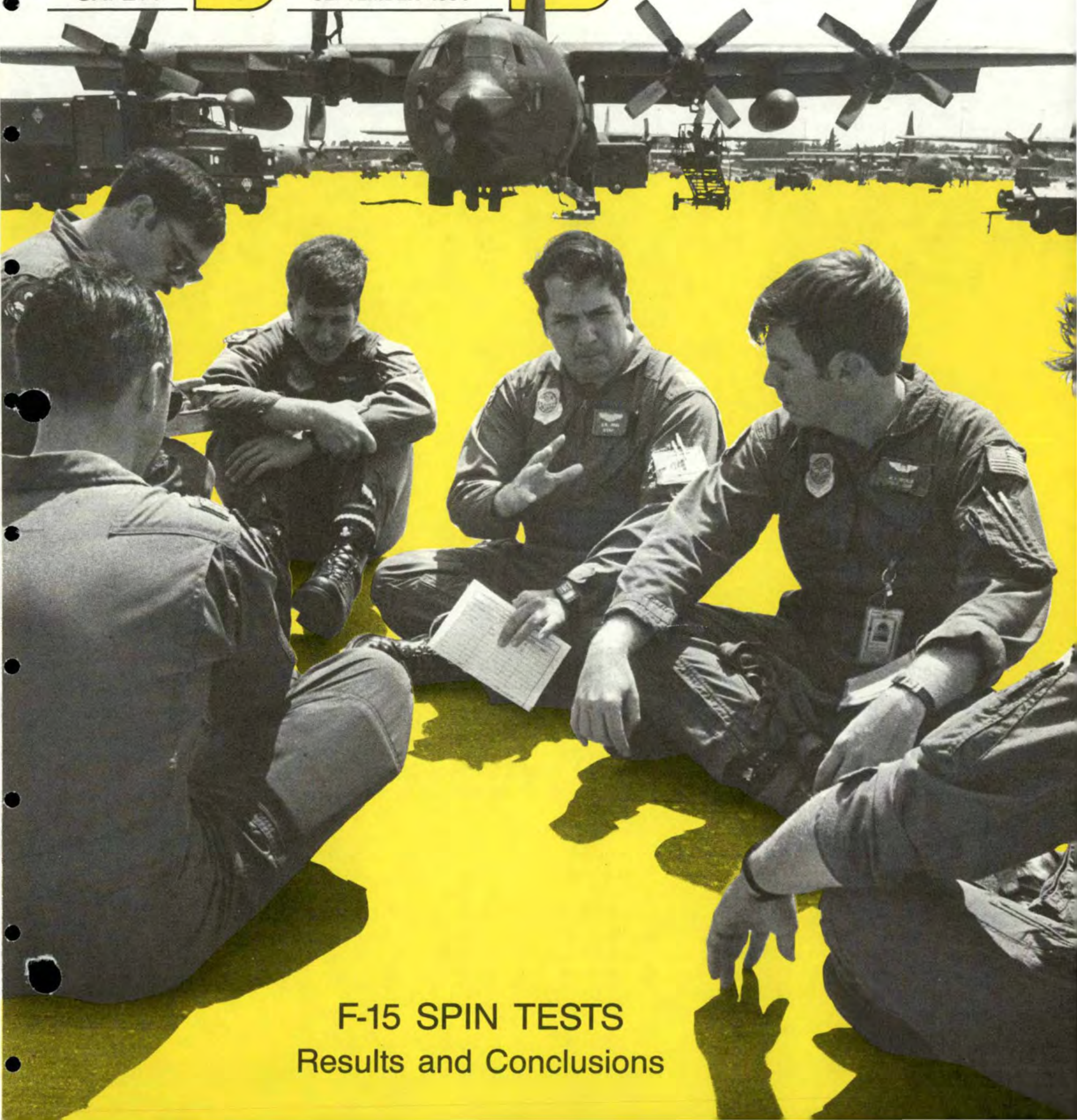
flying

SAFETY

SEPTEMBER 1984



F-15 SPIN TESTS

Results and Conclusions

THERE I WAS

■ When the Thunderbirds do a low altitude roll it sure is pretty to watch. Eleven years ago I tried the same stunt at a remote airstrip in SEA and very nearly didn't live to tell about it.

Whenever we landed our OV-10s to "show the colors" at this 3,000 foot airstrip, it became an unspoken expectation that, after we refueled, we would take off and fly by the field at low altitude with our smoke generator on. This was well received by the locals who would always turn out for an OV-10 departure.

On the day it was my turn to "carry the banner," my smoke generator was inoperative, so I decided I would do something sure to impress everyone. Little did I know how much it would impress me! As I taxied out, the locals started coming out of their "hootches" with many of them smiling and waving. I was ready to water their eyes!

I took off and immediately requested a fly-by which was cleared with much enthusiasm. I hung my Bronco on its props to gain as much altitude as I could in a sweeping turn. From about 4,000 feet, I lowered the nose and dove down to the runway where I leveled off at about 75 feet AGL. At midfield, I pulled the nose up and started a roll. With a 230 gallon centerline tank (fortunately empty) and three rocket pods, the nose started falling at an alarming rate, but not as fast as my jaw!

I couldn't put negative Gs on the airplane because, as any Broncobuster knows, zero Gs means zero oil pressure, and that means zero thrust (the props feather because they are held in the correct position by oil pressure). I guess I had sufficient airspeed, altitude and pitch (I certainly didn't have any ideas) to complete the roll before I hit the ground.

I was lucky. Another OV-10 unit lost an airplane and both pilots when they tried the same maneuver.

If you think a slow aileron roll is neat, try one — at altitude — on your next flight. Vary entry air speeds and pitch angles and watch just how much altitude you can lose! Then throw in some other factors such as a heavier aircraft (i.e., right after take off) and pressure altitude different from what you are accustomed to taking off with every day.

Bottom line — leave the airshows to the Thunderbirds! ■

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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F-15 Spin Tests
RESULTS AND CONCLUSIONS

Three of the most recent F-15 Class A mishaps were the result of pilot induced control loss or *perceived* loss of control. Discussions of departures, spins, and recovery techniques are understandably frequent in the F-15 community. To add some useful information to this interchange, we are reprinting a series of articles first published in the McDonnell Douglas *Product Support Digest.*

JACK KRINGS
Project Experimental Pilot

Definitions and Characteristics

■ A total of 811 high angle of attack maneuvers were conducted between April 1974 and July 1975 during 141 flights in the test program. Testing progressed from an initial evaluation of one G stall characteristics to the performance of simulated air combat maneuvers, without losing our airplane or our composure. Because we were specifically trying to get into spin situations rather than stay out of them (as any normal self-respecting pilot would do), there were a few physically uncomfortable moments and we did resort to the spin recovery chute in one safety-first situation.

The program produced approximately 70 developed spins of several types as described below, but many of our spin attempts were unsuccessful, which is a happy thought now that I look back at it! Holding pro-spin controls after accelerated stalls at high energy produced violent motions which would subside immediately when controls were neutralized. Early unsuccessful spin attempts also produced continuous rolls at less than stall angle of attack. Usually, three to four full rolls occurred, which would subside with neutral controls. When first seen, this was initially interpreted as a spin. Often, a rolling motion accompanies recovery from departure or spins.

Prolonged unsuccessful spin attempts on two occasions resulted in unintentional coupled entries. A high negative G couple to an inverted spin resulted in the only dual engine stagnation of the program. Sequential shutdown and relight precluded emergency system operation. The lake bed never looked so beautiful! A +9 G coupled maneuver also resulted from a 15 second aggravated pro-spin control attempt when the airplane really didn't want to spin.

Since one of the purposes of our program was to provide the pilot with an understanding of the high angle of attack flight capabilities of the F-15, here is a set of definitions regarding stall, departure, and spin characteristics.

Required yaw rates can only be generated by aileron deflection or asymmetric load. The yaw rate is the key parameter in the progression from stall through spin.

Stall-Maximum obtainable angle of attack at full longitudinal stick displacement.

The 1 G stall typically exhibits classical buffet and non-divergent dutch roll stabilizing at 90 to 100 knots, approximately 40 degrees angle of attack, and ± 5 degrees sideslip. Instant full aft stick abrupt stalls overshoot at 60 degrees angle of attack and 50 knots. Accelerated stalls ultimately typify 1 G stalls, but higher energy enhances the accelerations produced by the dutch roll. Divergence in yaw rate is noticeable with lateral asymmetry. Inverted stalls were stable at 120 knots and −20 degrees angle of attack. Accelerated inverted stalls can reach −30 degrees angle of attack.

Departure — Uncommanded motion at high angle of attack. Pick your own numbers.

Dynamic (less than one second to the aft stop) accelerated stalls would produce yaw and roll rates we termed departures. The effects of lateral asymmetry were very dominant. Departure always occurred opposite to the asymmetry. We chose to define departures as uncommanded maneuvers up to 30 degrees per second yaw rate. Yaw rate alone will maintain angle of attack above stall. Required yaw rates can only be generated by aileron deflection or asymmetric load. The yaw rate is the key parameter in the progression from stall through spin.

Spin-Uncommanded motion with a sustained direction of yaw having a yaw rate average in excess of 60 degrees per second.

■ **Oscillatory** spins are defined as spins with pitch oscillation over approximately 10 degrees. These spins were more violent with significant yaw rate hesitations. They were all self-recoverable when

" . . . We must keep in mind that the historic ability of early flight tests to predict future operational talent to depart airplanes has been notoriously poor."

Dynamic, accelerated stalls would produce yaw and roll rates termed departures. The effects of lateral asymmetry were very dominant.

continued

F-15 Spin Tests

RESULTS AND CONCLUSIONS continued

controls were neutralized. There is an academic line somewhere between departures and oscillatory spins. Yaw rates spike occasionally to 100 degrees per second and angle of attack can oscillate to 70 to 80 degrees.

■ **Non-oscillatory,** steady spins were developed from 65 to 140 degrees per second yaw rates. Precise timing of entry controls was required when laterally symmetrical. Lateral control (aileron) was effective to increase or decrease yaw rate. This capability allowed a step-by-step progress in spins to essentially maximum rpm with recoverability at each increment of spin rate. At lower yaw rates, the spin recovery trend with anti-spin aileron was sometimes barely discernible, but was ultimately effective. This slow-rate recovery was first encountered during the power approach (PA) spin when the recovery chute was deployed. Subsequent tests reproduced this type spin and successful aerodynamic recovery. The loss of altitude was only 1,000 feet per turn, so, at 35 or 40 thousand feet, there was no immediate concern.

Incremental increases in spin rpm allowed evaluation of spin/recovery characteristics, effects of controls, and the tendency to recover or increase rpm with neutral controls. The high rpm spins (above 100 degrees per second) produced from 2 to 3 Gs (eyeballs out). These spins were obviously uncomfortable. The torso harness was installed after the first few 2+ G flights. Prolonged pro-spin controls repeatedly produced flat 90+ degrees per second yaw rate non-oscillatory spins. At least a dozen "flat" spins were performed, all of which recovered positively and repeatedly with full anti-spin aileron. No other control or combination of control deflections enhanced recovery from any spins. Minor variation in spin and recovery characteristics were seen with symmetrical tanks/missiles, CG location, engine power setting, and entry technique variables.

■ **Inverted** spins are still distasteful. The inverted spin was easily attained and could be progressively explored. It was found to ultimately stabilize at −35 to −45 degrees angle of attack and 50 to 55 degrees per second yaw rate. The airplane is self-recoverable with neutral controls from inverted spins.

■ **Power Approach** spin tests were saved until last, as a result of the earlier PA spin chute recovery. A valiant attempt by some of the faint hearted to retroactively eliminate PA spins from the contract specification was denied. The slow recovery in the first PA spin was reproduced in the clean configuration. The PA spin was revisited successfully.

Susceptibility

Spin susceptibility is extremely low since stall departure susceptibility is low and self-recovery probability is extremely high (all cases tested), even with lateral asymmetry. Our tests did show however, that lateral asymmetry definitely increases departure and spin susceptibility. One AIM-9 and one AIM-7 on the same side will cause departures from accelerated stalls with full aft stick only. These departures are self-recoverable with neutral controls.

