flying SAFETY

JANUARY 1981

William Tell '80

F-15 Aerodynamics

FLYING SAFETY

An Ace Looks At Safety
Whoosh!
Air Traffic

Formerly
Aerospace
Safety Magazine

THERE I WAS . . .

■ . . . right between the proverbial rock and a hard place. It took me a while to convince myself I wasn't plumb crazy, vacillating between thoughts of how ridiculous the accident report would read and making a conscientious effort to fly the airplane and figure out how to get it back on the ground without bending it or inflicting grievous harm on my precious bod. As I look back, it was a plain and simple case of exceeding my capability.

Since I am a commercial pilot, courtesy of the FAA Military Competency Test, it was common for me to check out in a light plane at the local FBO while visiting family and friends on leave. Usually, I took the full treatment with the guy who owned the plane, but when they heard I had over 2,000 hours, I was a military pilot pushing one of the "heavies" around the world, etc, etc, the check out would deteriorate to a couple of hops around the pattern. In this particular case, I had rented a new four-place, 180 hp Scooter which was due a 100 hour check. The instructor asked if I would deliver it to the big airport about 50 miles away and he would pick me up in his two-place trainer for the return trip.

Everything went as planned, until on our return trip after dark we plowed into the leading edge of a slowly moving cold front that had slipped between the big airport and home base. Wisely, we executed the infamous 180 degree turn and went back to the big airport where there were students attending ground school who could give us a ride (on the ground) back home.

Now, the instructor had a problem: two airplanes at the big airport and none at home. He made me an offer I just couldn't refuse. If I didn't mind, I could fly his little plane back home the following day if someone could drive me back to the big airport.

The next day dawned bright and beautiful with a fairly brisk wind out of the North. My wife had some shopping planned in the big city, so she dropped me off at the little plane with plans of seeing me upon her return. Having some self pride in my aviation ability, I attacked the little plane (without a checklist) and looked at all the things I thought were important.

Having satisfied myself the thing was airworthy, I strapped in only to find that the dash contained neither a master switch nor a means to start the engine. After a big look around to see who might be watching, I climbed back out and traced the wires from some essential components through the fire wall and under the floor to where the two essential switches were neatly tucked under the seat. Undaunted, I strapped back in, started off on the first try and taxied for an intersection takeoff on the main runway which I soon discovered was not aligned with the wind. "Oh well, a little aileron and some rudder should do it."

Cleared by the tower for takeoff, I poured the power to my charge, released the brakes and almost immediately headed for the runway lights. At the first few flickers of the airspeed needle, I applied some back pressure. The race between flying speed and the grass at the side of the side of the runway was won by speed, with a little help from me by applying a healthy tug on the yoke as the pavement disappeared underneath me. I was climbing now and had the healthy feeling of solid performance as the little bird cocked into the wind and the *rudder pedals remained centered*.

It was then that my mind tried to do tricks on me. How stupid. You're up in an airplane you've never flown before and you have to get you and it back on the ground in one piece. How the report will read: time in the aircraft, zero; time in type, zero; previous experience, multi-engine *military*! As I bounced along like a shopping cart being shoved down a flight of stairs I sorted out all these thoughts just in time to realize that *one of the sod runways at home base was directly into the wind*. The great pilot in the sky was looking over me that day. His generosity in letting me return to earth gently and graciously proved an humbling experience never again to be repeated despite my intense personal pride. ■

Thanks for sharing your experience. There's a good message here for every pilot and especially, under those circumstances, for our aero clubbers and other general aviation pilots.

