strict altitude and airspeed schedule. Let's examine communication in a normal take off.

First, the pilots should listen to ATC and the interphone only — not the tactical radio. The pilot is flying. On the runway the copilot calls "S-1." The pilot should decide that take off is committed, unless the aircraft is incapable of flight. The copilot then calls "rotate." Both calls are required to be over the interphone. The pilot rotates, and when climb is established he calls "gear up." The copilot raises the gear. (Gear up is not a required interphone call. The pilot only needs to call for the gear to be raised.) My contention is that the call should be made over the interphone, specifying the exact configuration change (i.e., "gear up" rather than just "gear"). This should apply to all configuration changes.

After the gear is up, the pilot accelerates to and maintains a precomputed climb speed. The copilot can help the busy pilot by announcing this climb speed to the pilot across the cockpit. This directs his attention to the airspeed indicator as a performance instrument. He should announce it across the cockpit rather than over the interphone to eliminate cockpit distractions.

The flaps are raised at a pre-computed "clean-up" height. The copilot should call approaching this altitude, again across the cockpit, to direct the pilot's attention to the altimeter and avoid cockpit distraction. This level off height, and an equally important interphone call by the navigator, "110 seconds of water," ensures that the pilot reduces his climb rate, accelerates, and calls "flaps up" prior to the water running out. Again, the copilot can help by announcing the flap retraction speed(s) across the cockpit.

The idea is to minimize chatter over the interphone by making only the required calls and configuration changes. Maximum help to the pilot across the cockpit is achieved with well thought out key phrases. Basically, these principles apply to all flight phases.

During climb, cruise, and descent, the Dash 1 directs the pilot to announce any altitude change over the interphone. The crew need not acknowledge unless an error is detected. This is good policy because it includes the crew in the loop of detecting errors, while minimizing cockpit distractions. Altitude calls approaching the level off altitude must be made by the navigator, or copilot, if the navigator misses them. These must be acknowledged by the pilot.

Those calls are all good policy, but one essential element in cockpit communication is lacking, and it is up to the pilot to establish the atmosphere. The pilot must make it absolutely clear that if anyone hears a clearance differently than he does, or if an error is detected on a departure, cruise, or letdown procedure, the crewmember should speak up. Further, he, the pilot, should ensure that someone queries ATC or reexamines the FLIP publications, even

continued

Air refueling is a complex, demanding mission for both tanker and receiver. How do we make sure that the interplane communication channel is open? By keeping internal cockpit communication to a minimum during critical phases of the refueling.

All the techniques and procedures discussed here for KC-135s apply equally to other multiplace aircraft. There is also valuable information here for tactical fighters. The concept of clear cockpit communication is even more important when applied to communication between members of a tactical formation of fighters.

COCKPIT COMMUNICATION continued

if only one crewmember saw or heard it differently. This technique does not undermine the pilot's authority, but it certainly increases the crew's involvement and definitely enhances safety.

Air refueling is the next phase of flight for consideration. Without going into the details of the rendezvous, which involves considerable cockpit and outside communication, we will talk about air refueling itself.

Air refueling involves an aircraft flying very close trail behind a tanker. The boom operator must have "clear channels" to announce deviations from this "close trail" formation. If the receiver gets too close, or his rate of closure is too great, the boom operator calls "breakaway, breakaway, breakaway" over the air refueling (tactical communications) frequency.

Both tanker and receiver pilots need to hear this call. If either or both of them do not hear the call, a midair disaster is possible. How do we ensure the communication channel is open? We keep cockpit interphone chatter at an absolute minimum. Only the information which is essential is verbalized, and then it should be done across the cockpit as much as possible. Even the navigator can talk across the cockpit to the pilot if he yells loud enough.

The last phase of flight is the descent, landing, and traffic pattern. The pilots should listen only to the ATC radio and the interphone during this phase. If tactical communication is necessary, the navigator or boom operator can handle it. Interphone conversation, again, should be kept to the minimum required.

The Dash 1 certainly requires enough mandatory interphone conversation. Each approach must be briefed to the crew. Each checklist must be initiated and terminated over the interphone. Altitude clearances need to be echoed to the crew. The navigator, or copilot must make several "approaching (altitude)" calls at different points prior to level off. The pilot must respond to these altitude calls. The altitude calls once down close to the ground are the most important.

Approaching minimums (about 100' above) the navigator or non-flying pilot says "approaching 356 feet." The copilot then announces decision height, or minimum descent altitude ("MDA") and visual descent point ("VDP"). The pilot must then make a decision, and call "initiating go-around" or "landing."

These calls, especially the ones close to the ground, are logical, fairly simple, and standard. They enhance safety if used properly, but much more interphone chatter is distracting to the important tasks of flying, watching for traffic, checklists, safety checks, and ATC communication.

In summary, my recommendations to crews are to develop cockpit communications in an orderly fashion. Do as much communication across the cockpit as possible. Limit interphone conversation to that which is actually required by the Tech Order or is necessary in the interest of safety. Keep interphone calls short, using standard terminology or short, easily recognizable phrases in the absence of a standard. Even doing a mandatory approach briefing, keep it short, and pause to listen for incoming calls. For example, "Crew, ILS approach," pause, "By the copilot," pause, "Course 305°," pause, "decision height 504 feet," pause, etc.

Instructors should use short, well thought out, key phrases that communicate. These phrases should be used in briefings before flight, so the student knows what you mean when you spring it on him in flight.

Practice of new techniques which involve verbal coordination should be on a nice VFR day, not when the crosswinds are gusting to 25 knots with a 200 foot ceiling.

Our objective should be better communication as a crew so coordination is more effective. This will enhance safety. So, cheer up, will you? ■

ASIP is Not a four-letter word

JOSEPH F. TILSON
Structures Engineer
Directorate of Aerospace Safety

"The time has come, the walrus said
To talk of many things:
Of shoes — and ships — and sealing wax —
Of cabbages — and kings — . . ."

"Through the Looking Glass," Lewis Carroll

■ It might be wiser to attempt to explain cabbages and kings, but, wisdow not withstanding, we shall step through the looking glass into the confusing world of the aircraft structural integrity program (ASIP). We shall pause only briefly along the way to point out such things as data collection, crack growth analysis, fatigue-critical locations and arrive home free with a force structural maintenance plan. The world of ASIP stretches across the entire life of an aircraft and touches almost everyone who is involved with design, development, operations, and logistics support of the aircraft system. When one looks at the complex elements and the many variables of the program, it is no wonder we feel like Alice in Wonderland. So let's start with a few of the basics through an analogy that we can all relate to.

Assume you are the owner of a medium-sized newspaper firm. You just spent your 5-year cash reserve fund for the purchase of 100 small (½-ton) pickup trucks. You shopped around for these trucks and told all the manufacturers that they would be loaded fully (½ ton) and driven approximately 20,000 miles each year and must last for 5 years. Each manufacturer assures you that his truck is perfectly capable of carrying ½-ton loads for 100,000 miles of city street driving. You decide to buy the little "Kadota" because it will be cheaper to operate. Early fleet replacement or sudden unexpected costs could be disastrous.

If you gazed into the future and saw each little Kadota carrying 1,000 pounds and being driven 100,000 miles over city streets in 5 years time, you are not aware of that old Chinese proverb, "He who lives by the crystal ball, learns to eat ground glass." What is probably going to

continued

ASIP Is Not

happen to your fleet is as follows. Fifty are going to carry 1,000 pound loads for 100,000 miles over city streets; 25 are going to be used for administrative urgencies such as fetching coffee and doughnuts and transporting Miss Foggy Bottom to the ceremonial opening of the new metro station; and 25 are going to be loaded with 1,500 pounds and driven over 100,000 miles of unpaved road in and around Mt St Helens.

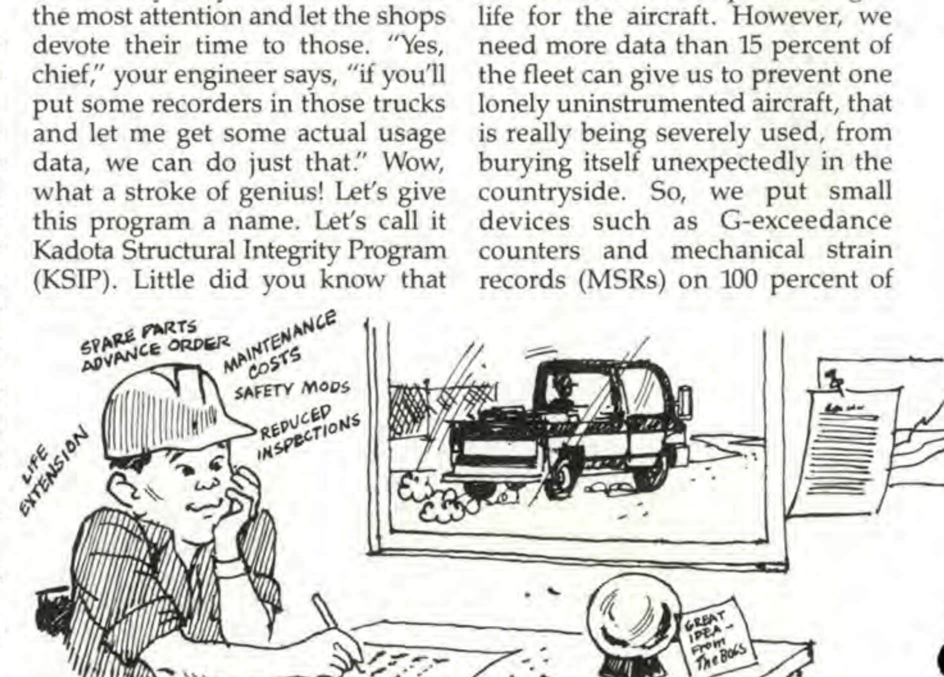
Now, if you make no plans for these differences, you are in for a surprise. However, if you are smart, you keep your office on the first floor with a swinging door to the chiefs of maintenance and engineering.