Greater asymmetry will produce spins with prolonged full aft stick after abrupt accelerated stalls. In previous spin programs, we were mystified as to why it went different ways on different days. We never had an airplane as repeatable, controllable, and recoverable as this one to explore and define this sensitive parameter.

The speed brake destabilizes the airplane and increases departure/spin susceptibility. It doesn't affect spin character or recovery. The Control Augmentation System has little or no effect on out-of-control susceptibility; and it turns off at 40°/second so is out of the picture in spins and during recovery.

The cause of the unintentional spin encountered in No. 1 F-15 became obvious during the program — it had 1,000 pounds of internal wing fuel asymmetry and the speed brake extended.

Modifications

Four airplane modifications were recommended. One of them was something I've been trying to sell for years — a "Spin Warning Cue" which tells the pilot that he has already departed but is still in the "self-recovery phase." In other words, "Let go, and it will recover itself!" Departure prevention is great if departures are really bad, but let's face it, how do you prevent a departure going straight up at zero degrees angle of attack which instantly changes to 180 degrees angle of attack? The audio warning in the F-15 tells the pilot that all this flopping around the airplane is doing can lead to a spin if he doesn't quit. The audio spin warning starts beeping slowly at 30 degrees per second yaw rate; the interrupt rate increases with yaw rate; and when it is steady (at 60 degrees per second), you are in Spin City. Now you have to figure out which way it is going and put in full aileron to ensure recovery.

Modification Number 2, the "Spin Recovery Aid," tells the control system (at 60 degrees/second yaw rate) to give you full aileron at any longitudinal stick position (we do the same thing with the gear down for better approach handling), essentially removing the anti-spin design of the flight control system. You have somehow out-foxed the anti-spin design (since you are spinning!), so let's make recovery easier. We satisfied ourselves that this mod will not affect spin susceptibility.

The third modification affects the

Tests have shown that the airplane is self recoverable in air-to-air configurations if controls are neutralized when the spin warning tone comes on.

fuel system and keeps wing fuel symmetrical; and the final change auto-retracts the speed brake above 15 degrees angle of attack.

For an airplane that is highly resistant to departures and spins, we seem to be proposing a fair number of out-of-control oriented modifications. However, we must keep in mind that the historic ability of early flight tests to predict future operational talent to depart airplanes has been notoriously poor.

Recoverability

With the modifications installed, stalls and departures up to the spin warning tone are permissible in the air-to-air configuration. Tests have shown airplane self-recoverability in any air-to-air configuration if controls are neutralized when the spin warning tone comes on.

When that guy comes along with the trick we couldn't find and manages to spin this airplane, the tone will stay on steady; now he must determine direction and apply appropriate aileron. When the aileron has done its thing and the spin breaks, the audio stops; now the controls can be neutralized and welcome to the club! Fairly simple, I'd say.

Category II

The USAF Category II program focused on things we didn't do in Cat I and three areas were explored: autorolls, large lateral asymmetry, and the centerline-tank-only configuration. Non-self-recoverable auto-rolls were generated, and recovery with opposite rudder was repeatedly successful. Pete Winters flew the Category II Air Force program, with Don Wilson directing the tests. Pete chased me a lot and had a unique talent for "creating" chase airplanes when none were available.

Neutral control self-recover ability was demonstrated with maximum lateral asymmetry in the air-to-air configuration. Stall characteristics were evaluated with as much as one full (600 gallon) external wing tank. Investigation during Category II of the centerline tank effects indicated that it significantly increased departure susceptibility but did not affect neutral control self-recovery up to spin warning tone yaw rates.

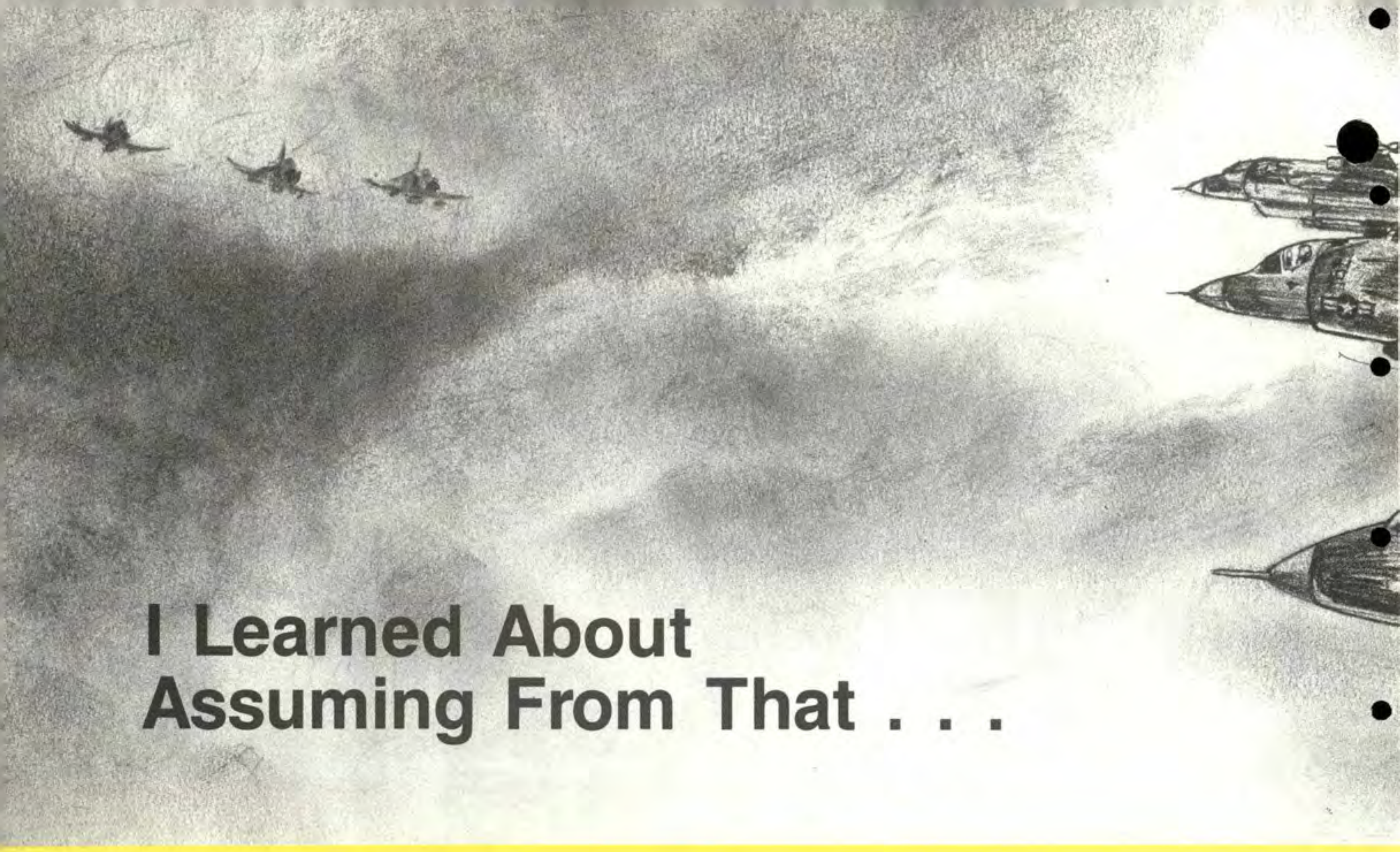
Operational Configuration

One flight was flown with the production system; all flight test indicators were masked; and all mods were installed, approximating the production configuration. Multiple stalls, departures, and spins were performed and recovered. I would personally have no reluctance to repeat such a flight without the emergency equipment.

Conclusions

Here are the key discoveries that were made.

- The airplane is essentially unrestricted.
- The operational pilot has a cue to identify how best to recover and confidence that it will.
- All angles of attack and sideslip (0 to 180 degrees) were achieved without incident.
- The engines performed beyond expectations.
- I think we fully explored all operationally achievable out-of-control maneuvers.
- We recognize our poor track record in forecasting spin losses and tried to do something about it. ■



I Learned About Assuming From That . . .

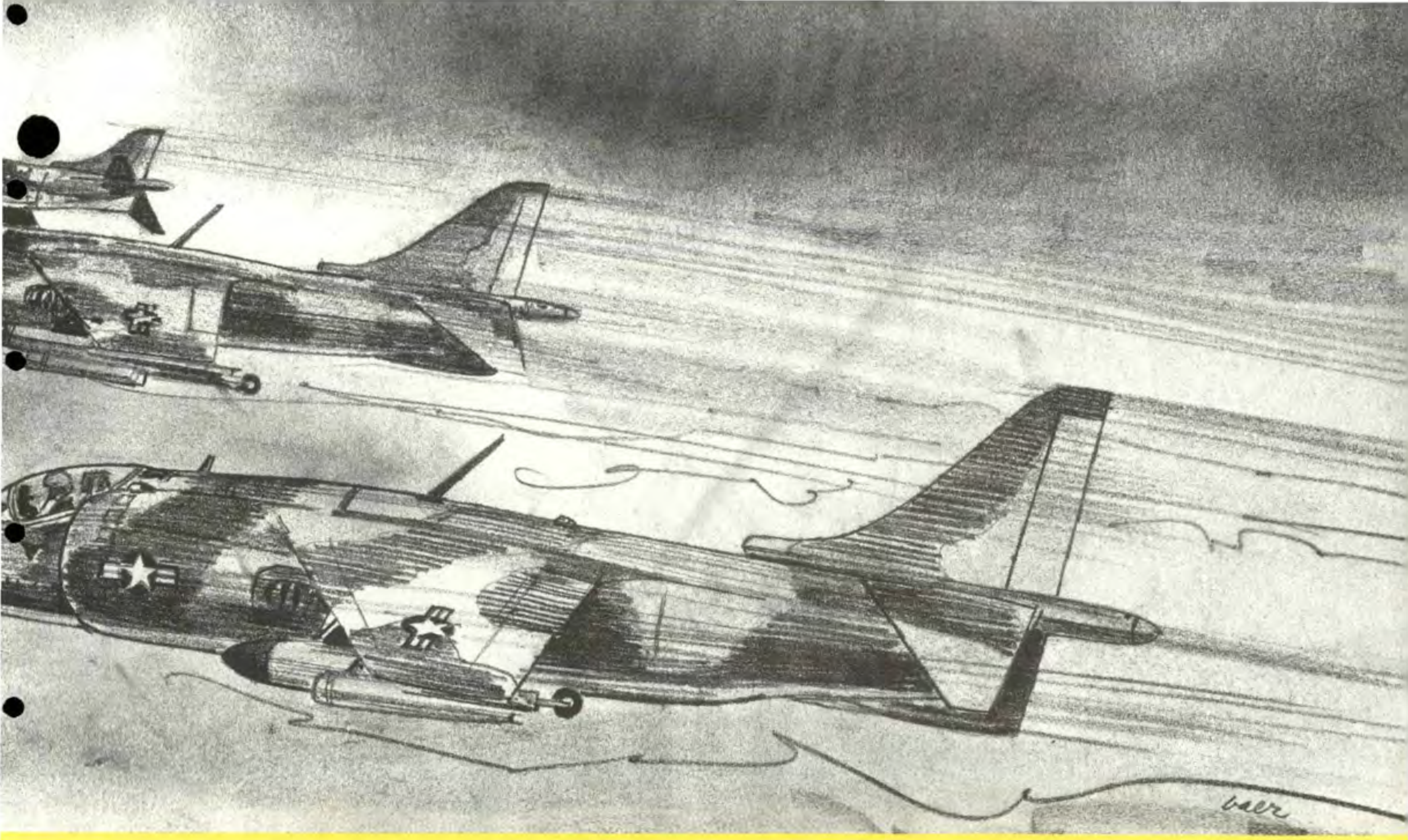
■ The mission was to be an early morning launch for a 4 v 4 DACT against our local squadron of Phantoms. It was to be the climax to a good week of DACT during our tactics phase but it didn't quite go as planned.

The wx forecast was poor; solid cloud cover from 500 to 15,000 feet but with a chance of lower cloud tops to the east. We spent a lot of time searching for suitable alternates since the recovery was planned for the Phantom base and it had no precision radar.