Brig Gen Leland K. Lukens
Director of Aerospace Safety

UNITED STATES AIR FORCE

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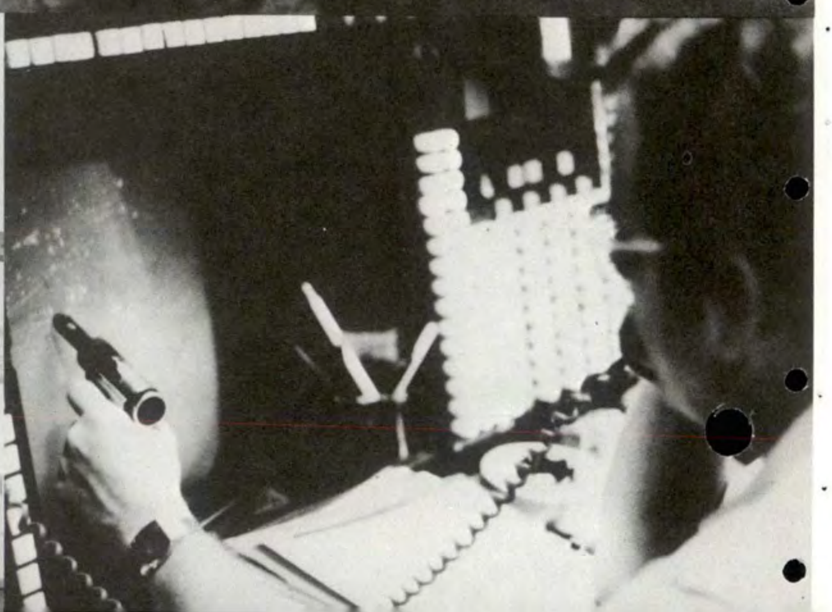
WILLIAM TELL '80



By MAJOR DAVID V. FROEHLICH
Directorate of Aerospace Safety

"It's not the critic who counts, nor the man who points out how the strong man stumbled, or where the doer of deeds could have done them better. The credit belongs to the man in the arena, whose face is marred by dust and sweat and blood, who strives valiantly, who errs and who comes short again and again, who knows the great enthusiasms, the great devotions and spends himself in a worthy cause, who at best knows the triumphs of high achievement, and who at the worst, if he fails, at least fails while daring greatly so that his place shall never be among those cold and timid souls who know neither victory nor defeat."

President Theodore Roosevelt

Way Back When . . .

■ Historically, the William Tell aerial weapons meet began in 1954 as the air-to-air rocketry portion of the third annual U.S. Air Force Fighter Gunnery and Weapons Meet. Air Training Command (ATC) and Air Defense Command (ADC) teams participated with the ATC team winning the competition.

An ADC team from the Eastern Air Defense Force won in 1955 by outshooting the ATC entrants. That year, William Tell went worldwide as four out of the seven teams were from overseas bases.

1956 saw nine teams representing seven major air commands competing in the final rocket meet held in Arizona. The Eastern Air Defense Force successfully defended its championship as F-86s, F-89s and F-94s were the mainstays of the competitors.

In 1958, when William Tell moved to its new home—Tyndall AFB, Florida—the contest accelerated greatly as the two-year-old F-102 Delta Dagger, first supersonic aircraft in the air defense inventory, entered for the first time. It was in 1958 that William Tell became exclusively an ADC competition and an impressive array of new equipment made its debut. Radio controlled Q-2A drones and electronic scoring replaced towed targets; the *Falcon* missile and *Genie* rockets made their first weapons meet appearance. The competition was divided into three categories, acknowledging the different capabilities of various types of aircraft. And for the first time, someone fired a *perfect* score—the Florida ANG team, flying F-86s.

Twelve teams, representing five major air commands, entered the 1959 competition, and the scoring was so close that the winner won by a margin of only 100 points in the 6,000 point match. F-100s and F-104s joined the F-89s and F-102s, and interceptors scrambled day and night in all kinds of weather toward targets at many different altitudes and speeds.

By 1961, subsonic aircraft and non-interceptors were absent from the meet. In their place were the F-102, F-106, Delta Dart, and the F-101 Voodoo.

The competition took on even more realism in 1963 when William Tell added an "intruder" mission. A drone was launched from an unannounced point, and intercept directors had to find it, scramble their fighters, and guide them to the target. The Air National Guard had begun flying more modern aircraft by 1963, and a team from Pennsylvania defeated all the regulars in the F-102 category. The F-106 winner was the 318th FIS from McChord AFB, Washington.

Canada entered an F-101 team in the 1965 meet, making this the first international William Tell. Sixteen teams flying F-101s, F-102s, F-104s and F-106s were on hand, and a team from the U.S. Air Forces in Europe controlled by Dutch intercept directors won first place in the F-102 category.

The Vietnam conflict imposed a five-year intermission on William Tell; however, in 1970, an austere William Tell was held again at Tyndall. Three categories, F-101, F-102, and F-106 were represented by teams from ADC, ANG and the Canadian Forces. The North Dakota ANG team won the F-101 category, while the Minnesota Guardsmen took the F-102 honors and the 71st FIS from Malmstrom AFB, Montana, captured the F-106 trophy.