The chief engineer tells you "the good news is that 50 of your trucks will last at least 5 years, and 25 will definitely last longer and not require replacement for 6 or 7 years. The bad news is that 25 will break down early, resulting in an injury lawsuit or costly repair in 2 to 4 years." Your chief of maintenance tells you "most of the Kadotas are great, but these periodic inspections at 5,000-mile intervals are knocking us out." Because of your great insight and your aversion to eating ground glass, you ponder the following questions.

- Can you tell which trucks carry 1,500 pounds?
- Can you tell which trucks traverse Mt St Helens?
- Can you measure the damage due to overweight?
- Can you measure the damage due to the volcanic roads?

Your engineer tells you that if you could do these things, then he could develop a computer model that will predict, with reasonable accuracy, when each truck will become unsafe or require a major structural modification. He could also predict in advance what structural changes will be necessary to keep the fleet safe. You can use this information to buy spare parts. You can predict exactly how much longer than 5 years the admin trucks will last. You can analyze the failures in advance and design a structural mod to extend their life even beyond 5 years (watch it, you're on a roll now). You can even stop the maintenance shop from inspecting every 5,000 miles because the mileage reading is not the critical item; it is the type of actual usage that counts, not miles. You can identify the yard birds that need the most attention and let the shops devote their time to those. "Yes, chief," your engineer says, "if you'll put some recorders in those trucks and let me get some actual usage data, we can do just that." Wow, what a stroke of genius! Let's give this program a name. Let's call it Kadota Structural Integrity Program (KSIP). Little did you know that your chief engineer was leaving the next day for the great 5-sided building with a plan called ASIP.

Now, let's take this little truck analogy and trash it up with all of the DOD acronyms and technological baloney. The result is ASIP. First, we place fairly sophisticated recorders on approximately 15 percent of our fleet. These recorder-equipped aircraft are spread around so they collect a broad range of actual usage data. These data are used to develop *actual usage* mission profiles. We compare it to the *design usage* profiles the manufacturer's structural engineers used when they built the aircraft. Here we can see if we use the aircraft more or less severely than originally expected. These actual usage profiles are used with other design and test data to predict structural damage and to calculate an expected fatigue life for the aircraft. However, we need more data than 15 percent of the fleet can give us to prevent one lonely uninstrumented aircraft, that is really being severely used, from burying itself unexpectedly in the countryside. So, we put small devices such as G-exceedance counters and mechanical strain records (MSRs) on 100 percent of



the fleet and have the troops fill out Individual Aircraft Tracking Program (IATP) forms. These forms are processed by the Oklahoma City Air Logistics Center computer and reveal how each individual aircraft (by tail number) is being used and from that it is possible to calculate how much damage each aircraft accumulates on each flight.

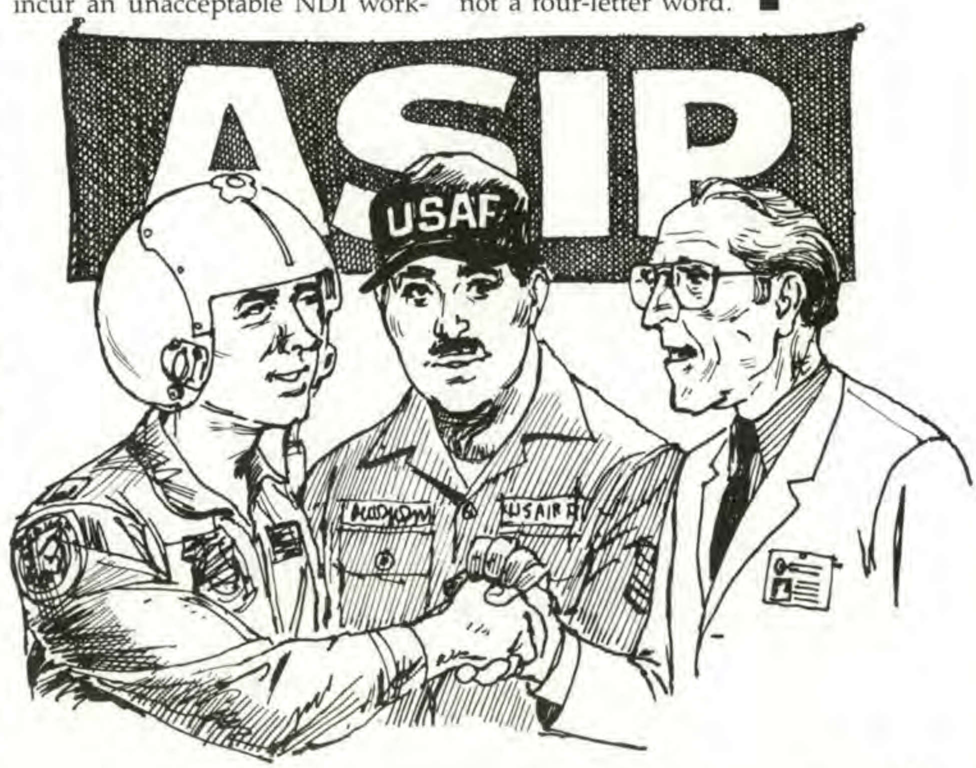
The structural engineers have tested and analyzed each aircraft design and identified what they call fatigue-critical locations or control points. Computer records are then established for the actual damage accumulated at these control points on every aircraft. As the data from the IATP form come in, these damage records are updated for each aircraft according to its actual use. The system program manager (SPM) can then prepare a document called a Force Structural Maintenance Plan which he uses to: schedule safety inspections; consolidate work for maintenance workload reduction; schedule life extension mods; program PDM inputs; recommend equipment rotation and mix to operators; advance order spares support; plan replacement procurement; develop funding requirements; and develop new design requirements.

If the SPM did not have such a document, he would be forced to "play it safe" and require many more safety inspections. In spite of these extra inspections, he could still be caught with the catastrophic failure of a worst-case manufacturing flaw that comes off the production line and grows to critical size very early. It is the actual usage data that enables him to do a crack growth analysis and predict when to expect a worst-case flaw failure. He cannot safely plan for life extension if he hasn't got actual usage data to forecast expected damage.

In case, by now, you don't see how ASIP affects you, let's take a look at an actual occurrence. During the development of one particular aircraft, it was analytically determined that the *expected design usage* would result in the center wing developing a large number of small, widely distributed cracks at just about the end of its 6,000-hour design life. Wise management equipped a large population of early production aircraft with MXU-553 recorders when they were delivered to the operational units. An early look at the recorded *actual usage* data indicated that the operators and designers who developed the expected usage mission profiles were "out to lunch" the day that task was performed. In short, the widespread cracking was not going to occur around 6,000 hours at the end of its required life. It was going to occur around 4,000 hours and cut the life by one-third.

At the same time, a worst-case analysis revealed that in order not to risk losing one of our nation's finest, we would have to inspect a couple of thousand holes in each aircraft center wing every 2,000 hours. Since the number of aircraft would run over 700, it was concluded that this would probably not sit well with the nondestructive inspection (NDI) shop. Rather than incur an unacceptable NDI workload to protect against the loss of a worst-case aircraft, it was decided to redesign the center wing section at the factory and structurally modify at the depot all center wings which could not be corrected on the production line.

It is common knowledge that the recorders are a nuisance for everyone concerned. They interfere with sortie generation, create ops and maintenance workload, malfunction frequently, and provide very little operational feedback to the user. Considerable effort is being expended to improve their reliability and make the ops/maintenance workload reasonable. Until such time as we can develop a more trouble-free, solid-state recorder, we are going to have to live with what we have. Take another look at what the SPM does with the data and you'll see that you can only lose if you don't help provide the data. The SPMs are looking long and hard at ways to reduce your recorder workload, improve malfunction on response time, and provide the operators with useful feedback information. Hang in there — help is on the way. ASIP is not a four-letter word. ■



IFC APPROACH

■ Because of a large number of recent instrument related incidents where aircrews were either unfamiliar or unsure of the correct instrument procedures to follow, we at the Instrument Flight Center would like to clear up some of the "gray areas."

Q Refer to the HI-VOR or TACAN RWY 22 at Amarillo International depicted below. Can a TACAN equipped aircraft use 10 DME in place of the depicted 10 NM fly-off?

A Yes. The intent in the approach design is to fly the depicted ground track for 10 NM. It can be accomplished by timing, (VOR only equipped aircraft) or by use of DME when available. A change has been submitted to this IAP showing both DME and nautical miles for the fly-off. Other approach fly-offs may be changed in the future to include both DME and NM distances after review/validation by approach designers.

Q Refer to the TACAN RWY 32 at Dover AFB depicted below. When can you depart the 1,700 feet restriction depicted at 9 DME on the 142° radial?

A Descend when you begin to turn off the 9 DME arc. The turn and descent could be initiated at the depicted lead radial, at a lead radial you have computed for your aircraft, or upon arriving at the 142° radial.

Q You are established in a holding pattern depicted on a published DOD High Altitude Instrument Approach Procedure and are "cleared for the approach." Can you immediately accelerate to and maintain penetration airspeed until departing the holding pattern?

A Yes, you may accelerate. Once you are "cleared for the approach" holding procedures no longer apply.

Q You are approaching the IAF with an intercept heading of 120° to the penetration course and are "cleared for the approach." May a lead point be used to start the turn to commence the approach or must the IAF be crossed prior to starting the turn?