I was the leader and spent considerable time briefing the IMC trail departure, RV, engagements and the recovery to the Phantom base. We delayed take off due to the weather but found ourselves rapidly approaching the latest take off time to achieve a GCI and an area deconfliction window.

As my 4-ship taxied out I informed departure that we would be flying a 20-second trail departure in pairs and requested a non-standard right turn out after take off to be cleared through our satellite radar unit. We launched off into the "goo" and I called the flight to departure frequency (mistake — I should have put everybody on departure frequency prior to rolling — non-SOP at this base). The base had just changed all the ATC frequencies and the Harrier has difficulties at the high end of the UHF spectrum. As you've probably guessed by now, leader couldn't talk or receive so I punched over to the arrival frequency, explained the problem, and told arrival to get the rest of the formation over to this frequency. I had briefed the departure well so the rear element was following my ground track. However, after 15 seconds of silence and the absence of any check in from my flight, I asked arrival where they were. This controller replied, "Re-attempt contact on departure!" I replied "NEGATIVE" and told him to get everybody on arrival frequency IMMEDIATELY." Unbeknown to me, departure had issued an altitude restriction due to traffic which, of course, I had not acknowledged. I was now climbing through FL 180, in cloud, for my assigned FL 230. At FL 200 I popped out VMC, my flight checked in and I glanced to the left to see, one mile away and at the same level, a KC-135. I called my passing level to the rear element and the position reference to the KC-135. A new controller screamed, "Aren't you at FL 180?"

We pressed onwards to the GCI frequency and joined up but the weather was worse than forecast. I dropped the rear pair into 3-mile trail for a trail let-down towards the "reported" better weather to the north. At this point the GCI controller must have taken a coffee break; after 10 minutes of letting down, turning, airspeed and altitude calls and two queries about the rear pair's position the controller finally informed us that we were



five miles line abreast with the Phantoms tracking towards us only 10 miles away. I told the GCI controller that we were not ready to play and that we would continue north for the better weather and vector Nos 3 and 4 into trail. Ten minutes later we flew into better weather comprising a 2,000 foot space between layers but we were now at the edge of the GCI radio coverage. A new frequency made no difference to communications and a handover to a more northerly GCI was out of the question as they could not accept us.

Just then: "Practice PAN, Practice PAN, Practice PAN. . . ." So I deselected Guard. I decided to join up the flight and head west for better weather and told the GCI controller we were unable to play. His reply was "Roger, F-4s bear 270 deg range 10, engaging." I retorted "Knock it off, knock it off! We are not joined and not ready to play!" GCI replied "Roger, we've lost contact with the F-4s."

I can't remember exactly my next words, (I can but they ain't printable), but we quickly spread out from close formation with the hope of avoiding a possible midair collision.

The F-4s hadn't liked it either and had begun to turn around. They were only trying to RV with us but we didn't know this at the time. I immediately called the flight to the pre-briefed opponent frequency but there was no reply. Over to Guard: "Knock . . . Practice . . . it . . . PAN . . . off." It took three attempts to override the Practice PAN and, thank God, one of the F-4s had turned Guard back on!

We broke out into the workable area where the F-4s had been loitering; the weather met the legal requirements but common sense said it wasn't enough for eight aircraft. Anyway it obviously wasn't my day and I had no heart for it so I called "The Harriers are RTB." The recovery was sporting but uneventful when compared to the first 40 minutes of the sortie.

The lessons learned from this mission are many. You can never assume that ATC understands nonroutine departures; the controller had been briefed that it would be a trail departure but because he was new he didn't really know what that meant. The altitude restriction was heard in the rear element and they assumed that I had received it on the arrival frequency. There was little if any, coordination between the arrival and departure controllers. GCI assumed we were using radar for separation in the IMC descent: "Oh! . . . forgot the GR3 isn't radar equipped . . ." Coordination between the two fighter controllers was poor due to poor comms with the fighters. And finally, the F-4s thought we were VMC.

The bottom lines are: "Don't assume, be prepared for the worst, brief the worst case and be positive while being flexible!" — Adapted from RAF *Air Clues*, March 1984. ■

Look Back To See

Everything they said back in '45 is just as true today. Flying a light plane is not something to take for granted.

Remember the Big Step Up?

The step Down is the same size

DON'T NEGLECT THESE SENSIBLE PRECAUTIONS

ASK FOR A CHECK RIDE.

REVIEW CIVIL AIR REGULATIONS.

REMEMBER THAT THIS AIRPLANE WAS DESIGNED FOR PEACETIME FLYING.

AERO INSURANCE UNDERWRITERS

2

TO ALL MILITARY AND NAVAL PILOTS HOME FROM THE WARS:

Frankly, gentlemen, you have us worried. The situation is so complicated with our respect for what you have accomplished, our friendship for you personally and your accident record here at home that we can not even be subtle. Here are the facts:

You have been doing flying most of us couldn't touch.

You are rightfully proud and you don't relish any stay-at-home suggesting you need advice.

Your accident record since you came home is rotten—an abnormal accident rate for every hour of flying, case after case of exhibitionism, buzzitis, and poor technique in airplanes that don't perform like the equipment you are used to.

Everyone is reluctant to place restrictions on you, which puts us exactly in the middle with our neck out. Well, we are not going to place restrictions on you either, but we *are* going to ask you to remember three things.

1. C.A.R. has been changed since you went away.

2. Under the new rules *any* flying that endangers the life and property of another is *RECKLESS* flying, and it may affect the whole future of the pilot involved.

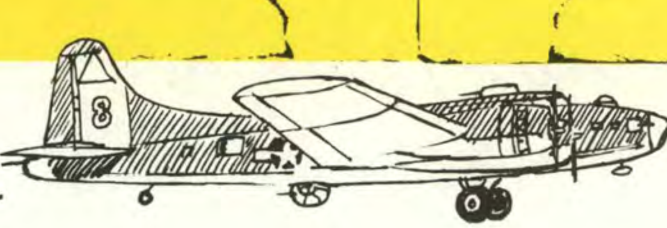
3. There is nothing wrong with a civil aircraft, *but it is different*. You are used to structures that will take a 9 G pullout with never a shudder. You are used to lots of horses out in front. Even more important, *you have come to expect things will happen—NOW—when you move a control*. The airplane you will rent or borrow won't be like that.

You know these things, of course, and you know they can add up to a rugged situation for us all. There isn't much we can do to help. Here are the revised sections of C.A.R. and here is our final bit of advice: *Ask for a Check Ride.*

Roger.

The Engineering Department
AERO INSURANCE UNDERWRITERS.

3



Ahead

MAJOR GARY R. MORPHEW
Directorate of Aerospace Safety

■ The two pages shown on the left were reproduced from a handbook given to returning aviators from World War II. After some pretty hairy mishaps, the insurance underwriters decided a review and caution were in order. It is obvious that they didn't pull any punches!

Many things have changed since then. The Civil Aviation Regulations have become the Federal Aviation Regulations, the requirements for civil flying became more stringent, and the aircraft became more efficient. How much concerning the military aviator taking a turn in light civilian aircraft has changed? Looking at statistics, very little.

Speaking as a military pilot having flown the F-105, the F-4, and one of the bug smashers of today's force, the OV-10, and being a light plane owner as well, I know the warning shown on the second page: "Remember the Big Step Up? . . . The Step Down is the same size," is accurate. (We all do remember the big step up, don't we?) When we step into a light plane after hours and hours of wrestling those fast, heavy, and maneuverable jets around the sky, everything appears to move at quarter time. Talk to anyone who has made that transition after an extended stay in the fast movers and he is likely to tell you that his cross check was like lightning; he didn't vary off his desired altitude more than 10 feet, airspeed was right on the money (except for the climb out where the airspeed dropped unexpectedly every time he pulled on the pole). He also might tell you the lack of dials, gauges, and switches made him feel a bit bored.

General aviation mishaps are predominantly a result of human error. Pilots overextend their ability or capability and get into a situation from which neither they nor their aircraft can recover. Unfortunately, they all too frequently involve someone who was "along for the ride." This sometimes plays an even greater role in the military pilot flying light aircraft. After all, if all you talk about is the thrill of flying, the "There I Was . . ." and so on, pretty soon those ground huggers are going to ask you to show them what it's like.

After a thorough preflight inspection (more thorough than normal to impress the uninformed), the intrepid aviator and his companion climb in, strap in, and leap into the air. Just cruising along is usually enough for the unsuspecting passenger, but the mighty fighter pilot can't take straight and level for more than a nanosecond. His turns peg out the turn needle, the coordination is a bit off (use rudder?) and the . . . aircraft just doesn't perform! He stretches the maneuver a bit too far and . . . OOPS! Hopefully, there is room to recover.

Federal Aviation Regulations (FARs) may seem quite unrestrictive to the standard military airman. After all, he has so many rules to dictate how he flies his jet that the broad general terms used in the FARs may appear to be license to disregard all he knows about flying safety. Most military regulations and directives are much more restrictive than their civilian counterparts. However, a few procedures and rules which normally don't affect the fast mover are critical to safe operations in lighter, slower aircraft.

Everything they said back in '45 is just as true today. Flying a light plane is not something to take for granted. Follow the three simple rules illustrated anytime you step from your Mig-chaser into the bug smasher. ■

Human Factors Happenings

COLONEL GRANT B. McNAUGHTON, MC
Directorate of Aerospace Safety

Loss of Control

■ Pilot induced control loss has been the greatest single contributor to the F-4 mishap history. With or without leading edge slats, the F-4 is very sensitive to lateral asymmetry, aft CG, pitch rate and yaw-roll coupling. The AOA gauge lags, and since it is located on the side of the fuselage, may not read accurately in the presence of much yaw. The presence of pylons and/or external stores improves directional stability (reducing tendency to yaw), but degrades longitudinal stability (increasing tendency to pitch more quickly).

A rapid pitch rate can cause an AOA "overshoot" and enhance any lateral asymmetry, no matter how minor. Even a small weight imbalance at high G causes the heavy wing to drop/lag, inducing a slight roll into the heavier wing. As AOA increases, this roll becomes yaw away from the heavy wing. This advances the down-going (heavy) wing, increasing its lift, while the up-going (lighter) wing loses some lift. If AOA increases a bit more, the up-going, receding wing stalls, and the aircraft can do a little mini-snap roll away from the lower wing. The combination of inertia and high AOA will usually cause several rolls, unless there is swift unloading. Most pilots won't be able to stop the rolling maneuver. This is a primary contributor to departure in F-4s, F-111s and many other aircraft. Some examples:

■ **F-4E** The mishap aircraft was number 2 of a 2-ship tanker/range mission. Due to poor weather at the range, the alternate mission of aerial refueling and intercepts was flown. However, the aircraft was not reconfigured; it retained three external tanks, left wing mounted SUU-21A, practice bombs and an ECM pod in the left forward sparrow well, and was thus laterally asymmetrical. The weather was 6,500 feet overcast, haze above with no clear horizon. Three intercepts were flown, with the mishap aircraft attacking on the first and the third. On the first, the attacker overshot the conversion turn, generating a high overtake.

On the mishap intercept, beginning at flight level 200, the mishap pilot had even less vertical and horizontal maneuvering room available than on the initial intercept. He compensated by starting a hard left slice to a stern conversion. During the turn, the pilot felt a bump; he relaxed the G momentarily, then reapplied G. As he increased G and bank angle to convert, the aircraft abruptly departed, rolling to the right to an inverted, nose low attitude. The pilot unloaded the aircraft as the nose dropped to the vertical; he searched for outside references to reorient himself, and unable to find any, transitioned to the ADI. When he reapplied back stick pressure to level the nose, ADI movement with respect to the aircraft symbol on the ADI face created the illusion of rolling again. At this point, he unloaded again, depressed the paddle switch, and retarded the throttle. He then pulled the aircraft toward the horizon, but by the time he neared a level attitude, he was in the overcast and airspeed had decayed below 225 knots. Whether a roll occurred at this time is unknown. It is possible that vestibular inputs could have created just such a sensation, or with airspeed decaying and AOA climbing, the aircraft could have departed again. Regardless, the pilot interpreted it as a control malfunction and ordered ejection, which was accomplished successfully at less than

With or without leading edge slats, the F-4 is very sensitive to lateral asymmetry, aft CG, pitch rate, and yaw-roll coupling.