BQM-34A and EB-57 targets made the 1972 William Tell an ☞

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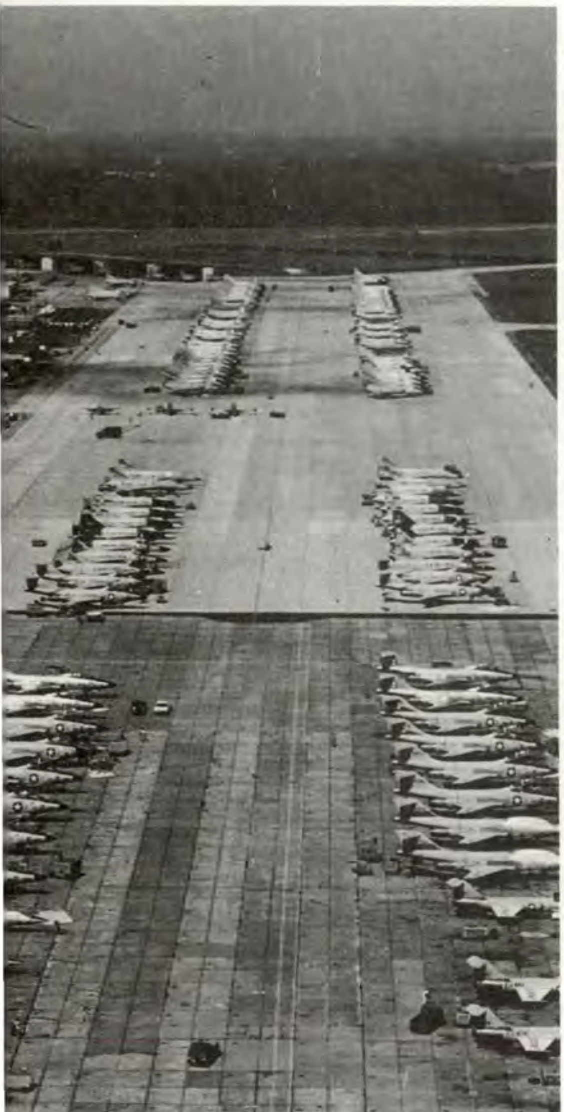


exciting event. The "Happy Houligans" from the North Dakota ANG won the F-101 trophy; the Wisconsin ANG's 115th Fighter Group captured the F-102 prize; the F-106 honors went to the 460th FIS from Grand Forks. But a Canadian F-101 crew won the "Top Gun" award for a direct hit on the evasive BQM-34A drone.

The 1974 William Tell competition included the new twist of adding in the total team scores from the Weapons Loading Competition that had been held earlier in the year. Winner of the Weapons Loading Competition was the 416th All Weather Squadron, Chatham, New Brunswick. Second place honors went to the 119th FIG, Fargo, North Dakota, while the third place finishers were from the Boise ANG. Targets for William Tell '74 included the BQM-34A, the EB-57, and TDU-25B which is towed and used mostly as a stern attack target for infrared (IR) missiles. The 1974 winner in the F-101 category was the 101st FIG MAINE *iacs,* while the 124th FIG from the Boise ANG won the F-102 honors, and the 120th FIG from Montana's "Big Sky" country won the F-106 competition.

William Tell '76 had a few different wrinkles. First, the scores from the Weapons Loading Competition were *not* counted in the overall scoring. Second, the F-4 made its first appearance in a William Tell competition. Next, the F-102 was absent for the first time since the first appearance in 1958. Finally, there was no overall "Top Gun," instead, a "Top Gun" was picked out of each aircraft category.

In 1976, the Bicentennial edition of William Tell saw the ANG continue its winning streak. The 142nd FIG, Portland ANGB, OR, won in the F-101 category and the 120th FIG, Great Falls, MT, took top honors in the F-106 competition. Also, in the F-4 Phantoms' first appearance in William Tell competition, the 4TFW (TAC), Seymour Johnson AFB, NC, won that category.

The 1978 competition saw the 49th FIS, Griffiss AFB, NY, take top F-106 honors; the 86th TFW (USAFE), Ramstein AB, Germany, win the F-4 competition; and the 147th FIG (ANG), Ellington AFB, TX, capture the F-101 category.