A In this situation, assuming no further clearance, the IAF must be overflown prior to starting a turn to

Figure 1

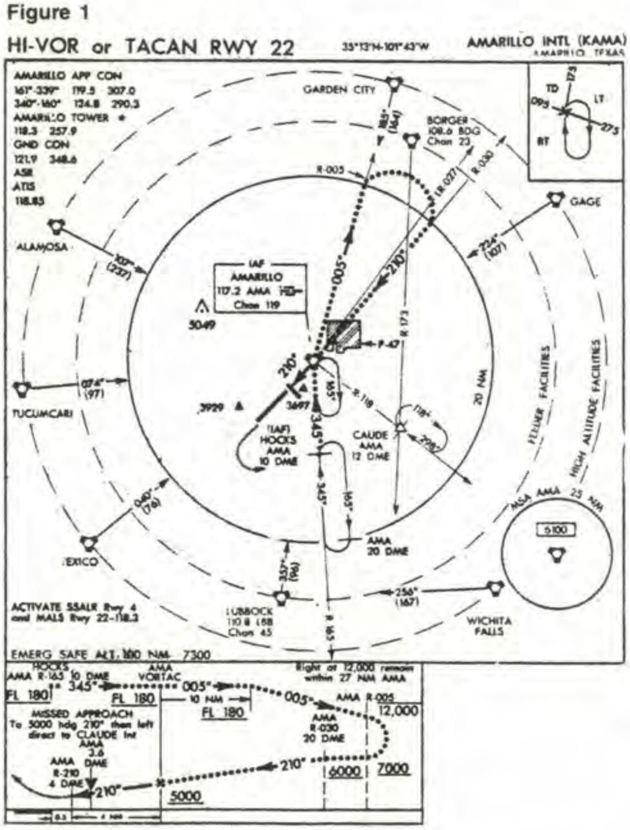
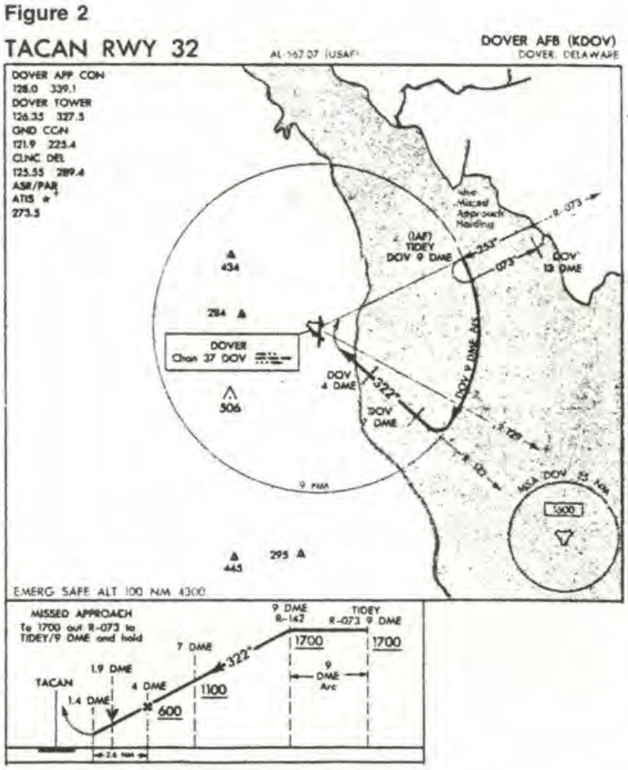


Figure 2

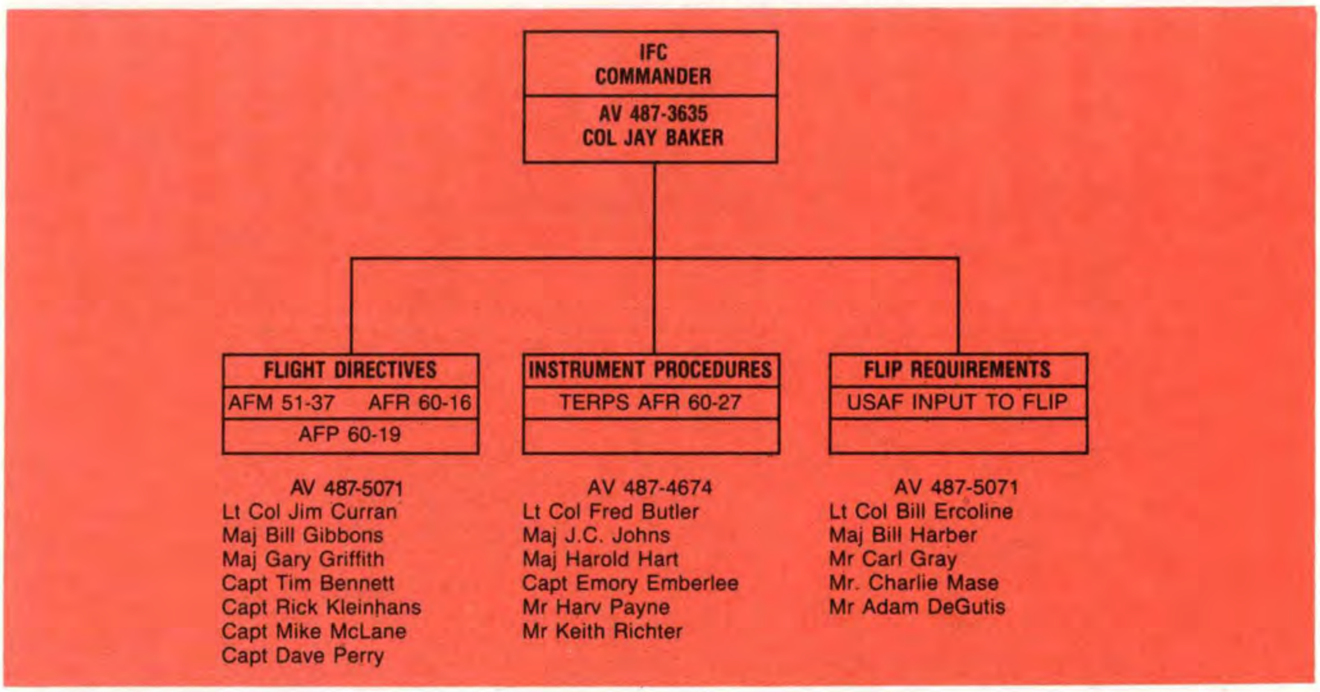


the approach course. If you request an amended clearance you could compute a lead point; however, these calculations can become complex and may place the aircraft well inside the IAF before a descent can be started. A better technique to employ when intercept headings exceed 90°, is a request to maneuver laterally (with respect to the IAF) to position the aircraft in a more favorable turn position.

Q Who/what is the Instrument Flight Center (IFC), and how do I get in contact with them?

A The following is an organizational chart of the IFC with personnel, phone numbers and primary responsibilities.

Direct any questions or comments to USAF IFC/FD (Capt Bennett), Randolph AFB TX 78150 or call AUTOVON 487-5071. ■



New Tape/Slide Program

■ A tape/slide program titled "Introduction To The Military NOTAM System," developed and produced by the 4235th Strategic Training Squadron, has been placed in the Defense Audio Visual Library for distribution Air Force-wide to all MAJCOM unit Base Operations. The initial distribution for CONUS installations has been coordinated and should have been in the field by mid June 1984. It is available for use by HQ USAFE, HQ PACAF and Alaskan Air Command units upon request.

The program is aimed at the airman/NCO entering the airfield management career field. It describes the purpose of the NOTAM system, the agencies responsible for maintaining the NOTAM system, and the responsibilities of the airfield management specialist in both the Air Force Central NOTAM Facility and in Base Operations.

This is the first of a three-part series covering the military NOTAM system. The second and third programs will address the subjects of receiving the NOTAM summary and hourly updates, and the creation of a new NOTAM. These programs are being developed and, once completed, should also be considered for Air Force-wide dissemination. — TSgt Billy P. Layfield, 4235 STS, Carswell AFB TX. ■

"SAFETY TROPHIES"

for distinguished contributions during 1983

THE KOREN KOLLIGIAN, JR. TROPHY

Awarded to the Air Force aircrew member who most successfully coped with an inflight emergency. Major Alexander was on a unit transatlantic deployment with tanker support when he lost an engine on his F-4 while more than 500 miles from land. Unable to maintain level flight, he had descended to 7,500 feet before the tanker caught up. The lack of sufficient thrust and control difficulties made refueling extremely difficult. Three hook ups were necessary. The brute force disconnects after the first two each resulted in further descent by the F-4. The third contact was 1,600 feet above the water and at 180 knots. The tanker then towed the F-4 some 200 miles over the cold Atlantic slowly gaining altitude until the F-4 had sufficient fuel, altitude, and airspeed to make it to the diversion base, Gander, Newfoundland.

MAJOR JON R. ALEXANDER

4th Tactical Fighter Wing
Seymour Johnson Air Force Base, North Carolina

THE COLOMBIAN TROPHY

Symbolic of excellence in military aviation safety for tactical flying operations, the Colombian Trophy for 1983 was awarded to the 4th Tactical Fighter Wing. The wing flew more than 27,000 hours and 22,300 sorties in F-4 aircraft during 1983 without a single Class A or Class B aircraft mishap. This outstanding safety record, accomplished while performing high risk, low altitude maximum performance flight operations and maintaining full mission readiness testifies to the professionalism of the aircrews and dedication of maintenance and support personnel.

4TH TACTICAL FIGHTER WING (TAC)

Seymour Johnson Air Force Base, North Carolina

THE SICOFAA FLIGHT SAFETY TROPHY

Awarded by the System of Cooperation Among the Air Forces of the Americas for excellence in aircraft accident prevention for wing-level organizations involved in defense, airlift, training, rescue, refueling, bombardment, strategic reconnaissance, and airborne control operations. This is the first time a SAC wing has won this prestigious award since the award was established in 1976. The 28th BMW completed its 13th consecutive year of operations without a Class A aircraft mishap despite a three-fold mission involving long range bombardment, worldwide air refueling and airborne command control communications operations.