Pilot induced control loss has been the single greatest contributor to the F-4 mishap history.

2,500 feet AGL.

It was concluded that the combination of lateral asymmetry and increased pitch rate caused an AOA overshoot resulting in a yaw-roll coupled departure to the outside of the turn, and away from the heavy wing. Lack of external references produced disorientation, and misinterpretation of the ADI added to the confusion such that the pilot was unable to properly manage his recovery, losing over 14,000 feet in the process. He should have held the stick front and center until the aircraft stabilized and airspeed increased. If that failed to stabilize the aircraft, a flight control malfunction should have been suspected and ejection ordered. When he was still out of control/unrecovered below 10,000' AGL, one of the crewmembers should have initiated a dual sequenced ejection. Fortunately, they both got out in the nick of time.

▪ **F-4E** The aircraft was to perform a single-ship low level training tactical sortie and was equipped with TISEO, two 370 gallon tanks outboard, a 600 gallon center line tank, an ALQ-119 pod, and ALE 40's on the inboard pylons. The flight progressed normally through an IFR letdown into the low level area. While approaching the low level turn point, a 400 foot microwave relay tower on a 2,260 foot hill, the

mishap aircraft made visual contact with two A-10s conducting practice surface attack tactics in the area. After spotting the first A-10, the F-4 turned right to assure lateral separation, then began a left turn toward the turn point. While in the left turn, the F-4 apparently spotted the second A-10 and continued his turn, misappropriating his attention on the A-10 instead of monitoring his own flight path. He suddenly became aware of an impending collision with the microwave tower, abruptly pulled back on the stick, and departed the aircraft. The WSO initiated a dual sequenced ejection half a second before impact. Two fatal.

▪ **RF-4C** The pilot was flying a strike control and reconnaissance (SCAR) mission with two fighters. While ingressing the target area, he apparently departed his aircraft at low altitude and impacted before the ejection sequence could work. Several factors were quite likely players in this mishap.

▪ General atmosphere of the daily, post-flight video tape debriefings plus composite tapes from previous similar exercises which showed that camera operators had more difficulty keeping an aircraft in the tracking bars when the aircraft maneuvered in the vertical. The tapes had comments such as "He's dead," "We got him," or "Wow, that's good maneuvering!" In the last instance, the aircraft had been maneuvering excessively in the vertical, rolling inverted, and pulling abruptly out of a dive at low altitude. Comments by fellow crewmembers of a laudatory nature, e.g., "Man that's some *heavy* jinking!" etc., reenforced the impression that it was tactically sound to defeat the camera. This may have motivated some crews to use overly aggressive jinking without regard to a specific threat or realistic tactics. Only two days before this mishap, two other fighter crews flying SCAR with the mishap pilot stated that he had performed the most aggressive ridge crossings they had ever seen. It "really got their attention."

▪ Aircraft and configuration: the

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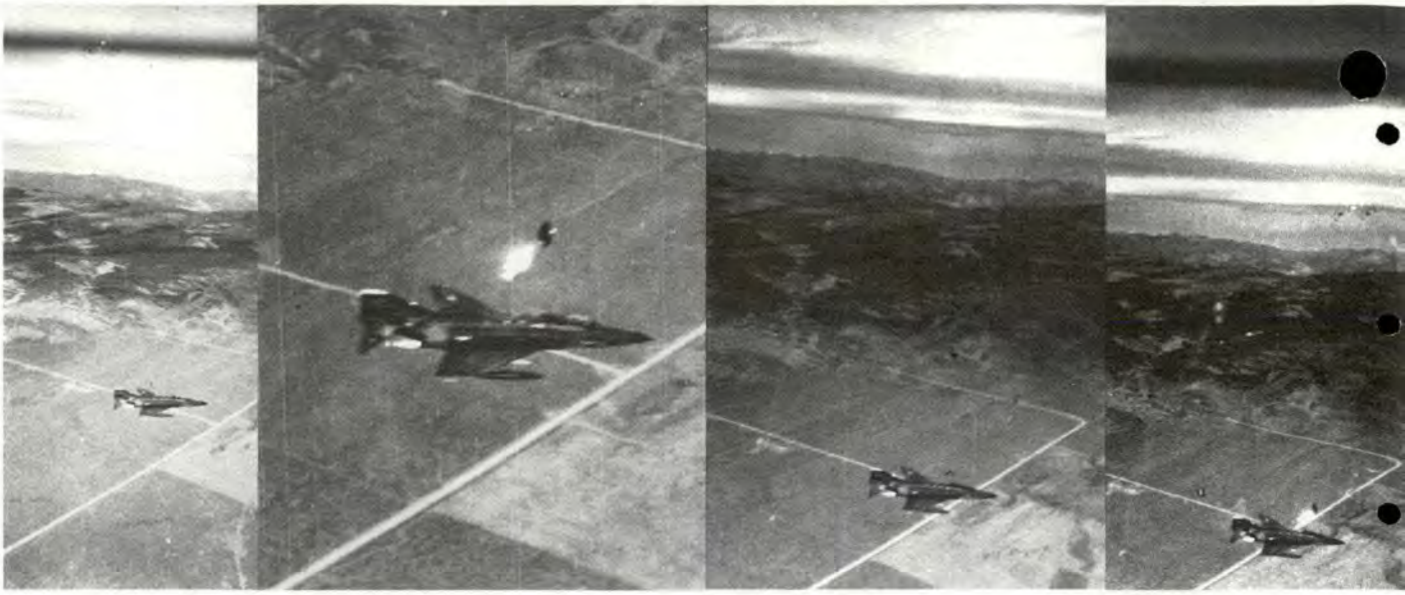


Human Factors Happenings continued

mishap aircraft was more pitch sensitive than the one the pilot had flown the previous three days. On the preceding day's mission, the pilot had to terminate early because of fuel. On the mishap flight, the pilot took on extra fuel such that he departed the tanker with nearly a full fuel load. His aircraft was, therefore, heavier and with a CG farther aft than any he'd flown in this threat area. With an ECM pod on the right inboard pylon, the aircraft was also asymmetrical.

The mishap pilot was described as an aggressive, confident, good stick who reacted to threat indications with heavy jinking in the vertical. On the mishap flight, the pilot departed the tanker orbit, leading the SCAR formation into the low level threat area. He crossed one ridge line, released chaff, and began jinking aggressively in the vertical. He then pulled to the right and released more chaff, descended back to 300 AGL, turned left and started another pull-up. He apexed at approximately 1,000′ AGL in a right roll and continued to an inverted position, impacting the ground in a steep nose low attitude. Impact occurred only 12 minutes after leaving the tanker.

The SIB felt that the combination of a different aircraft with known pitch sensitivity, aft CG, heavy gross weight and asymmetry, plus aggressive pitch rate inputs and rolling to the inverted caused a high energy departure from controlled flight. Indications are that he had recovered from the departure — just didn't have enough room.

Ironically, at the mass debriefing on the day preceding this mishap, two other RF-4C crewmembers stood up before the other exercise participants (and the video camera) and described why and how they had nearly met their Maker that very day. The pilot related the effect the video tape debriefings had had on him. For example, there was "light" jinking and "heavy" jinking — and he, for one, "wasn't going to have any of that light jinking. They're not going to shoot me down!"

The result was that although he entered the threat area at about 540 KIAS, after some three minutes worth of "heavy" jinking he felt his speed was down below 350 KIAS (although he wasn't watching his airspeed because of attention

"I said to myself, saving it isn't going to mitigate this thing at all. You know you should eject for the wife and the kid."

directed outside the aircraft).

At any rate, he got way too slow. As he approached a threat, he pulled up and rolled to 120° of bank. As he rolled back to an upright attitude and pulled on the stick to arrest his sink, the plane "bucked, snorted, rocked, and rolled," and continued its descent. He would have ejected but thought he didn't have time or room. With the ground rushing up, he knew they were going to die. The aircraft wallowed down into ground effect and mushed along without hitting anything for what seemed like an eternity, and finally regained enough airspeed to recover.

The pilot concluded this very timely and pertinent story by emphasizing that this was, after all, a training exercise; that the idea was to learn; that it didn't matter at all if you were "shot down" by the camera; and finally described how misdirected overmotivation had nearly killed them both. The WSO then spoke saying the camera was a 0 percent kill, but the ground was 100 percent kill. He also made the point that, being from a sea level base, some time was required to recalibrate his eyes and to reprogram his frame of reference to the surface altitude of the exercise area.

Because they were on a different schedule, the mishap crew missed this very dramatic and credible story by two of their peers. Perhaps it might have made the difference.

Some Notes on the Ejection Decision

All escape systems, no matter how good, have two important limitations. One is time. For example, depending upon airspeed, the rear seat out of the F-4 takes 4 or 5 seconds from initiation to full parachute and the front seat takes about a second longer. The faster the airspeed at ejection, the faster the chute inflates, though even after full inflation, it still takes another fraction of a second to decelerate to final descent speed.

The other limitation is trajectory. Even under optimum conditions of seat boarding weight and CG, and of aircraft attitude and velocity, the rear seat of the F-4 will overcome a sink rate of only about 50 FPS, and the front seat 40 FPS (because of the 0.85 sec delay). These escape systems are not designed to overcome the horrendous sink rates generated by out of control aircraft, which may exceed 600 feet per second! Indeed, we have good evidence that another F-4E, out of control, lost 7- to 8,000 feet in less than 16 seconds, and possibly as little as 11 seconds, for an average sink rate exceeding 500-600 FPS!

■ **F-4E** In this instance, the crew had been defending during an ACT engagement, and while pressing to defeat his attacker, the pilot departed his aircraft, above an overcast/haze layer which topped at 7,000' AGL. This pilot had a reputation as an aggressive, up and coming, good-stick, and he tried hard to salvage his mistake, rotating the nose from near vertical to near horizontal just above the overcast layer — probably trying to avoid entering it, but undoubtedly inducing a secondary stall. We'll never know

continued

Human Factors Happenings continued

for sure what went on in those clouds. Perhaps this pilot became disoriented. That's certainly to be expected. One thing is certain, though. Both crewmembers lost awareness of how fast they were coming down.

Pilots, of course, are trained to recover aircraft. This pilot was almost likely totally wrapped up in flying the aircraft, and would quite likely be attending those instruments most pertinent to that end — namely the ADI, airspeed indicator and AOA gauge. Since the mind time-shares, absorbed as he was in one task, the thought of ejecting may not have occurred to him. Since the altimeter would not help him untangle his mess, he may not even have looked at it, although he should have known that even had he gotten the aircraft flying again, the ensuing dive would eat up another 4- to 5,000 feet. Thus, when that aircraft fell through the 4,000 foot AGL mark, it was destined to crash in the not-too-distant future, and it was absolutely futile to stay with it. And when that aircraft broke through the base of that 1,500 foot overcast with them still aboard, they were both dead men. The WSO did initiate a dual sequenced ejection shortly thereafter but barely achieved man-seat separation when he hit the ground.

Ironically, less than a week prior, this WSO had assured his wife that he'd never ride one in. The Air Force lost two fine people and left a pair of widows and a couple of fatherless kids. A real tragedy — more so because they had enough time to make it had they respected their mandatory bail-out altitudes. There's a good reason for those altitudes. You just don't have much time.

■ **F-111A** The fact that a pilot can become so involved in diagnosing and treating his departure situation that he never even considers ejection was well-illustrated by a very good test pilot a few years back. This pilot was performing spin tests in the F-111A from 37,200′ MSL. Antispin controls failed to work, and the spin-chute tore away. However, both the pilot and the test engineer (in the right seat) thought the aircraft was recovering. As the aircraft shot through 16,000′, the chase pilot yelled "Get out, Pete!" Fortunately, the urgency in the chase pilot's voice, plus the use of the test pilot's first name, broke the code and the ensuing ejection was successful.