As usual, 1980's rules were tough and the competitors were top-notch. The key to success, however, lies in the fact that a total and coordinated effort is expended by the crews as well as the hundreds of "behind-the-scenes" professionals.

The Players . . .

Ten teams with a total of 50 aircraft competed in three categories – F-101, F-4 and F-106 aircraft respectively. Teams participating in this year's events were:

CATEGORY I: F-101 Voodoo
- Canadian Forces Air Defence Group Composite Team
- 107th FIG (ANG), Niagara Falls, NY
- 147th FIG (ANG), Ellington AFB, TX

CATEGORY II: F-4 Phantom
- 347th TFW (TAC), Moody AFB, GA
- 119th FIG (ANG), Hector Fld, ND
- 191st FIG (ANG), Selfridge AFB, MI

CATEGORY III: F-106 Delta Dart
- 5th FIS (TAC), Minot AFB, ND
- 49th FIS (TAC), Griffiss AFB, NY
- 102nd FIW (ANG), Otis AFB, MA
- 144th FIW (ANG), Fresno, CA

Strategic Air Command (SAC) B-52G bombers participated in the 1980 William Tell for the first time. Crews from SAC bases throughout the United States flew numerous sorties with two profiles scheduled for each sortie. On each profile, the bombers made a low level simulated bomb release while the William Tell competitors flew intercept missions against the bombers as they simulated penetration of the target area. Each of the profiles was also scored to provide a competition to select the winning SAC crew.

The modern and complex intercepts require a close interface between ground controllers and aircrew members. Since ground based radars and skilled controllers give our interceptors a decided advantage over enemy aircraft, it is only fitting that controllers' skills also be evaluated as part of the William Tell '80 Weapons Meet. F-101 and F-106 aircraft were guided to their targets by weapons controllers using Back-up Interceptor Control (BUIC), a sophisticated, compact, command and control system. F-4 aircraft were worked by manual control from the Tyndall Wetstone Control Center. In addition to trying to help their team attain the overall meet "Top Gun" award, controllers competed for a coveted "Top Scope" honor, which showed the team in each category with the highest total score for the four profiles. Controller teams for this meet were from the 21st, 23rd, 24th and 26th Air Divisions, Canadian Forces, 507th Tactical Control Wing and 678th Air Defense Group.

No discussion of the players in the William Tell arena could be credible without strong and continuous mention of the ground crews and support folks. Hundreds of conscientious and professional maintenance technicians tuned, turned, polished, tested and, in general, mothered "their babies" on the Tyndall ramp. The greatest "shooter" in the world will always acknowledge that he can do nothing without the maintenance pros who consistently give him a sound machine to fly.

Another group that always rises to the occasion is the entire support community at Tyndall AFB. This year was no exception as Tyndall and Panama City rolled out the red carpet for William Tell visitors. The ramp was also ably and safely manned and organized by Dennis Britt and his super Transient Alert crew. So the stage is set, the players arrived and the meet began. . . .

☞

For almost 20 years, the F-106 Delta Dart has been one of the foremost William Tell competitors.

"It's important to have this training. It not only brings out a sense of competition but brings everyone on the air defense team into play. The airplanes and the pilots who fly them . . . the controllers who must locate the elusive targets . . . and direct the pilots to the target . . . the technicians with the know-how in maintenance to keep the planes flying and the munitions experts who load and arm the rockets used in air defense."

Gen Daniel (Chappie) James, Jr.
(About the 1976 William Tell)

WILLIAM TELL '80

continued

Top. A Firebee Drone begins its journey to elude the hunters. Bottom. A drone is recovered from the Gulf of Mexico—one that got away.

The Fight . . .

Aircrews flew four different attack profiles during William Tell 1980.

"Hostile intruders" attacked at various altitudes and speeds, and in one profile used a variety of radar confusing techniques. Because of the many possibilities a crew must face, William Tell incorporates several different profiles for the pilots, weapons and ground-based controllers to encounter.

During the competition, teams flew the following profiles:

Profile I (Front Fly-up). Each interceptor is committed individually on a front fly-up attack against a supersonic target at high altitude.

Profile II (F-4 and F-106 Two-Ship Attack). Interceptors will be committed in pairs against a PQM-102 drone at medium altitude. One interceptor will fire a radar missile on the front while the other will position for a stern shot with a heat seeking missile.