28TH BOMBARDMENT WING (SAC)

Ellsworth Air Force Base, South Dakota

CHIEF OF STAFF INDIVIDUAL SAFETY AWARD

Presented to Air Force personnel who made significant contributions to safety during the previous calendar year.

LIEUTENANT COLONEL HAL W. WOLD
United States Air Forces in Europe

As Chief of Safety for the 501st Tactical Missile Wing, RAF Greenham Common, United Kingdom, Lt Col Wold developed and implemented outstanding safety policies, programs, and procedures for the first ground launched cruise missile wing in the Air Force and for the largest Air Force ammunition supply squadron in Europe. Despite a year of intensive activity, his exceptional safety leadership enabled the wing to successfully pass a three-phase initial nuclear surety inspection and meet all milestones for initial operating capability without a single weapons mishap and with ground mishap rates well below the command average.

MAJOR JOHN B. HAMMOND
Air Force Systems Command

As Chief of the System Safety Engineering Division for the Ballistic Missile Office, Major Hammond developed, implemented, and managed the system safety engineering program for the Peacekeeper weapons system. His superb management skills and technical knowledge contributed to significant design changes which greatly enhanced the overall safety of the weapons system. His comprehensive program ensured the efforts of the Air Force and 15 associate contractors were integrated into a single effective team resulting in highly successful and safe Peacekeeper test flights.

CAPTAIN MILTON J. MILLER
Air National Guard

While serving as an instructor pilot at the Air National Guard Fighter Weapons School, 162d TFG, Tucson, Arizona, Captain Miller identified a "turning and looking" maneuver which had resulted in several aircraft accidents. He developed a comprehensive low altitude training program to train pilots in the areas of task management, visual perception, physics, aerodynamics, and basic aircraft maneuvering. He consolidated his knowledge into a training manual and briefed more than 1,500 aircrews in an effort to prevent future accidents. He also wrote, directed, co-produced, and narrated a video tape for worldwide distribution in an attempt to alert all aircrews to the unique risk of low altitude flight and provide pilot-oriented solutions. His efforts to isolate and correct some of the causes of low altitude aircraft mishaps have greatly enhanced the Air Force Flight Safety Program.

MASTER SERGEANT JERRY K. CLINEMAN
Air Force Communications Command

While serving as safety technician for the 1937th Electronics Installation Squadron, Yokota Air Base, Japan, Sergeant Clineman's outstanding initiative, determination, and leadership enabled unit personnel to record nearly 1 million operational manhours without a lost-time injury, operate government vehicles in excess of 220,000 miles without a reportable vehicle mishap and complete mission essential projects on schedule. His expert analyses of existing hazards and the ability to eliminate these hazards made major contributions to the successful mission of the Air Force Communications Command.

USAF SAFETY AWARDS

THE

DIRECTOR

OF AEROSPACE

SAFETY

SPECIAL

ACHIEVEMENT

AWARD

1983

LIEUTENANT COLONEL JAMES D. THAMES

355th Tactical Training Wing
Davis-Monthan AFB, AZ

As Chief of Safety for the 355 TTW, Colonel Thames provided safety leadership for the largest and safest flying program in TAC. His contributions benefited not only the 355 TTW but significantly enhanced the safety of the entire A-10 aircraft community.

LIEUTENANT COLONEL JEFF I. FITCH

Headquarters, Strategic Air Command
Offutt AFB, NE

Colonel Fitch's leadership as Chief of Flight Safety for SAC was a key element in SAC's outstanding year in flight safety. His efforts to establish a system safety program for the B-1B bomber made significant contributions to the program and to a safer operation for one of the vital Air Force weapons systems of the future.

MR. JAMES B. EDWARDS

7551st Ammunition Supply Squadron
RAF Welford, UK

As safety manager for the largest munition storage and maintenance in Europe, Mr. Edwards' exceptional initiative and professional knowledge contributed greatly to the weapons safety programs of USAFE and the USAF. His skill and dedication have had long-lasting and positive effects on the mission readiness and safety of US forces in Europe.

MR. ROALD E. PETERSON

Ogden Air Logistics Center
Hill AFB, UT

As aviation safety specialist for the Ogden Air Logistics Center flight test operations, Mr. Peterson made many significant contributions to the overall safety of the program. He developed outstanding midair collision and birdstrike hazard avoidance programs. His comprehensive knowledge of safety and flight operations contributed greatly to improved flight line and maintenance safety.

MICROBURST WIND SHEAR: an aviation hazard

Adapted from a presentation by Mr McCarthy to the 89th Military Airlift Wing on 5 Dec 1983.

JOHN McCARTHY
National Center for Atmospheric Research
Boulder, Colorado

■ It was a humid afternoon in New Orleans on July 9, 1982. Pan Am Flight 759 taxied out into what seemed to be a typical summer thunderstorm situation in New Orleans. Exactly 60 seconds after the pilots of the Boeing-727 airplane released the brakes, and only 20 seconds after liftoff, the flight crashed just east of New Orleans International Airport, killing all 145 persons aboard and 8 persons on the ground.

The National Transportation Safety Board listed the probably cause as the aircraft's encounter with severe low altitude wind shear.* The report also stated: "Contributing to the accident was the limited capability of current ground based, low level wind shear technology to provide definitive guidance for controllers and pilots for use in avoiding low level wind shear encounters" (NTSB, 1983).

Low altitude wind shear, in the aviation context, is rapidly changing wind, in either space or time (or both, since space and time are in a sense interchangeable with an appropriate transformation). The effect of wind changes, particularly near the earth's surface, can be quite serious for an aircraft, especially if the change is large over a short distance. Figure 1 illustrates the effect of this change during a particularly severe form of low altitude wind shear — that occurring in a microburst. In this scenario, an aircraft taking off encounters first an

continued

Sometimes low altitude wind shear is called low level wind shear, but this term is being replaced by the former to avoid confusion regarding the magnitude of the shear.

A benign appearing rain shaft from a high *non*-thunderstorm cloud base directly over Stapleton Airport, Denver, CO. A 65-mile-per-hour headwind/tailwind was associated with this event on the runways shown.

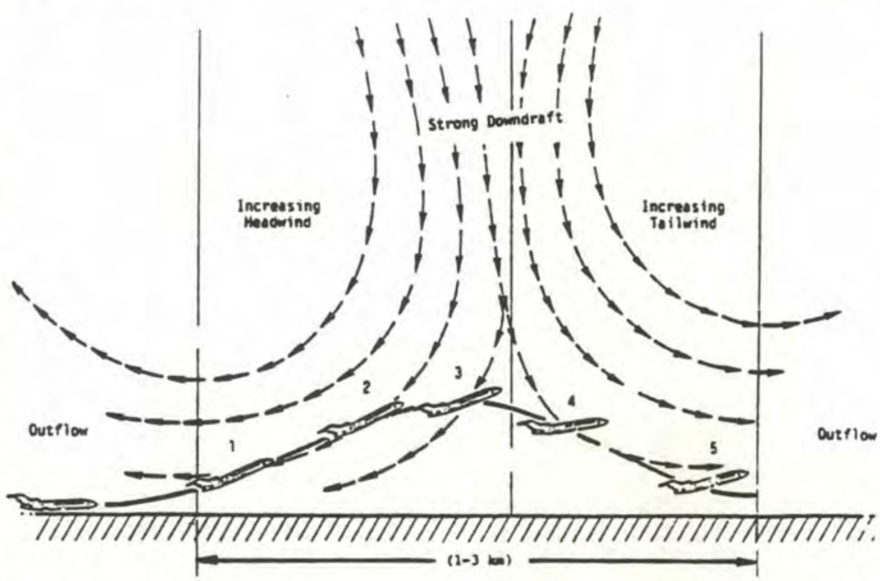


Figure 1. A schematic representation of a takeoff in a microburst situation similar to the flight of Pan Am 759. The aircraft first encounters a headwind and increasing performance. This is followed shortly by a downdraft and a strong tailwind, both causing serious performance loss, and possibly a crash.

Local dust associated with a microburst. Microbursts are small scale events averaging only 3.1 km in size and lasting only minutes on the surface.
(Photo: Fujita, University of Chicago)

MICROBURST continued

increasing headwind, a downdraft, followed by an increasing tailwind. This sequence results in a rather serious energy loss for an aircraft on either short final or immediately after take off.

The crash of Pan Am Flight 759 was not an isolated event. Of 19,332 NTSB reports of accidents and incidents in airport terminal areas, at least 28 involved larger airplanes (greater than 12,000 lbs) in encounters with wind shear. In addition, in 1981 alone, 662 fatal accidents occurred in general aviation aircraft, with "weather" accounting for approximately 40 percent. Although it is not known to what extent wind shear was a causative factor in these accidents, due to inadequate detailed investigation and lack of reconstruction data, it can be presumed that wind shear played a significant role in many of them. While low altitude wind shear crashes are not common, they clearly make a sizable impact on air carrier injuries and fatalities. Consequently, the aviation system must take wind shear into full account when addressing long-term solutions to the problem.

The Joint Airport Weather Studies (JAWS) project was initially conceived in 1980 by combining the expertise of three scientists representing three important subdisciplines. Professor Theodore Fujita of the University of Chicago had previously discovered the existence of the microburst phenomena, but desired a greater examination of the event. James Wilson of the National Center for Atmospheric Research (NCAR) had been addressing operational wind shear detection by Doppler radar and wanted to further pursue similar objectives. The author had extensively examined aircraft performance in low altitude wind shear and wanted to gather more information in this area.

We believed that many aspects of the microburst wind shear problem had not been adequately addressed, from both basic scientific and applied aviation hazard perspectives. A highly focused effort which combined our expertise and personal scientific objectives could bring improved understanding to this pressing meteorological and aviation system problem.