Since this was a test program, the capsule was highly instrumented, and the aircraft tracked by special ground cameras, which recorded the entire spin and ejection sequence on film. It was possible to determine with considerable precision, sink rate and capsule separation altitude: the sink rate had reached an incredible 821FPS, and the actual separation altitude was 12,050′ MSL. Three seconds later, the capsule would have been outside the escape envelope. The pilot later admitted that he never even thought about ejection until prompted by his chase. He doubts that he or his engineer (who was not a trained WSO) would have made that decision and acted upon it within the next three seconds.

Loss of situational awareness . . . Channelized attention . . . Trying to recover from a perceived pilot error . . . These have all led to a delayed ejection decision. Don't let it happen to you.

■ **F-16A** The mishap aircraft was part of a two-ship formation conducting surface attack tactics. The centerline fuel tank failed to feed, trapping 1,000-1,300 pounds of fuel, and the pilot became aware of this only shortly before his engine flamed out.

After the engine quit and airstarts were unsuccessful, the pilot spotted a straight road about four miles long, of white caliche. He told his wingman "Hey, maybe there's a chance of putting this down on a road." His wingman reconnoitered the road, thought it unsuitable and repeated several times: "I don't recommend you land this thing." But the pilot had other ideas, as he later stated, "I'm sure I had the attitude that it's got to be a pilot error and if I land the plane, and it's OK, that it will somehow mitigate a pilot error."

Things went well until in the flare, when the pilot got a real good look at his runway. There were big ruts, the road was partially washed out, it looked very narrow (not as wide as the landing gear), it was crowned, and it sloped off to one side. A number of things went through his mind in that split second, but one thing was "If you get this thing on the ground, how are you ever going to get it to stay on the road? If you catch a main gear off to the side, the thing may cartwheel." And then I said to myself, "Your saving it isn't going to mitigate this thing at all; you know you should eject for the wife and the kid." Although quite low, his sink rate was nearly zero'd out — and ejection was successful.

The foregoing examples have illustrated several reasons where crews delayed ejection:

■ Loss of situation awareness or lack of sufficient commanding information to force the decision: neither crewmember could have known how little time remained.

■ Attention channelization by trying to overcome the problem to the exclusion of all other inputs. In order for the ejection decision to be made, it may need to be done by someone other than the pilot — either the GIB (in a two-place aircraft) or an element-mate (in the case of single seat aircraft).

■ Attempting to mitigate a (perceived) pilot error. ■

What You Always Wanted To Know ABOUT HATRs And . . .

LT COLONEL NICHOLAS O. GASPAR
Directorate of Aerospace Safety

■ The HATR program has been around since 1976. But there are still some misconceptions about it. Do any of the following comments sound familiar?

"We don't need to 'elevate' this incident; we can handle it in house. It's no one's business when one of our people makes a simple mistake."

"If we report this incident, we'll be the laughing stock of the whole command. Let's just take care of it in house."

"It was just the usual conflict we always have this time of the year when all those VFR aircraft fly through our area. What good will it do to report it and get everybody excited?!"

"At my last base we faithfully reported these types of incidents yet nothing was ever done to resolve the problem — so I see no need to go through all that hassle for nothing."

"This is a unique problem and doesn't really have any application Air Force-wide, so why report it?"

"If we report this incident we'll never hear the end of it! Remember that fiasco at . . .?"

These are some of the typical perceptions and rationalizations we've heard. Surely, you wouldn't use any of these excuses, would you?

At one base, pilots were being cited by ATC on a weekly basis for failing to comply with the altitude restriction in the SID. Because no HATRs were filed, many more pilots inadvertently violated the SID restrictions. Some of these altitude deviations brought them close to airliners descending into a major metropolitan area. Busting SID restrictions is a sure way to "earn" a formal FAA violation package. In the case above, it was not until many months later when the formal packages finally arrived at AFISC that the special projects officer was able to alert base officials to the SID problem. Once the problem was identified, the rest was simple.

Some incidents are reported yet never enter the "formal" HATR system — they just fade away. Here is an example.

■ During RTB, the pilot of a fighter aircraft refused to follow ATC instructions for some unknown reason, though no emergency had been declared. The fighter's projected flight path would conflict with the departure path of a jumbo airliner which had already been released for take off from an adjacent civil airport. The alert controller, realizing this conflict between the two flights cancelled release on the jumbo. The airliner, which by then was already on take off roll, aborted — fortunately, without incident. But, things could have ended quite differently. Any lessons we might have learned from this incident are lost because no HATR was filed.

Some bases have not filed any HATRs in several years. This lack of HATR data gives the impression that these bases have no hazardous air traffic problems. This is unlikely.

It may be argued that recurring, near midair collisions are caused by the unique location of a base — its proximity to other airports, to popular VFR flyways, to resort areas, etc., and therefore not have applicability elsewhere. Not so. There is still a lot to be learned from these reports if they are processed through the HATR system. By not reporting an incident, the nature of the corrective actions taken, if any, remain confined to the local area. A lack of history of past mistakes and unusual "experiences" denies us and those who follow us an opportunity to learn from the past.

continued

What You Always Wanted To Know ABOUT HATRs continued

To get a true perspective of the HATR program and its aims, we need to see why a separate program was established to deal specifically with hazardous air traffic incidents.

The disastrous Grand Canyon midair collision between a TWA Constellation and a United Airlines DC-7 — and some other equally serious incidents — prompted several legislative acts, including the Aviation Act of 1958.

During the following decade, air traffic related accidents continued at an unacceptable rate. In the 1970s Congress tasked the FAA to establish a safety reporting program which would identify potential accidents and their causes — the objective being to correct these causes before they result in actual disasters.

The system established as a result of this congressional mandate is what we know as the Aviation Safety Reporting System (ASRS). The purpose of this reporting system was and remains the identification of unsafe acts, procedures, rules, regulations, deficiency in design of airports, or deficiency in design or operation of equipment — certainly a very broad charter.

The Air Force experience was similar to that of civil aviation. Our mishap rates were too high and the hazard report (HR) system was not sufficiently responsive. Often, by the time the report got to where it needed to go (for investigation and corrective action) too much time had elapsed and the ATC tapes and other records were gone. That made it difficult and sometimes impossible to reconstruct the true circumstances surrounding the specific incident. The HR system was not a bad system, it was just not responsive enough for the time sensitive air traffic control incidents.

Thus the genesis and the key points of the HATR program: *Immediately notify ATC and your flight safety officer of HATR reportable incidents, then follow up with a written report.* Many NMAC reports lose their preventive value because the "other" aircraft is never identified and those pilots remain unaware of the close call they experienced. That's why ATC must be informed right away, so that they have a better chance to locate the other aircraft. We need to exchange information with our civilian counterparts on our mutual mission needs as well as to find out more specifics about the close call. We need to know if they saw our aircraft, what they were doing at the time of the near midair (climbing or descending is quite different from doing airwork), were they in contact with any ATC facility, were they squawking, etc? Then, through cordial discussions with our professional FSOs, these civilian pilots can better understand the scope of the problem we all face.

This implies that we need to keep an open mind and try to learn from each other how to optimize airspace deconflictions. Occasionally, you may come across a vocal maverick who will tell you in clear and concise terms what you can do — fortunately those are the minority. As a whole, the aviation community is composed of mature and intelligent individuals whose interest and love for aviation makes them willing to work common problems.

Incidentally, do you know about the immunity provision of AFR 127-3? To ensure that none of you pass up an opportunity to identify hazardous situations, the Air Force (and FAA) grant you immunity from disciplinary action if you submit an HATR on a hazardous incident. Become enlightened and read the reg — it's short and to the point.

To people outside of safety channels, this article on HATRs might sound complicated. It really isn't! Do yourself and others a favor; don't ignore potential hazards. If it is a hazardous situation reportable under the HATR system, report it. It will allow the safety folks to analyze the incident and decide if a change in procedures is warranted, and hopefully make it safer for all who fly. If in doubt, talk to your friendly FSO. If the FSO doesn't have the answer, the Airspace and Air Traffic Control office at AFISC can help and is only a phone call away at AUTOVON 876-3416. ■

Hints for HATR Investigators

A few hints for HATR investigators: because NMAC incidents with civil aircraft need the involvement of the Flight Standards District Offices (FSDO), the investigating safety officer should call them as soon as possible (along with the heads up call to air traffic). The FSDO people have the connections; they can call local fixed base operators and civil towers to try and locate the civil aircraft involved in the incident. (HATR incident reports must be mailed to the FSDO concerned — terminal facilities, FSS and FSDOs have no AUTODIN terminal available to them.)

IFC APPROACH

By the USAF Instrument Flight Center, Randolph AFB, TX 78150

MICRO-BURSTS... SHEAR TERROR

■ On 9 July 1982 at New Orleans International Airport, a Pan American World Airways Boeing 727 encountered a disastrous wind shear. During liftoff and initial climbout, the aircraft experienced a 40 knot decrease in head wind and subsequent loss of airspeed and lift which caused it to abruptly pitch down. The pilot added full power and attempted to raise the nose, however, recovery was not possible. The crash occurred a few seconds later, killing all 145 persons on board and eight persons on the ground.

The National Transportation Safety Board determined that the probable cause of the accident was wind shear associated with a thunderstorm microburst. This was the ninth major commercial aviation accident attributed to wind shear in just over seven years. The first occurred in 1975 when another Boeing 727 crashed on landing during a thunderstorm at John F. Kennedy International Airport, New York City, killing 113 persons on board. During the investigation of the JFK accident, thunderstorm downbursts and microbursts were first extensively examined and found to be causal to aircraft accidents.

What Is Wind Shear?

Wind shear is a sudden change in wind direction and/or speed over a short distance in the atmosphere. These changes can occur in both the horizontal and vertical planes. Wind shears are most often caused by low level jets, wind funneling, land-sea breezes, fronts, and thunderstorms. Most aircrews will, at sometime, encounter wind shear in either the departure or arrival phase of flight. The result usually is only minor fluctuations in airspeed and altitude which can be easily corrected by the pilot. However, in some situations the atmosphere is capable of producing severe wind shears that result in wind direction changes of 180 degrees and wind speed changes in excess of 60 knots. A wind shear of this intensity can be treacherous should an aircraft unexpectedly fly into it at low altitude.

Downbursts and Microbursts

Downbursts are downdrafts with speeds up to 60 miles per hour that disperse in a sunburst pattern upon reaching the ground. Microburst is a term used to describe a very small (less than two and a half miles across), short-lived downburst (see

continued

Classical ring of dust showing immediate impact point of microburst. (Fujita, University of Chicago)

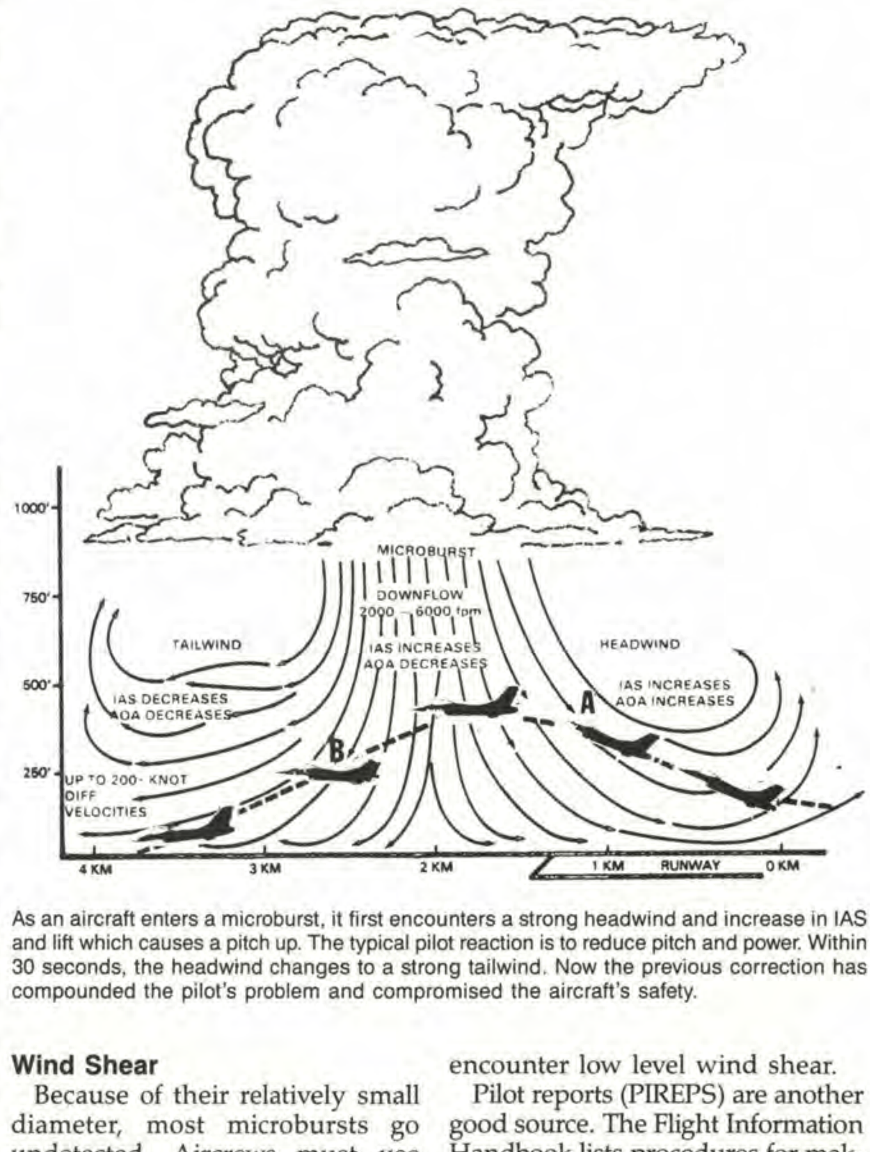
Microbursts: Shear Terror

Figure). Because of their small diameter and short life span, microbursts do not affect all departing and arriving aircraft. Those landing between downbursts will be relatively unaffected by wind shear. However, since the possibility of encountering a microburst exists, aircrews should know the effects that the resulting wind shear can have on aircraft. The July issue of *Flying Safety* magazine contains a good discussion of microbursts and their effects.