Profile II (F-101–Low). Interceptors will be committed individually on a towed target at low altitude and will fire a heat seeking missile.

Profile III (F-4 and F-106–Cold ID-Shoot). Aircrews will be committed in pairs on a cutoff attack against an unidentified target. The target will be an F-101, F-106 or F-4 with a colored panel displayed in the rear canopy. Interceptors must identify the aircraft and color before receiving clearance to fire. Scores for simulated infrared missile shots from each aircraft will be recorded by the air combat maneuvering instrumentation range equipment since the F-101 is not equipped to fly on the ACMI. Consequently, it will fly the profile against a drone and will live-fire infrared missiles.

Profile IV (Electronic Countermeasures, ECM). Each team will be given a liability period during which they will defend an area against penetrating B-52 bombers. Simulated weapons launches will be scored by assessment of recording equipment on board each fighter.

The Winners . . .

In his opening remarks, Major General John Piotrowski, TAC's Deputy Commander for Air Defense said, "Through this meet, we are demonstrating the professionalism of North America's strategic defensive forces. The benefits we gain from this competition are worth many times over the costs."

I think all participants would agree. The competition was stiff, the action realistic and the training value beyond measure. There were no real losers, but when the dust settled, there had to be a "best" of the best.

Early in the competition, Mother Nature let it be knows she was still the boss as rain forced several cancellations and rescheduling's of missions. The skies cleared and missions began again. The first actual "kill" recorded was by the 191st FIG (Selfridge AFB, MI) as the F-106 shooters downed a BQM-34F Supersonic Firebee drone. Later that same week, there was another drone "death" but this PQM-102 veered off the runway on takeoff and came to rest in a ditch. It had been scheduled against the Fresno 106 drivers, so several of the California Guardsmen immediately claimed a "kill" in that the 102 was obviously too scared to fly and had committed suicide. (Nice try, guys.) That "kill" was not granted, but as it turned out, the 144 FIW from Fresno would emerge victorious even without credit for the "suicide."

In their first William Tell appearance, the California F-106 unit garnered 33,871 points (possible 40,000) to take the overall winner honors as well as tops in the F-106 category. For their dual win, they were awarded the "General Daniel 'Chappie' James, Jr., Fighter Interceptor Team Award" and the "Richard I. Bong Trophy."

Despite a competition-long hazing about their primarily air-to-dirt mission, the 347 TFW (Moody AFB, GA) "mudbeaters" finished tops in the F-4 category with a total of 32,706 points.

Return winners (1978 WT also) in the F-101 Voodoo category were the Texans from the 147th FIG at Ellington AFB.

"Top Gun" winners in the F-106, F-4 and F-101 categories respectively were: Major Greg Beckel (102 FIW; Otis AFB), Captains Tim Rush (pilot) and Peter Tully (WSO) (347 TFW, Moody AFB) and Lt Col Maurice Udell (pilot) and Major David Miller (WSO) (147 FIG, Ellington AFB).

"Top Score" awards went to the only all-enlisted controller team composed of TSgt Mike Quintero and SSgt Dale Wise of the 26th Air Division. They provided the "eyes" for the Fresno F-106 shooters.

For their performance in the B-52 profiles, the crew from the 379th Bomb Wing at Wurtsmith AFB, Michigan was presented the Lt Gen Gerald W. Johnson trophy for the best bomber crew.

"Top Crew Chief" honors went to Master Sergeant Joseph Forrest of the 147th FIG. SrA Kevin Eudy of the 347 TFW and TSgt John Ferrante of the 102nd FIW took the crew chief honors in the F-4 and F-106 categories respectively.

Another winner was the entire operation. Several drones bit the dust, but without injury. Other than a few headaches and skinned knuckles, this year's William Tell was again held safely. No personnel injuries or mishaps. A credit to the professionals, the rules and the organization of the entire event.

The Future . . .

The awards have all been given, the competitors have departed and Tyndall has settled back to semi-normality. What of William Tell '82?

The Canadians have probably seen their last William Tell for awhile due to the conversion of our F-101 units to other aircraft and therefore a lack of an F-101 Voodoo category. They have participated since 1965, fought and done well, and their presence will be missed. We are all a little more knowledgeable and professional for our association with the "up-North" neighbors.