The convective microburst, the probable cause of the crash of Pan Am Flight 759, was the principal focus of the JAWS field program conducted near Stapleton International Airport between 15 May and 13 August 1982. A three-year program, JAWS is being managed by NCAR in Boulder, Colorado, and by the University of Chicago. The project is sponsored by the National Science Foundation, the Federal Aviation Administration, the National Aeronautics and Space Administration, and the National Oceanic and Atmospheric Administration.

The JAWS effort has concentrated on three aspects of microburst-induced, low altitude wind shear: basic scientific investigation of microburst origins, lifecycles, and velocity structures; various aspects of aircraft performance, including numerical models, manned-flight simulators, instrumented research aircraft response, and operational air carrier performance; and low altitude wind shear detection and warning using direct and radar remote surface and radar sensing and airborne systems.

In the sections to follow, we will examine in some detail one particular type of low altitude, wind shear — microbursts — and outline very recent progress made in their identification, description, and detection. Finally, we will address a scenario that could substantially, if not completely, eliminate low altitude wind shear as a serious aviation hazard.

For our purposes, a microburst is defined as a downdraft-induced, diverging, horizontal flow near the surface, whose initial horizontal dimension is less than 4 km, and whose differential velocity is greater than 10 m/s.

Figure 2 is a multiple Doppler radar analysis of a microburst that occurred over the JAWS instrumented research network on July 14, 1982. This case is illustrative of the diverging flow seen at the surface and the intense downdraft seen in the microburst center. Figure 3 shows the frequency of microbursts as a function of time of day, as seen by Doppler radar. Notice that microburst events tended to peak during the early afternoon, and again in the early evening, and were generally associated with convective weather peaks.

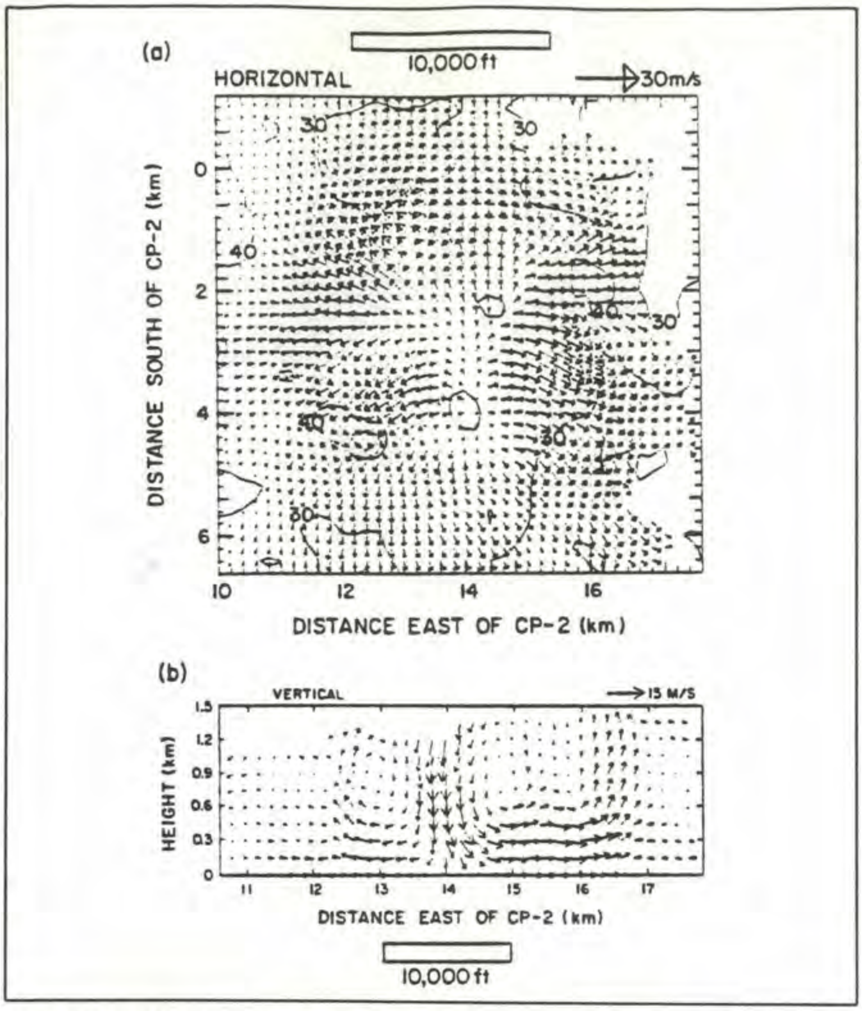


Figure 2. Dual Doppler radar analysis of a severe microburst. Shown are (a) the horizontal wind field near the earth's surface; notice the strong diverging outflow typical of a microburst, and (b) a vertical cross section through (a), which shows the downdraft, outflow, and a commonly observed, horizontal vortex circulation. Note also how remarkably similar this cross section airflow is to the "schematic" of Figure 1. For reference, typical 10,000 foot jet runways are shown.

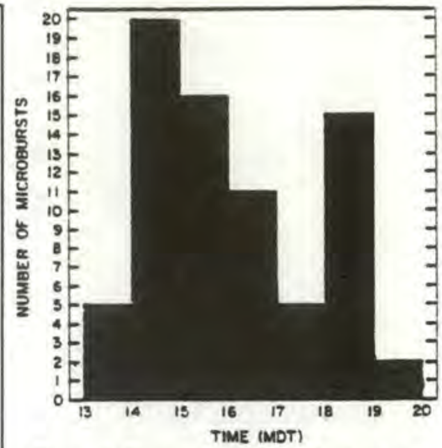


Figure 3. The number of JAWS microbursts, identified by Doppler radar, by time of day. These microbursts are clearly related to convective phenomena with significant peaks near 1400 and 1800 hours.

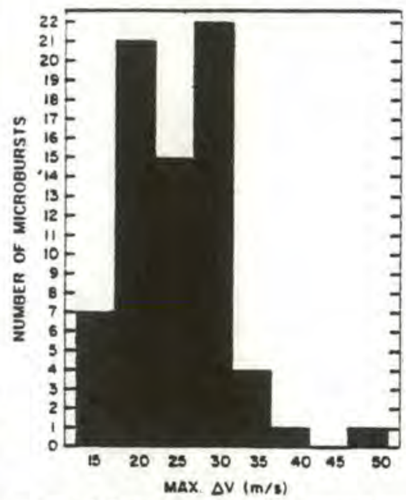


Figure 4. The figure shows the approximate maximum headwind to tailwind shear that an aircraft would encounter when penetrating the microburst. The velocity differential believed encountered by Pan Am Flight 759 was 24 M/S or approximately the average value shown here.

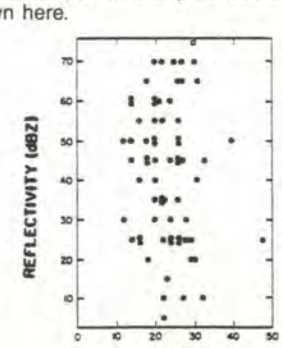


Figure 5. Maximum radar reflectivity (echo intensity) vs maximum velocity differential. Serious low altitude microburst wind shear can occur in a wide range of activity from nonthunderstorm to intense thunderstorms. Severe shear can occur when radar reflectivity is low.

The intensity of Doppler radar-detected microbursts can be seen in Figure 4, which shows the microburst frequency as a function of wind speed maximum differential near the surface. In this illustration, the maximum headwind to tailwind velocity difference is shown, ranging from 10-50 m/s (approximately 20-100 knots); one microburst observed by Doppler radar had a differential of 48 m/s (100 knots)! The microburst velocity differential that brought down Pan Am Flight 759 was only 24 m/s, or approximately the median value of radar-observed JAWS microbursts.

Conventional aviation wisdom uses radar echo intensity (radar reflectivity) as an indication of storm severity. The more intense the return is, the more likely the "thunderstorm" will be severe. Of course, a conventional weather radar cannot measure windspeed. Figure 5 shows the correlation between microburst echo intensity (reflectivity) and maximum velocity differential. Clearly, there is no correlation, with strong microburst wind shears having reflectivities ranging from near zero to above 70 dBZ. Hence it is clear that a conventional airborne or ground-based radar cannot be used to detect severe microburst wind shears.

When we examined 40 microbursts thoroughly with Doppler radar, we found that 50 percent reach their maximum intensity within 5 min after first detection, while 95 percent do so within 10

continued

Classical ring of dust showing the immediate impact point of a microburst similar to Figure 6. Microburst velocity differences have been measured as high as 85 knots. (Photo: Fujita, University of Chicago)

MICROBURST continued

min, from the time the diverging outflow first appears at the surface. Sometimes they dissipated within 5-10 min, with the maximum velocity differential increasing from 12 to 24 m/s in the first 5-10 min. Furthermore, we found that microbursts are not circularly symmetric in their horizontal diversity outflow as implied in Figure 1, but are decidedly asymmetric. They are clearly small scale events, being only 1.8 km in diameter when first detected, growing to only 3.1 km on the average in 6.4 min.

Figure 6 is a composite drawing of a microburst life-cycle as observed by Doppler radar. Notice that the full sequence is seen to last 15 min, with the event being small-scale at the surface for only several minutes. Data such as these have made the JAWS project unique in that we have obtained, for the first time, high resolution velocity data on these small-scale and short-lived, severe wind shear events. In the following sections we will address in detail the effects these events have had on aviation safety.