Effects on Aircraft Performance

In the figure, aircraft A has just flown into a microburst. The aircraft will initially experience a strong increase in head wind with a resulting increase in indicated airspeed and lift that will cause the aircraft to pitch up. With no pilot inputs, the aircraft will gradually slow to the airspeed for which it was previously trimmed. Most pilots, however, would attempt to correct by reducing power and applying nose down pressure on the controls at the onset of the pitch up.

Approximately 30 seconds after flying into the microburst, the aircraft at B in the figure suddenly loses the head wind and picks up a strong tail wind. The resulting loss of indicated airspeed and lift causes the aircraft to pitch down. Pilot reaction would typically be to add power and apply back pressure on the controls. However, that action might be too little or too late if the pilot had just previously corrected for the head wind (reduced power, nose down) and unknowingly compounded the effect of the tail wind. Aircraft recovery will now depend on pilot reactions, aircraft performance capability and altitude at which wind shear was encountered. A sudden loss of head wind at low altitude may exceed pilot and aircraft recovery capability and result in tragedy such as occurred in the two 727 accidents.



As an aircraft enters a microburst, it first encounters a strong headwind and increase in IAS and lift which causes a pitch up. The typical pilot reaction is to reduce pitch and power. Within 30 seconds, the headwind changes to a strong tailwind. Now the previous correction has compounded the pilot's problem and compromised the aircraft's safety.

Wind Shear

Because of their relatively small diameter, most microbursts go undetected. Aircrews must use other indirect indicators to avoid areas of significant low level wind shear.

Visual cues often indicate the presence of strong surface winds and wind shear: blowing dust or smoke, precipitation trails or virga, blowing trees, and heavy rain. All of these phenomena have been associated with strong downdrafts and microbursts. Pilots observing these indicators should expect to encounter low level wind shear.

Pilot reports (PIREPS) are another good source. The Flight Information Handbook lists procedures for making reports which should include: the loss/gain of airspeed and altitude, location of shear, and type aircraft. Because thunderstorm microbursts are of short duration, PIREPS must be made and disseminated immediately.

If the aircraft is equipped with a weather radar, the take off or arrival path should be examined for the presence of strong radar returns. Wind shear is often associated with these returns; however, absence

The best action to take for microburst wind shear is to avoid it. Delay takeoff or arrival for a few minutes.

Thunderstorm rain core with possible microburst outflow near the surface shown on left. (William Mahoney, Univ. of Wyoming)

does not preclude the existence of wind shear.

At many civil airports with high susceptibility to wind shear, the FAA has installed Low Level Wind Shear Alert Systems which include remote and centrally located anomometers to measure wind speed and direction. Readings between anomometers are constantly recorded and compared. If the difference between any two readings exceeds an established limit, an alert signal appears in the control tower and wind shear alert is then passed to arriving and departing aircraft. Aircrews receiving such an alert should exercise caution and look for other clues that indicate the presence of shear.

The National Center for Atmospheric Research, Boulder, Colorado, has been doing research on a wind shear detection system for the future which uses a Doppler weather radar and is capable of depicting winds on a radar screen. The computer displays wind directions and speeds highlighted with varying colors to indicate whether winds are blowing towards or away from the radar station. A microburst makes an easily identifiable pattern on the radar screen.

Pilot Techniques

The following are pilot techniques that will minimize the effects of wind shear.

- The best action is to stay away from trouble by delaying take off or arrival until conditions are more favorable. Most Air Force missions are flexible enough to avoid the short lived microburst phenomenon.
- If avoidance is not possible, plan ahead. A shear which decreases head wind is the most dangerous and, if suspected, plan to fly higher than normal speeds. Calculate both a minimum approach speed (IAS) and a minimum ground speed (GS). Then, fly the approach or departure so that neither the IAS or GS goes below the calculated minimum speeds. The resultant higher airspeed will help counteract any downdrafts or sudden loss of head wind. If ground speed read-out is not available, it may be advisable to increase normal approach speed to provide an extra margin of safety.
- On multiple aircraft, one crewmember should constantly monitor the flight instruments until safe landing or departure is assured. The crewmember should be aware of the TAS/IAS/GS relationships and alert the pilot when things don't look right. If an approach during wind shear conditions becomes unstable below 500 feet, a go-around should be executed.
- Become familiar with any wind shear procedures outlined in the aircraft Dash One.

Summary

Current technology cannot provide controllers or aircrews with timely information to aid in avoiding low level wind shear. Microbursts will continue to lurk insidiously out there waiting for the unsuspecting pilot. Aircrews should keep in mind: (a) Conditions which cause low level wind shear, (b) The affects of shear on aircraft, and (c) A "plan" to recover the aircraft from wind shear. The bottom line is don't get complacent during approach or departure or the first encounter with a microburst may ruin your entire day.

We encourage your comments and suggestions. If you have any topics you feel should be discussed in IFC Approach, please write us at the USAF Instrument Flight Center/FD, Randolph AFB TX 78150, or give us a call at AUTOVON 487-4071. ■

"Negative Transfer Of Training"

Could it Happen to Me?

MAJOR ROBERT L. MYER
Indiana ANG

■ As I completed reading the final Class A mishap report involving one of our unit's aircraft that resulted in the death of a good friend, it was hard to believe that a pilot with his experience and expertise could be involved in a learning phenomenon called negative transfer of training. In this mishap, the pilot reacted under an acute stress emergency situation. He evidently regressed back to old emergency procedures learned from a previously flown fighter aircraft for he activated inappropriate handles which deactivated the automatic chute opening features of the ejection seat system.

Negative transfer of training is a learning disorder often associated with pilots transitioning to new aircraft. Well learned habitual tasks can be unconsciously "carried" from the old weapons system to the new. Psychologists suggest that if the old and new situations contain similar stimulus patterns, they can have a tendency to evoke the same responses. For a pilot responding to an emergency situation, these similar but incorrect actions can be dangerous and potentially lethal.

An important factor strengthening negative transfer of training potential is the fact that most pilots do their most thorough learning during pilot training and the early portions of their flying careers. During this portion of their careers, there is the natural tendency to work harder and learn more thoroughly. Then, during transition later to new aircraft, there is not the compelling and overwhelming need to learn as well or practice as hard the new procedures associated with the transition since they are "known" professionals and familiar with all the basic skills of aviating.

Unfortunately, this can result in older, well-learned habit patterns being left deeply ingrained in our subconscious memory system. If these habits ever conflict with a new required habit, the response may be associated with the old habit and be totally incorrect. This negative transfer will usually expose itself when an individual's attention is distracted or he is exposed to a high stress situation.

An example of this phenomenon is when a 55-year-old lady took up bicycling after not riding a bike for over 30 years. She purchased a new 10-speed bike equipped with hand brakes. On one of her first few rides, a car unexpectedly pulled out in front of her. Unconsciously she attempted to brake using the non-existent coaster brakes. In this example, she regressed back to a well-learned habit pattern after over 30 years of non-use.

In aviation, an effective method to help preclude the potential for this phenomenon would be to standardize critical systems between specific types of aircraft (i.e., fighter/attack egress systems). Although human engineering and design people attempt to systematically adapt the "machine to the man," there are numerous instances of lack of standardization of critical systems.

A classic example of this is obvious in reviewing current fighter/attack aircraft ejection seat initiation handle locations. The F-4 and F-16 aircraft require initiation from a center-mounted handle, while the F-15 and A-10 are initiated from a side mounted handle system.

As many of our pilots are transitioning between these different ejection seat equipped aircraft, it is obvious that possible "death traps" have been built into our current aircraft because of lack of standardization. This situation has created ideal opportunities for future "human factors" related mishaps involving possible negative transfer of training.

With these potential lethal "traps" identified, flying units should acknowledge their existence and modify training programs accordingly. The following are a few ideas to assist in training programs to preclude negative transfer of training.

■ Thoroughly compare old aircraft systems and procedures with the new aircraft, attempting to identify potential "traps."

■ If potential "traps" are identified, establish or modify the training syllabus to highlight their existence and the consequences of habit pattern regression.

■ Notify MAJCOM personnel of the potential hazard so possible remedies can be initiated.

■ Establish realistic emergency simulator training programs to stress the identified problem areas, with emphasis on the potential for negative transfer of training during actual high stress emergency situations.

■ Consider increasing the frequency of emergency simulators and/or egress training sessions during the early portions of a transition to a new aircraft.

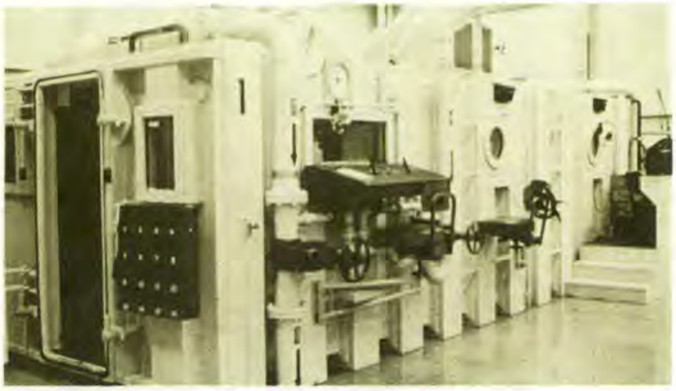
■ Consider locally adding "Bold Face" emergency procedures that would highlight the potential habit pattern regression procedure (i.e., EJECT — *Center* handle — Pull).

In answering the question addressed in the title of the paper, I can, through experience, answer *yes*. During the F-4 mishap sequence referred to, I was in the rear cockpit and also experienced an example of negative transfer of training.

While accomplishing post ejection procedures, I found myself attempting to unsnap the parachute attachment fittings (Koch fittings). I had reverted back to a procedure required after ejection from the F-100 aircraft. Luckily, I realized my mistake before any damage was done. This was a very sobering experience.

Yes, negative transfer of training is a real, current threat and it could happen to *you*. ■

The F-4 and F-16 aircraft use a center-mounted handle and F-15 and A-10 a side-mounted handle system.



Aircrew Refresher Physiological Training

COLONEL GEORGE A. LaHOOD, BSC
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Improvements in physiological training planned for this year include a curriculum geared to specific weapons systems, more emphasis on human factors, and altitude chamber flights tailored to the category of aircraft flown.