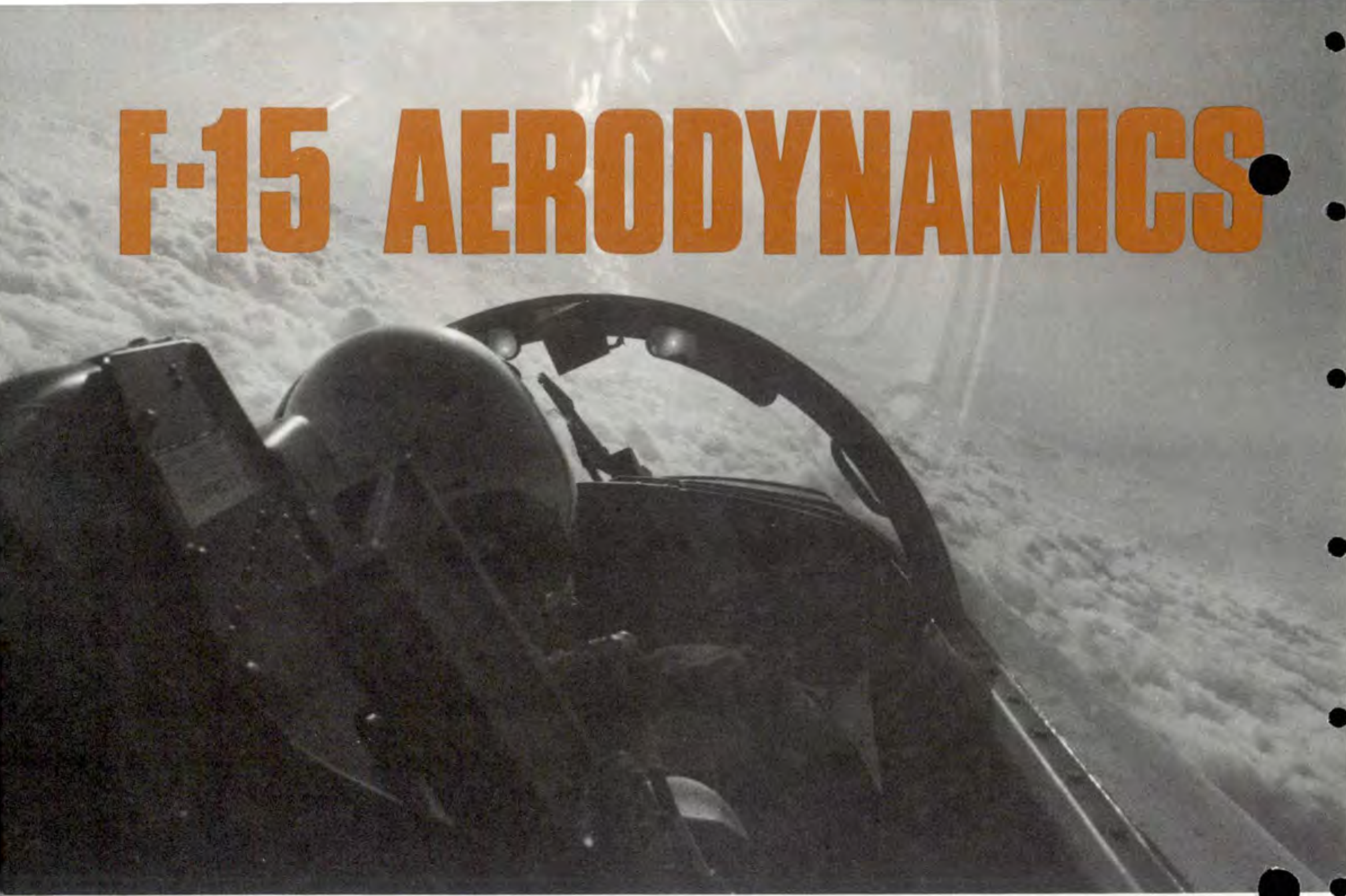
The F-4s and 106s will be around for awhile. The F-15 and F-16 could certainly provide a viable competition should the William Tell tradition be kept alive in '82. Nobody will offer a second guess!