Evaluation of the Low Level Wind Shear Alert Systems (LLWSAS)

The LLWSAS is the only wind shear detection and warning system in routine operation. Fifty-nine systems are operating at major airports in the United States, while 51 additional systems are expected to be installed by 1984. The system is an array of wind speed and direction measuring devices that are spaced in a ring around a centerfield site, as shown for Denver's Stapleton International Airport in Figure 7. In this case, a microburst lasting only 50 sec has occurred at the southeast site. In Figure 8, data from both the LLWSAS and the NCAR Portable Automated Mesonet (PAM) surface weather station system have been combined to show the maximum wind velocity for a particularly severe microburst event at Stapleton. In this case, the velocity differential over the north-south runways is approximately 85 knots; this shear was one of the most severe seen in JAWS and is

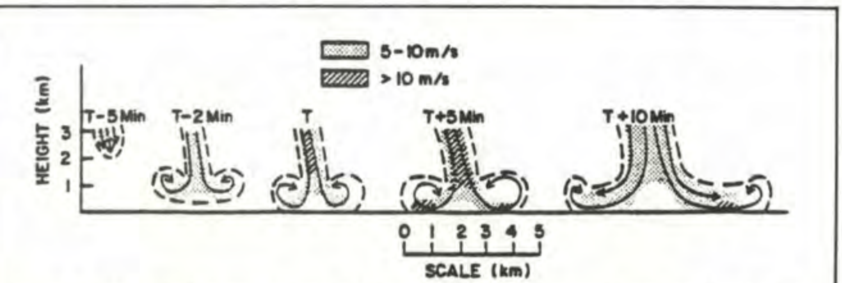


Figure 6. A vertical cross section of the evolution of the microburst wind field. T is the time of initial divergence reaching the surface. It takes about 5 minutes after T for the microburst to reach maximum intensity. The divergence is observed above the surface several minutes before surface impact.

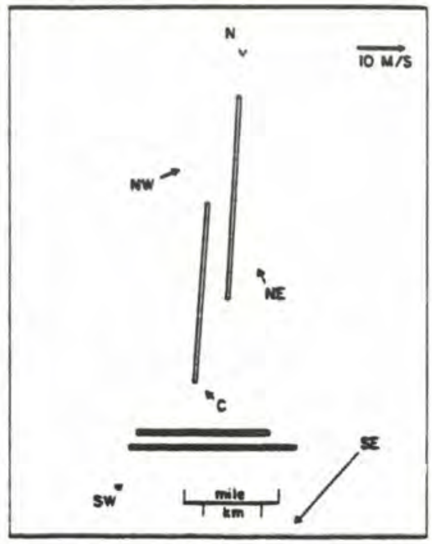


Figure 7. Plot of LLWSAS wind vectors at 1410 MDI on 14 July 1982 indicating the positions of the LLWSAS sites in JAWS. The 20 m/s gust at the SE sensor was a microburst seen for only 50 sec.

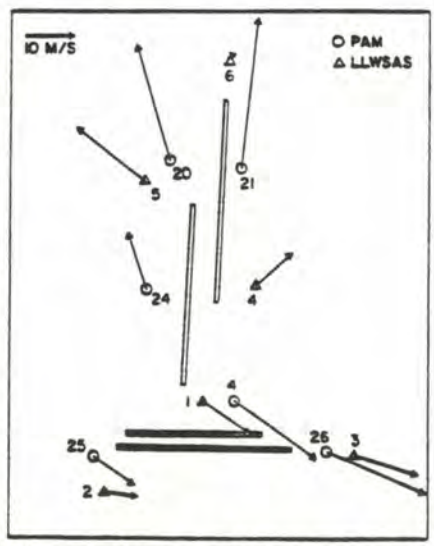


Figure 8. Merging of LLWSAS and NCAR PAM wind velocity data for 1369 PDT, 15 July 1982, over Stapleton. A potentially lethal 85 knot headwind/tailwind existed along the north-south runways.

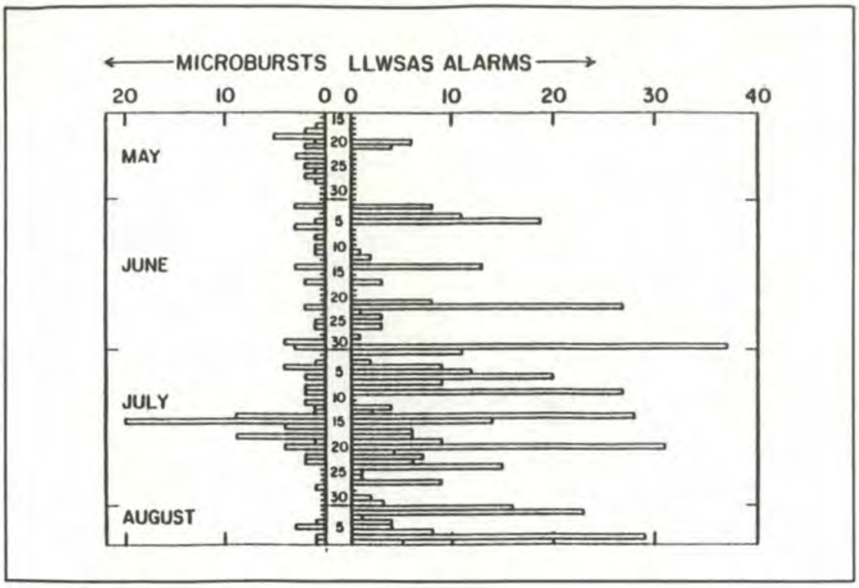


Figure 9. A comparison, by day, of the number of microbursts seen by Fujita (private communication) in the Stapleton area to the number of LLWSAS alarms. An in-depth study indicates that the LLWSAS registers an alert in many instances when significant low altitude wind shear is absent.

believed to be unflyable either on an approach-to-landing or immediately upon takeoff.

Figure 9 shows the number of LLWSAS alarms recorded during JAWS, by number per day, in comparison to the number of microbursts seen by Fujita using the PAM system. Notice that the LLWSAS system indicates the presence of shear events on days when microbursts are not present. Scrutiny of those days suggests that the LLWSAS system is triggered for events that do not seem, upon inspection, to be significant.

Preliminary conclusions regarding the LLWSAS analysis suggest that the curent system is deficient because its station spacing is too coarse to adequately detect microbursts. Furthermore, the centerfield site is not wind-shear effective because its averaging period is too long. The effective station spacing for the LLWSAS ranges from 3-6 km, depending on how one considers the effectiveness of the centerfield wind-measuring site.

While the LLWSAS system clearly can detect some wind shear events at the surface, such as gust fronts and larger microbursts, the system needs improvement. This can be accomplished by upgrading the centerfield site by decreasing its averaging period, by increasing station density, and by improving data quality. In addition, by recording the LLWSAS data at all locations, we would be able to improve the national wind shear statistical data base; this is sorely needed because we do not have a clear understanding of the low altitude wind shear frequency nationwide.

The great success of Doppler radar in detecting microburst wind shear during the JAWS effort has led to the concept of an airport terminal Doppler radar. Studies of radar positioning and simulations of microburst have led to the conclusion that a dual Doppler system with two radars installed would be the optimal (but expensive) solution. As an alternative, a single radar off site has the best chance of observing incipient clues of microburst information but may seriously underestimate the magnitude of the headwind or tailwind shear that an aircraft would encounter along the runway. Assuming a dual system is not installed, a single Doppler radar at the airport center has the best chance of measuring the shear intensity along each active runway.

continued

Classical benign appearing microburst photo showing high base, virga, and dust ring at the surface. A microburst at Andrews AFB has been recorded at 130+ knots velocity.

Thunderstorm rain core with possible microburst outflow near surface shown on left. JAWS data is providing more accurate information on these phenomena. (Photo: William Mahoney, University of Wyoming)

MICROBURST

continued

Improved Flight Simulator Training in Low Altitude Wind Shear

Airline, business and military pilots use manned-flight simulators for their initial and recurrent training needs. Over the years, the principal source for wind shear data has been the reconstruction of aircraft accident records. These reconstructions are somewhat deficient for a number of reasons. The data used are necessarily crude because of the low-resolution and questionable quality of the input flight recorder data. In addition, the wind shear profiles derived do not take into account mass continuity in the atmosphere, and therefore are somewhat unrealistic. Finally, it does not seem likely that the most severe wind shear profiles are represented by these previous investigations.

Data sets such as those shown in Figure 2 are being prepared for improved high resolution wind shear models for flight training. Figure 10 shows the vertical and horizontal flight profile for a B-727 aircraft on approach through a JAWS microburst data set, as determined from a numerical model of aircraft performance. In this case, a model which includes a numerical edition of a pilot attempts to fly the ILS approach path as accurately as possible. As can be seen, the airplane crashes about 1.4 km short of the runway. Studies such as these are instrumental in providing improved safety through pilot simulator training.

The advantages of JAWS data in this area include providing more accurate, high-resolution data for simulation and identifying three distinct microburst situations, those which (1) can be easily flown, (2) can be flown only if an appropriate wind shear penetration piloting technique is used, and (3) cannot be flown successfully because they are lethal to aircraft near the ground.

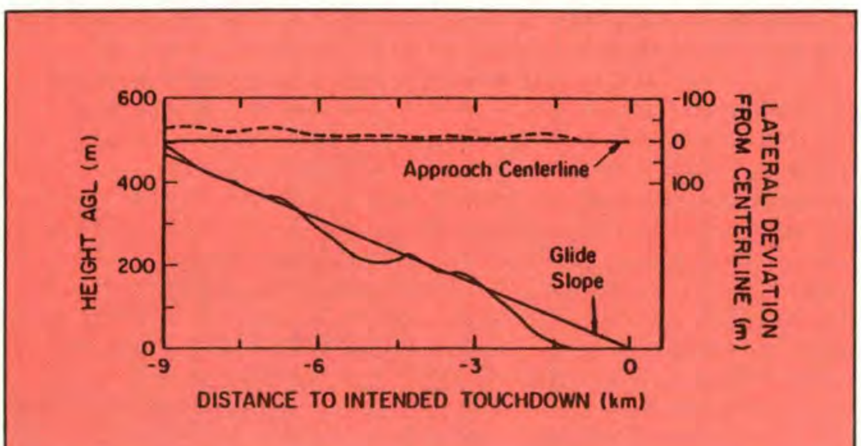


Figure 10. Computer simulation of a Boeing 727 piloted airplane which penetrates a microburst on an approach-to-landing. Pilot's best effort cannot avoid a crash 1.4 km short of the runway.