■ A formal study, to improve the effectiveness of refresher physiological training, has been ongoing for several years. The main objective of the study is to tailor the training to the aircrew weapon system. Currently, the study is in Phase III (program development) of its four phases. When completed, refresher physiological training will be provided based on three categories of weapon systems: Category I, high performance aircraft (fighter/attack/trainer); Category II, multiplace aircraft (bomber/cargo/transport); and Category III, low and slow aircraft (mostly helicopter). Full implementation (Phase IV) of the results of this study will most likely occur later this year. The revised refresher course will include a curriculum specific to weapon systems with emphasis on human factors, and altitude chamber flights tailored to the category of aircraft being flown.

Included in the refresher study was a review and analysis of the most appropriate frequency for providing this training. Two separate, formal studies were conducted. Data was collected and analyzed from these sources:

- Two opinion surveys of over 2,500 aircrew members.
- A survey of 180 flying safety experts.
- Computer analysis of all physiological flying incidents for five years — 1973-1977.
- A report on aircraft accidents, 1974-1977.
- Computer analysis of actual Class A, B, and C aircraft mishaps, 1977-1981.
- Review of the literature on education and knowledge retention.

The findings and recommendations of the studies on the frequency of refresher physiological training were provided by the MAJCOMs and the Air Staff. Concurrence and approval from these agencies have now been finalized with these conclusions:

- The frequency of training will remain unchanged at three years.
- New aircrews entering the fighter and attack inventory will receive their first refresher course within one year of undergraduate flying training, then every three years thereafter.
- The current five year training frequency for officers with more than 25 years of rated service who must fly with an instructor remains unchanged.
- The remainder of the refresher study will be completed to tailor the refresher course by weapon systems.

Implementation of the one-year refresher training requirement for first assignment fighter and attack aircrews will be temporarily delayed, however, pending resolution of the impact on the Lead-In Fighter Training pipeline. One of the possible methods of minimizing this impact is the establishment of a physiological training facility at Holloman AFB, New Mexico, the location of the Lead-In Fighter Training school. Tactical Air Command (TAC) is studying this alternative to determine its feasibility and cost effectiveness. Appropriate changes to AFR 50-27, Air Force Aerospace Physiological Training Program, will be made subsequent to the completion of the TAC impact study. ■

X-COUNTRY NOTES

REX RILEY
Directorate of Aerospace Safety

■ Recently, a transient alert maintenance operation was involved in a sequence of events which could have had very serious consequences.

An F-4 was launching from a non-F-4 base. The crew strapped in and the transient alert maintenance technician assisting the launch pulled the remaining ejection seat safety pins and handed them to the crew. Apparently the technician unknowingly pulled the rocket motor initiator hose pin (see picture) as well (even though it was not streamered). This action disconnected the initiator hose and deactivated the rocket motor.

The crew launched, and it was not until the postflight at home base that they found that the front seat rocket was deactivated.

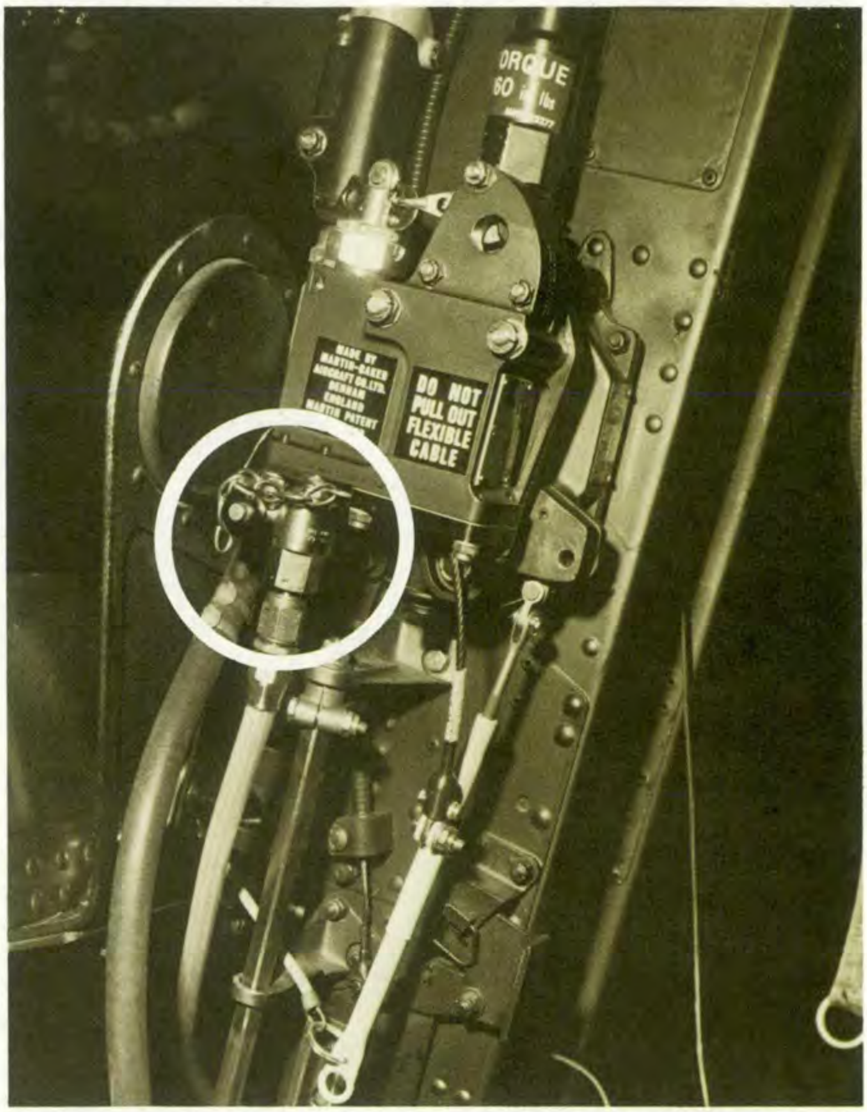
The lesson of this story is not to point fingers. Transient alert personnel are required to be familiar with a variety of aircraft systems most of which are not indigenous to that base. Thus, TA must depend upon the accuracy of Tech Orders for their systems knowledge. In the case of this pin, the T.O. guidance was somewhat vague, and the actual significance of this particular pin was not explained.

There is, however, a reasonably reliable solution. The pilot could have avoided the whole incident by pulling *all* the pins except the face curtain before climbing into the cockpit.

In more general terms, every aircraft has certain peculiarities which, if overlooked, can be serious. The aircrew knows these and should either point them out to the TA folks or check the item personally.

On the subject of ejection seats, I prefer to check it myself. I want to be sure the seat will work if I have to use it.

How thorough is your briefing to TA? And, how well do you preflight on a cross-country flight? ■



The pin shown in the picture above is *not* one of the seat safety pins which should be removed before flight. Pulling this pin (the rocket motor initiator hose pin) disconnects the initiator hose and disables the seat rocket motor.

OPS

Learning Experiences

Aviation Safety Reporting System (ASRS) — and *Callback*, its voice — is a non-elitist operation. Incident reports are received from air traffic controllers, air carrier, general aviation, and military pilots, airport people, miscellaneous observers (including passengers) . . . All receive equal attention: lessons may be gained from any of the sources, and it is our endeavor to share these lessons to increase safety awareness throughout the aviation community. Two reports from GA pilots indicate that reporters learned from their errors — and, perhaps, from the self-analysis that followed.

■ . . . I called entry into downwind leg. I don't recall if I said, "left downwind," or just, "downwind." In any case, I entered a right downwind. This field uses a left-hand pattern, a fact that was immediately pointed out to me by UNICOM. They must have seen me, as I'm quite sure I didn't call, "right downwind." Rather than contort my approach worse than it already was, I announced that I'd fly this one to the right and watch it in the future. . . . It was my intention to fly a left-hand pattern — I knew that this was correct in this case. I'm embarrassed to say that this has happened to me now and then. . . . Evidently I'm failing to visualize how my entry will look to me when I arrive at the field. I've tried using a computation based on runway heading . . . to cue me as to pattern entry, but it hasn't helped. Now I've added to my "before landing" checklist, "visualize traffic pattern," and I resolve to say to myself, "put the runway on your left." I'm tired of embarrassing myself.

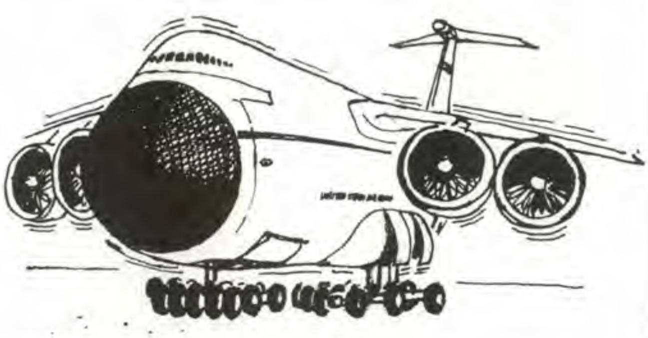
■ Departed for an airport 12 miles west on pleasure flight. I was receiving radar advisories; I was told to report destination in sight. I had never been there and thought I should have seen the airport by now. Radar then asked if I had it in sight. I said, "Yes," even though I didn't (I didn't want to bother them — that was real stupid on my part). Radar service was then cancelled and I went in search of the airport on my own. While looking, I thought I saw it; however, I ended up on downwind at another airport 7½ miles south of my destination. I immediately climbed above the ATA and departed northbound. I very seldom use a sectional chart and usually fly to airports with radar or a VOR on the field. I should have called the tower when I recognized what I did, but I was too embarrassed. It won't happen again! The most embarrassing aspect of this is that I'm an air traffic controller at a VFR tower and definitely know better than this! — Courtesy ASRS *Callback*, May 84.

Gear Up and Locked — Head Likewise

■ On a normal, seemingly uneventful landing I inadvertently missed the GEAR item on my landing checklist and failed to extend it before landing . . . The damage was quite minor (prop tips) . . . I believe the primary cause of my failure to hear the gear warning horn is that I routinely wear a headset with close-fit "muff-type" earpieces . . . I will have to remove the head set prior to landing sequence or else discontinue use of this type of headset completely.

But then you may miss something else important — controller warning, party line, etc. There are other alternatives . . . Gear-down lights help. — Courtesy ASRS *Callback*, May 84.

TOPICS



C-5B Landing Gear Tests Completed

Testing has been completed successfully on the main landing gear and landing door actuation system designed for the U.S. Air Force's C-5B military transport aircraft.

Testing of the new gear began in December 1983 using a C-5B landing gear simulator, and involved a total of 6,130 extensions and retractions (cycles) of the landing gear.

The C-5A system requires 40 gear boxes — 10 boxes for each landing gear — to rotate torque tubes which activated the landing gear. The new system, however, will eliminate all but two gear boxes per landing gear.

Integral with the new landing gear actuator, the new gear boxes give the system increased redundancy, easier maintenance and better reliability. The new system also includes a fail-safe emergency landing gear extension and an evenly-distributed load during extension and retraction.

A Back Stabber

A C-130 loadmaster used his combat knife while rigging a container delivery system for airdrop.

After completing a portion of the checklist, the loadmaster sat down. As he did so, the knife which was attached to the adjustable velcro waist strap of his flight suit caught in the nylon web seat. It came out of its sheath lodging in the webbing, blade toward the loadmaster.

He then leaned forward, and when he leaned back again in the seat the knife penetrated his right side and nicked the lung.

That's Not Part of the Aerobics Course

At dusk one evening, Tower controllers at an air base observed a jogger run up to and across the active runway. Fortunately, there was no traffic at the time.

We are told that the individual was counseled by his supervisor.

What's An Initial?

A civilian pilot in a Commanche contacted an Air Force Base Tower for clearance through the airport traffic area. The Tower controller advised him that traffic was "two F-4s on initial." The civilian pilot saw the F-4s, but being unfamiliar with military terminology did not understand that the F-4s would begin a break to downwind at mid-field. When the first F-4 started his break, the civilian pilot took evasive action by climbing, and the F-4s passed 150 feet beneath him.

The investigator of this occurrence also found that the civilian pilot believed that the Tower was responsible for aircraft separation despite the fact that all aircraft were VFR. The investigator recommended that Tower controllers be more explicit when talking to general aviation aircraft about military unique operations.