The JAWS project at NCAR, under sponsorship of the FAA, has recently completed a wind shear information video tape entitled "The Probable Cause," designed to provide pilot and controllers with current information regarding the nature and severity of low altitude wind shear, and with methods for pilots to use should they happen to encounter such a situation. This tape highlights the need for increasing pilot and controller awareness regarding severe shear. As a first step toward increasing awareness of the wind shear hazard, the JAWS project has distributed copies of the tape throughout the aviation community.

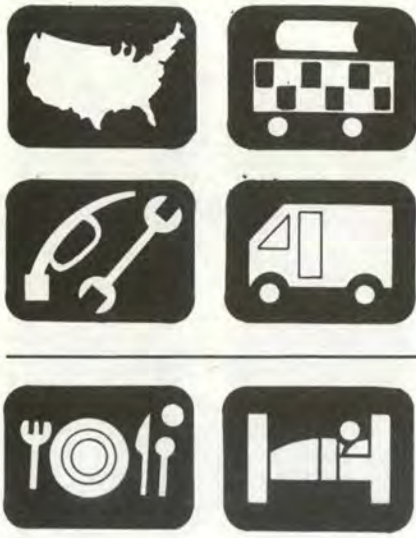
The ongoing analysis of the JAWS data set has led to the following set of recommendations for improved safety in the aviation system in terms of wind shear:

- Pilot and air traffic controller awareness regarding the serious nature of low altitude wind shear needs to be greatly increased. Many pilots apparently feel that they can successfully penetrate all wind shear situations, in spite of the record of accidents. Controllers often are not aware of the need to rapidly disseminate highly perishable wind shear pilot reports and other similar observations.
- Wind shear penetration flight procedures must be improved, to better equip pilots for such penetrations, should they encounter wind shear. The best plan, of course, is to avoid severe shear if possible. However, it is imperative for aircraft manufacturers to develop such improved techniques for successful penetrations, and airline training personnel must transmit such procedures to flight crews.
- LLWSAS must be improved by increasing station density and by enhancing the capability of the centerfield sensor by decreasing its averaging time. The system must be recorded nationwide to provide a national statistical base on wind shear occurrences, to provide a record for accident investigation, and to allow for much improved routine maintenance of the system (ordinarily, it is not recorded but it was for the JAWS field experiment).
- Pilot training must stress a philosophy of "reading all of the danger signs." Clues such as those seen on the current or improved LLWSAS, visual characteristics of wind shear events seen from the cockpit on the ground or in the air, reports of encounters from other pilots, signs from cockpit flight instrumentation, and other sources must be collected by the pilot. These clues can then be used to help pilots avoid severe wind shear.
- An excellent and available solution appears to be terminal Doppler radar to be situated on or near major airports. Although such a system would not be foolproof, a high degree of protection would be provided to those airports that had such an installation.
- Probably the ultimate solution would be the successful development of an effective airborne detection and warning system, capable of detecting wind shear in all known conditions several miles ahead of the airplane. This system, probably based on a pulsed, microwave Doppler radar as part of the airplane, would not be dependent on a ground-based system. Current airborne wind shear detection and warning systems do not allow for significant avoidance, since these systems merely alert the pilot of the in-situ presence of shear conditions.

Our examination of JAWS data and the conclusions we have drawn lead us to several imperatives. It is important to accept the fact that no single solution to the low altitude wind shear problem is sufficient. We require a variety of solutions, including better basic scientific understanding, better training, and better detection instrumentation. In addition, the aviation system requires a carefully integrated wind shear effort to accomplish the scenario described here. Without such a broad spectrum approach, we cannot hope to solve the problem sufficiently to eliminate hazardous wind shear encounters. ■

Vortex ring circulation associated with leading edge of a microburst.

(Photo: T. Fujita & B. Smith, University of Chicago)



X-COUNTRY NOTES

MAJOR WILLIAM R. REVELS
Directorate of Aerospace Safety

The Program

■ We're still receiving a lot of calls asking how a unit goes about nominating or applying for the Rex Riley Transient Services Award. Let me take a few moments to re-emphasize some of our program guidelines:

BACKGROUND — The Rex Riley Transient Services Award program was established in the early 1950's to recognize Air Force installations providing outstanding service and facilities for transient aircrews. Although enjoying several different names over the years, the program has survived and still serves as a mark of distinction for Air Force airfields throughout the world. The goal of the program is mishap prevention through the recognition and improvement of USAF transient services.

PHILOSOPHY — We feel that one of the mainstays of any installation aircraft mishap prevention program should be the facilities that are used by transient aircrews. Not only are we interested in the obvious flight line hazards and operations, but we also attempt to evaluate (and improve) facilities which could be classed as irritants. These include flight planning, messing, transport, billeting and other areas which could directly, or indirectly, affect aircrew frame-of-mine or fatigue levels. In short, we are targeted to seek out and bring attention to any condition which could increase the probability of a mishap.

ELIGIBILITY — As a minimum, bases must meet the following criteria in order to be eligible for evaluation under the Rex Riley Transient Services Award program.

- Active USAF, AFRES or (AF)ANG installation, listed in the IFR supplement as possessing facilities to serve transient aircraft and crews.
- Available hours to transients a minimum of 8 hours per day and five days per week.
- Have no continuing OBO or other major limitations to transient aircrew arrival or service. (NOTE: PPR status is not an automatic ineligibility factor. Many installations are using PPR as a valid management/sequencing tool. A permanent PPR restriction will be evaluated by the Rex Riley program director for determination of eligibility.)

ADMINISTRATION — The award program is administered by the Safety Education Division of the Air Force Inspection and Safety Center. Although not a formal IG-type inspection, the evaluations are carried out on a no-notice basis using extensive checklists. Evaluators basically look at such areas as Base Ops facilities, billeting, availability of meals and transport, and transient servicing and maintenance. The goal is to

A mainstay of any base's aircraft mishap prevention program is the transient aircrew support and facilities provided.

The goal of the Rex Riley Program is mishap prevention through recognition of outstanding USAF transient services.

visit/revisit every Air Force base serving transient aircrews within recurring 2-year periods.

ENTITLEMENTS — Units selected for the Rex Riley Transient Services Award will be added to the award lists published in *Flying Safety* and *Maintenance* magazines. They will remain on the list and move upward as seniority is increased.

In addition, a certificate suitable for Base Ops display will be forwarded to the commander of the unit responsible for airfield management. (Mini-certificates for other base agencies are available from "Rex" upon request.)

Transient alert personnel are authorized to wear Rex Riley patches at the unit commander's discretion. Standardized design is provided but units are responsible for the local procurement and expense of patches should they be desired.

REMOVAL — Bases having the award removed will receive a letter of explanation, and the base's name will be deleted from the next list published. Removal will result from:

- An unsatisfactory evaluation.
- The advent of continuing or permanent restrictions published by a base which severely limit the availability of services to transients. (As determined by the Rex Riley program director.)
- Transient Alert personnel are involved in a mishap or allow a safety of flight item to go uncorrected.

Trip reports

The following base reports are from the most recent Rex Riley evaluation trips. Services are generally good at CONUS bases with several new units appearing on the Rex list for the first time this year.

New Awards

LUKE AFB AZ Luke has a highly responsive transient services program, with enthusiastic personnel and quality facilities. Operational activities are brisk at Luke, so keep your eyes open in the local area and

continued

THE REX RILEY *Transient Services Award*

LORING AFB	Limestone, ME
McCLELLAN AFB	Sacramento, CA
MAXWELL AFB	Montgomery, AL
SCOTT AFB	Belleville, IL
McCHORD AFB	Tacoma, WA
MYRTLE BEACH AFB	Myrtle Beach, SC
MATHER AFB	Sacramento, CA
LAJES FIELD	Azores
SHEPPARD AFB	Wichita Falls, TX
MARCH AFB	Riverside, CA
GRISSOM AFB	Peru, IN
CANNON AFB	Clovis, NM
RANDOLPH AFB	San Antonio, TX
ROBINS AFB	Warner Robins, GA
HILL AFB	Ogden, UT
YOKOTA AB	Japan
SEYMOUR JOHNSON AFB	Goldsboro, NC
KADENA AB	Okinawa
ELMENDORF AFB	Anchorage, AK
SHAW AFB	Sumter, SC
LITTLE ROCK AFB	Jacksonville, AR
OFFUTT AFB	Omaha, NE
KIRTLAND AFB	Albuquerque, NM
BUCKLEY ANG BASE	Aurora, CO
RAF MILDENHALL	UK
WRIGHT-PATTERSON AFB	Fairborn, OH
POPE AFB	Fayetteville, NC
TINKER AFB	Oklahoma City, OK
DOVER AFB	Dover, DE
GRIFFISS AFB	Rome, NY
KI SAWYER AFB	Gwinn, MI
REESE AFB	Lubbock, TX
VANCE AFB	Enid, OK
LAUGHLIN AFB	Del Rio, TX
FAIRCHILD AFB	Spokane, WA
MINOT AFB	Minot, ND
VANDENBERG AFB	Lompoc, CA
ANDREWS AFB	Camp Springs, MD
PLATTSBURGH AFB	Plattsburgh, NY
MACDILL AFB	Tampa, FL
COLUMBUS AFB	Columbus, MS
PATRICK AFB	Cocoa Beach, FL
WURTSMITH AFB	Oscoda, MI
WILLIAMS AFB	Chandler, AZ
WESTOVER AFB	Chicopee Falls, MA
ELGIN AFB	Valparaiso, FL
RAF BENTWATERS	UK
RAF UPPER HEYFORD	UK
ANDERSON AFB	Guam
HOLLOMAN AFB	Alamogordo, NM
DYESS AFB	Abilene, TX
AVIANO AB	Italy
BITBURG AB	Germany
KEESLER AFB	Biloxi, MS
HOWARD AFB	Panama
GEORGE AFB	Victorville, CA
PETERSON AFB	Colorado Springs, CO
CLARK AB	Phillippines
MOODY AFB	Valdosta, GA
RHEIN-MAIN AB	Germany
RAF LAKENHEATH	UK
ZARAGOZA AB	Spain
TORREJON AB	Spain
LUKE AFB	Glendale, AZ
BLYTHEVILLE AFB	Blytheville, AR
NELLIS AFB	Las Vegas, NV
BERGSTROM AFB	Austin, TX
DAVIS-MONTHAN AFB	Tucson, AZ

X-COUNTRY NOTES

continued

be prepared for busy ramps and taxiways. For best service, call ahead with your arrival time, and the folks at Luke will take care of your needs.

BLYTHEVILLE AFB AR Blytheville has the professional personnel and facilities to ensure excellent services for transients. Ramp construction to improve parking areas should be ready for use by the time you read this article. Also, remodeling in Base Operations will improve flight planning, weather, and snack bar facilities. The personnel at Blytheville are enthusiastic about improved transient services and will go the extra mile to ensure quality. Give 'em a try on your next cross-country.

NELLIS AFB NV Nellis has long been a favored stopping place for transients because of its fine services and preferred location. New parking areas for transient aircraft have been established and Nellis can now handle more RON aircraft with good services. When you go to Nellis expect high density air traffic, with busy ramps and taxiways. The folks at Nellis are ready to make your stay the best, but they need your cooperation so they can give you the best possible service.

BERGSTROM AFB TX Bergstrom is an ideal cross-country stopover point. It is centrally located in South Texas and the services are excellent. You'll find competent and fast T/A personnel, first class quarters, and a highly professional staff at Base Operations. The transient services people at Bergstrom are ready and willing to make your next stopover a good one.

DAVIS-MONTHAN AFB AZ Davis-Monthan has had plenty of experience handling high volume transient traffic and multiple aircraft types. The very capable transient alert personnel will speed you along if a quick stop is in order, or bed down the aircraft overnight. They even have the capability for local repairs — you may have to supply parts, depending on aircraft type. Base Ops, billeting, and transportation are also well organized to provide the best to transients. Because of the weekend volume, PPR is in effect. There is no intent to shut off transients. Give the Davis-Monthan troops a call, and they'll give you excellent service.

Re-evaluations

GRISSOM AFB IN Need a mid US stopover base? Grissom is a good one, and it's not too heavily traveled, as Rex Riley bases go. They are currently PPR for a construction project in progress, but are willing to go out of their way to get you in and out quickly. Give them a call for either a quick turn or an RON.

GEORGE AFB CA George is still a fine stopover base in the Southern California desert. Remodeling is underway in Base Operations and a new VOQ is programmed for the near future. The transient services people at George are working hard to maintain high standards.

WILLIAMS AFB AZ Williams continues to provide quality transient services for TDY aircrews. Currently, Williams is in PPR status due to construction on the main ramp. The flow of aircraft is presently limited to 6 per hour. The Base Ops folks don't anticipate significant limitations to transients during the construction period, but you should plan ahead for an arrival window through the PPR process.

MATHER AFB CA Mather provides quality service for transients in all areas. Heavy traffic periods exist on Fridays and Saturdays, and a call ahead will assist the T/A personnel in coordinating your arrival. Give the Mather folks your cooperation and they'll give you real quality service.

FAIRCHILD AFB WA Fairchild is a long-term holder of the Rex Riley Award, and the services today are better than ever. All personnel are enthusiastic, friendly, and helpful. They work hard to make life simpler for transient aircrews.

HILL AFB UT The Hill transient service people continue to provide excellent service. You will soon see some changes at Hill. There is a large scale remodeling job in progress at Base Operations including a new crew lounge, new flight planning room, and general approach throughout the facility. The new look should improve the service and capabilities for your next visit. ■

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 Accident Prevention Program.

MAJOR
Jon R. Alexander

MAJOR
Daniel J. Silvis III

4th Tactical Fighter Wing
Seymour Johnson Air Force Base, North Carolina

■ On 5 September 1983, Majors Alexander and Silvis were the crew of an F-4E on a unit transatlantic deployment. While at 26,500′ MSL over the Atlantic the right after burner nozzle failed open. Major Alexander's wingman confirmed the failure and also reported that there was oil on the bottom of the aircraft. Major Alexander immediately turned toward the closest divert airfield 520 NM away. Shortly thereafter, the right engine oil pressure began to fluctuate below minimum operating oil pressure. Major Alexander then shut down the engine which subsequently seized. The aircraft was heavyweight and with the right engine seized the crew could not maintain level flight with single-engine military power. Major Alexander began a descent, planning to level at the highest altitude where level flight could be maintained. To complicate matters, the right hydraulic system also failed when the right engine seized. At the same time, the INS failed. While the F-4 continued to descend, the tanker which Major Alexander had requested passed over them but did not see the F-4 because it was in the weather. Shortly thereafter, Major Alexander's wingman spotted the tanker on

continued

WELL DONE continued

radar and vectored it to a position 1.5 NM in front of the F-4s. The crippled F-4 was still unable to maintain level flight nor was Major Alexander able to close on the tanker. Use of afterburner caused a severe right roll.

The tanker crew, realizing the F-4's problem, slowed and Major Alexander was finally able to hook up at 2,000 feet and 190 knots. This hook-up could not be maintained and another was made at 1,600 feet and 180 knots. After three hook-ups, despite severe power limitations and control difficulties, the F-4 was able to take on enough fuel to make it to the divert base. The crew then made a successful single-engine approach and landing through an 800-foot ceiling with strong surface winds. The superb airmanship, judgment, and actions of Majors Alexander and Silvis when faced with a critical emergency saved a valuable aircraft. WELL DONE! ■

L to R — Capt Wojcikowski, Capt Goodman, Capt Clover, SSgt Simmons

CAPTAIN
Robert J. Goodman

CAPTAIN
Michael F. Clover

CAPTAIN
Karol R. Wojcikowski

STAFF SERGEANT
Douglas D. Simmons

42d Bombardment Wing
Loring Air Force Base, Maine

■ On 5 September 1983, Captain Goodman and crew were in a KC-135 escorting a flight of F-4s on a transatlantic deployment when one of the F-4s developed a serious inflight emergency culminating in the failure of the right engine. The F-4s began a diversion to the nearest base over 500 nautical miles away. After being cleared by the cell commander, Captain Goodman turned to intercept the two F-4s — now some 100 NM away — to escort them to the divert base. The crippled F-4 was heavyweight and unable to maintain altitude. Thus the tanker was required to rendezvous in a descent complicated by layered clouds. The tanker crew then found that the F-4 was thrust limited and only able to maintain 190 knots in a descent. In addition, the F-4 had lost right hydraulics and was having control problems. Because the F-4 could not close on the tanker, Captain Goodman kept slowing the KC-135 in 3 to 5 knot increments as directed by the boom operator to, in effect, "back in to" the F-4. Sergeant Simmons, the boom operator, was especially skillful in making the

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hook up due to the F-4's problems. Once the hook up was made at 4,500 feet above sea level, the tanker actually towed the F-4 while transferring fuel. Shortly thereafter, a brute force disconnect occurred despite the efforts of both aircrews. The F-4 began to descend again and Captain Goodman was forced into an idle descent to give the F-4 a power advantage. The second hook up was made at about 2,000 feet. The KC-135 then began a gentle climb, while refueling and towing the crippled F-4. They were able to reach 6,000 feet before another brute force disconnect occurred. The sequence was repeated, bottoming out at 3,500 feet this time and climbing back to 5,000 feet. After a third disconnect, the F-4 was able to maintain altitude and actually climb to 9,500 feet and complete the diversion successfully.

The skill, professionalism and airmanship of every member of this crew were instrumental in saving a valuable USAF aircraft and preventing possible loss of an aircrew. WELL DONE! ■

CAPTAIN
John J. Shields

FIRST LIEUTENANT
Pietro Raffa

4th Tactical Fighter Wing
Seymour Johnson Air Force Base, North Carolina

■ On 5 September 1983, Captain Shields and Lieutenant Raffa were flying an F-4E as wingman on an over water deployment when their lead developed a critical inflight emergency. Heavyweight flying on one engine with only partial hydraulic power, the lead F-4 was unable to maintain altitude. In addition, the lead aircraft INS had failed and the nearest divert base was over 500 NM away. Realizing the seriousness of the situation, Captain Shields stayed with his leader while coordinating tanker support. Lieutenant Raffa took over navigation and radar vectored the tanker to the crippled F-4 when they were unable to visually rendezvous due to weather. Needing fuel themselves but knowing how much lead needed to get on the tanker, Captain Shields and Lieutenant Raffa refueled their aircraft quickly and efficiently, then turned the tanker over to lead. Fully expecting the lead aircrew to have to eject, Captain Shields and Lieutenant Raffa calmly prepared for RESCAP duties. Their assistance and support were the key to a successful recovery at the diversion base. The calm, clearheaded actions of Captain Shields and Lieutenant Raffa are in the finest tradition of good wingman support. WELL DONE! ■

Painting by Keith Ferris • Courtesy of Air Force Art Collection

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