He also suggested that controllers should pay attention to the location of VFR aircraft cleared to transit the ATA and reminded controllers that they have the option to direct heading or altitude changes to transiting aircraft to avoid conflicts with aircraft on approach to the base.

ROTATING THE F-16

MAJOR JOHN C. PLUTA
Directorate of Aerospace Safety

■ An F-16 pilot had completed all his preflight procedures correctly and then started his take off roll. At the computed rotation speed of 140 knots he initiated back pressure, but the aircraft did not seem to want to rotate. The pilot felt as though he had to force the aircraft off the ground. The aircraft became airborne 5 knots above computed takeoff speed but felt "mushy" to the pilot. He therefore elected to set the aircraft back on the runway and abort the take off. After the aircraft touched down, the pilot applied full braking and lowered the hook. The aircraft engaged the departure end BAK 14 at 130 knots.

Subsequent investigation of the failure to rotate incident uncovered no aircraft problems with the possible exception of an under-inflated nose strut.

During the past eight years, 21 mishaps have been caused by a high-speed abort due to "failure to rotate." In ten cases, the mishap investigation board positively identified an underserviced nosegear strut as the cause. In the other eleven cases, the cause was undetermined — often with no mention of having checked the nosegear strut for proper servicing.

In the past two years, five F-16s have failed to rotate. This has created a high level of interest due to the potentially catastrophic results of a high-speed abort. An analysis by General Dynamics revealed that an underserviced nosegear strut can increase nosewheel lift-off speed by as much as 15 knots in the F-16. There are two reasons for this: (1) The decrease in deck angle — better known as "angle of attack," and (2) The lack of positive pressure in the strut which, when properly serviced, assists in achieving rotation as airspeed increases to nose wheel lift-off speed.

This information has resulted in the following efforts: (1) The development of a "failure to rotate troubleshooting checklist" for the F-16 maintenance community which includes checking the nosegear strut for proper servicing, and (2) A change to the Dash 1 to alert pilots of the increased airspeed necessary to achieve rotation with an underserviced nosegear strut.

Remember, proper strut servicing is a function of gross weight/configuration and includes the right combination of hydraulic fluid and nitrogen, which can only be verified by maintenance with gauges. So, if a strut "looks about right" but is bottoming out during taxi, it is *not* properly serviced. Give it back to maintenance before you take off. ■

MAIL CALL

EDITOR:
FLYING SAFETY MAGAZINE
AFISC (SEDF)
NORTON AFB, CA. 92409

Acronyms

I am an A1C (first-term) and work in the Civil Engineering Squadron at Edwards AFB, CA, and I have just read the article "LOC Survey" in the January 1984 issue of Flying Safety.

My supervisor receives this magazine every month and distributes it to her staff to read if they so desire. I, personally, read it every month.

Unfortunately, I am not a pilot and I don't come in contact with any pilots so I sometimes get a mite confused by the acronyms used by pilots and flight crews.

Could you please tell me where I might be able to find the meanings of these acronyms? Any help you can give me would be greatly appreciated as I thoroughly enjoy reading this magazine.

A1C Sarah R. Hernandez, USAF
Edwards AFB, CA

Thanks for your comments. We try to be careful with acronyms and abbreviations. However, you identify one key point. Our target audience — aircrew members — use many acronyms every day. They are familiar with them and have no trouble understanding them.

One publication that might help you if you find an unfamiliar abbreviation is AFM 11-2, "Air Force Abbreviations."

As for the special pilot acronyms and language, I'm afraid the only suggestion I can make is to find someone familiar with the language to explain. There are many crewmembers and support personnel who can help. Any base that receives Flying Safety *has a flying mission, so you should be able to locate someone who understands the term.*

FSM Distribution

Those of us down in the squadrons like to read *Flying Safety* magazine. I see that the reader per copy ratio you publish is 3 to 1. How come we don't get that many here at our base?

Sometime FSM Reader

The reader per copy ratio for Flying Safety *is 3 to 1. But we don't know where those 3 are unless you tell us. The way to do that is to survey your squadron. Figure your total population of aircrew or direct aircrew support personnel (Ops, Life Support, Air Traffic Control, etc.). That number divided by three is your authorized number of copies of* Flying Safety.

Check with your admin section or the person who orders your regs. That's the person who can get with the base Publishing Distribution Office and make sure you are getting the proper number. If you are already getting a 3 to 1 ratio of magazines, maybe you ought to check some desk drawers to see who's hiding them.

The "Heavies"

The "Heavies" safety report in the May issue of *Flying Safety* is very interesting, but I noticed that you did not include the E-4A/B aircraft. Perhaps you have labeled it a "Super Heavy."

As one of the past Logistics/Maintenance single points for the E-4 program, I think it has a pretty impressive safety record. Thanks for your time.

Major John W. Roth, USAF
92d Strategic Squadron

Flying Safety Record

I was disappointed, but not surprised, to discover that our T-43's outstanding flying safety record was omitted from the May issue of your magazine which was devoted to "The Heavies." At times it seems that most USAF people don't know we exist, so your apparent oversight is understandable.

Our aircraft is now 11 years old and we've never had a Class A. We've had only a few Class Bs, and they were all due to birdstrikes and tire failures. I personally feel that our safety record is outstanding, particularly when you consider that we have some really miserable winter weather. We're extremely proud of our accomplishments here at Mather AFB and plan to keep our flight safety record intact. Perhaps a little recognition in next month's magazine is in order. Thanks for your indulgence.

Major Gary L. Greeson, USAF
Mather AFB, CA

There were several aircraft omitted from our annual review. Space limita-

continued

tions required that we be selective about which aircraft were covered.

The purpose of this annual report is not recognition, but rather a report on previous mishap experience and future developments. Those aircraft which had no significant problems like the T-43 and the E-4 or are limited in deployment to one or two bases were not covered in the magazine.

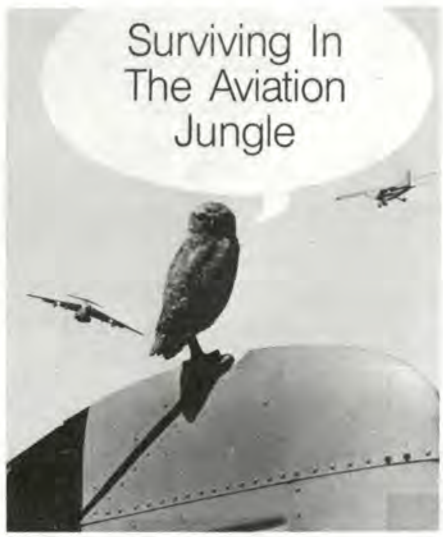
Your safety record is a fine one. AFR 900-26 "Safety Awards" contains procedures for safety awards nomination.

to aircraft.

I suspect most aircrew members, as well as support personnel, are not aware of the intensive engineering effort done on airfield matters in direct support of the USAF safety program. I also suspect the information will be of most benefit to all.

Capt Ramon A. Cardona, USAF
24 CSG, APO Miami

Thanks for the suggestion. We have contacted the experts on airfield criteria, and an article will appear in a future issue.




The vast majority of aviation activity in the United States involves general aviation aircraft and pilots operating primarily under VFR. Military pilots must also know and understand these rules for we share the air with our general aviation counterparts.

Airfield Safety Criteria

I recommend an article be prepared . . . on the subject of airfield safety criteria. Upon reading an article by Major Kurt P. Smith in the May 1983 issue of your publication I noticed the author made a statement on page 15, line 29, left hand column: "Luckily, the areas adjacent to the runways were relatively clear, or the results could have been worse." This statement perhaps reflects a lack of knowledge about the Air Force airfield criteria as spelled out in AFR 86-14, "Airfield and Heliport Planning Criteria."

In recognition of accidents that have had aircraft roll off the paved runways, extensive work is done to prevent installation of equipment not necessary for airfield operations. Furthermore, the equipment allowed must meet frangeability requirements. This means that equipment can be easily separated from fittings so as to minimize damage

"Surviving in the Aviation Jungle"

The special feature, "Surviving in the Aviation Jungle," by Captain Trebon in the June 1984 issue is exceptional. It's not only factual, but also unbiased. Considering the mix of high-tech and low-tech vehicles in the air, it's amazing that the system is still fairly tolerant and safe.

L.J. Long
Lyn-Air Aviation
Fort Worth, Texas

More On "Surviving in the Aviation Jungle"

The article in your June 1984 issue, "Surviving in the Aviation Jungle" by Captain Greg Trebon was absolutely outstanding. It's very well written, easily understandable, and accurate. It should be incorporated as required reading in the annual Instrument Refresher Course, Undergraduate Pilot Training, and copies distributed to the flying safety offices of all major airlines.

We IFR jet pilots tend to have conceited misconceptions about who "owns" what airspace, and the lack of knowledge of many of my peers is really scary. I'm surprised we don't have a lot more military/civilian midairs. You might follow up by soliciting an article on other "shared" airspace, such as MOA's, Restricted Areas, Warning Areas, and IR/VR Routes.

Major Eric P. Hansen, USAF
Edwards AFB CA

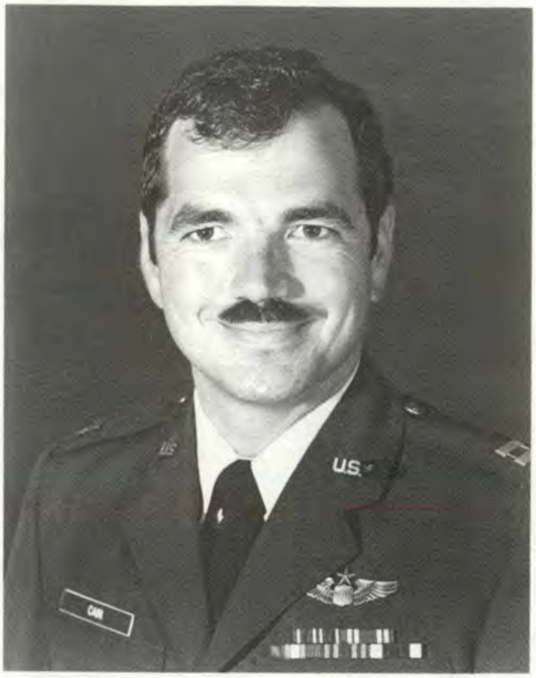
Thanks for the kind words. Your suggestion for an article is a good one. Are there any volunteers?

☆U.S. GOVERNMENT PRINTING OFFICE: 1984 — 783-026/18

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.



CAPTAIN

Richard S. Cain

58th Tactical Training Wing
Luke Air Force Base, Arizona

■ On 13 September 1983, Captain Cain was flying a surface attack sortie in an F-16A as a part of the F-16 qualification course. He had completed a low level and performed radar bomb deliveries prior to commencing a low angle strafe pass. While recovering from a strafing pass, Captain Cain advanced the throttle and when passing three-fourths forward, felt the throttle resistance lessen. Rpm stabilized at 90 percent and although he could move the throttle freely, the engine rpm remained at military. Captain Cain turned the aircraft toward Luke AFB, initiated a climb, and declared an emergency. Fuel on board at the time was 3,200 pounds with fuel flow of 8,300 PPH. Captain Cain established communications with the Luke supervisor of flying. Attempts to regain engine throttle response in UFC and BUC were unsuccessful. Hotel conference discussions with engineering and flight test personnel could not determine the cause or offer other suggestions to resolve the problem. After establishing an orbit over Luke AFB, Captain Cain descended in the aircraft to 18,000 feet. He started the jet fuel starter and emergency power unit and using the throttle unsuccessfully tried to shut down the engine. He decided to wait until the engine flamed out and performed a flameout pattern and remained at 18,000 feet until this happened. He made one level turn as airspeed bled down from 350 knots to 210 knots and then a descending turn so as to arrive at high key at 10,000 feet. The gear handle was lowered and the emergency gear extension handle was pulled. The flameout pattern was flown as prescribed in the Dash 1, and Captain Cain landed the aircraft uneventfully. Captain Cain's ability to function in an extremely stressful situation, combined with superb airmanship, averted the possible loss of life and prevented the loss of a valuable aircraft. WELL DONE! ■

The Birds Are Coming

See your local FSO for details