There are always critics of such "games." William Tell has been, is, and will always be no *game*. There are friendly rivalries, competitions and good-natured harassment by all parties. But the bottom line is a tough, professional group of aviators engaging in the most demanding and realistic air-to-air intercept training possible. There are many considerations when discussing large exercises or competitions like William Tell, but in these days of shrinking airspace, tight budgets and expensive weapons systems, there can be no price tag put on readiness for self-defense. William Tell provides not only the test, but also the research and training ground for the fine tuning of our nation's defenders of the sky. We hope to see you at William Tell '82. ■

The William Tell '80 patch was designed by SRA Terry P. Roth, an F-106 crew chief at the 5FIS, Minot AFB, ND.

Top 1980 overall William Tell winners—California Guardsmen. Bottom. Our Northern neighbors—the Canadians.

F-15 AERODYNAMICS



LT COL EDMOND N. DUROCHER
Directorate of Aerospace Safety

This article is in three parts. The first part covers F-15 asymmetry. The second part is technical and contains an aerodynamics review on lateral stability. It is linked to F-15 asymmetry, as it contains an explanation on departure from flight, out of the heavy wing. The third part is dedicated to information to be published in the new Dash One. We feel the material is important enough to get the word out ASAP. The words are not verbatim throughout, but the new flight manual will agree with what's printed here.

PART ONE
F-15 ASYMMETRY

■ This part is intended to diffuse the grey cloud surrounding F-15 asymmetry. Consider the following scenario.

Your mission is point defense and the point happens to be your own airpatch located some hundred miles from the FEBA. Obviously, you have a vested interest in the success of this particular mission. The controller alerts you to activity in the system which appears to be headed your way. As the level of excitement increases, and a feeling of "today's the day" becomes overwhelming, you force yourself to regain your composure and review the tactics briefed by your flight leader. As part of the high CAP your section should be the first to engage the enemy; the low CAP picking up the bandits that blow through the merge.

Another call from the controller brings you back to reality. He informs the flight that the original "gaggle" of aircraft has split and there appears to be a twelve-ship headed your way. The flight lead signals an in-place 180 and your four-ship rolls out of the turn with bandits 070/80. Lead calls: "Contact, Judy" and commits.

You run your AQ symbols out to the blob on the VSD and squeeze and release the TDC. As you wait for the symbology to settle on the VSD, you make one last check of the cockpit. The status on your two Sparrows and two Limas is normal, you recheck that you're armed, and note the fuel. The centerline is dry and your internal wings show 1,800 in the left and 1,500 in the right. It immediately registers in your blue, aerospace brain that the fuel imbalance is out of limits and 30 CPU (cockpit units AOA) should not be exceeded.

Back on the VSD, you note the target you're locked to is a low altitude, high speed bogey, and from the chatter between lead and three, you can tell that your target is part of the package. At the prebriefed range to target, lead initiates a wavedown from your high CAP altitude.

As you race toward the deck your wingman gives you a directive call: "THUNDER, HARD RIGHT, BOGEY RIGHT FOUR, 8,000 CLOSING." You initiate your defensive turn and visually acquire the bandit. There's no doubt he's a threat and you continue your defensive turn. STOP!

What can you expect from your Eagle jet with your "out of limits" asymmetry? Must you avoid 30 CPU? Will you be forced to "check and extend" in the hopes your wingman will blow the bogey away? Or can you set the hook; "reef and sneef/flat plate" the bad guy at the proper moment; reverse on his overshoot; and, stuff a Lima up his tailpipe.

Having no further information on your jet's performance, you may be resigned to doing what you have to do to stay alive and praying the airplane hangs in there with you.

If you knew the "behind the scenes" rationale of the 200 lb restriction, you'd realize that with one Lima on each inboard and symmetrically loaded Sparrows, you're in fantastic shape.

When we talk asymmetry in the F-15, we express the moments on the aircraft in foot pounds (ft lbs). In our example we had 1,800 lbs on the left and 1,500 lbs on the right, resulting in a net balance of 300 lbs left wing heavy. The moment arm of that weight is approximately 8 feet, so the resultant vector is approximately 2,400 ft lbs. Okay guys, that's about as deep as we will get into physics and you won't have to be a rocket scientist to follow this article.

Rather than delve into a lengthy discussion on flight test procedures and directional stability, we'll simply lay out a summary in table format.

Table 1
Departure/Spin Susceptibility Summary

Aircraft	Departure	Spin	
Lateral Asymmetries (ft-lb)	All Loadings	Without Single Centerline Tank	With Single Centerline Tank
0 to 5,000	Resistant	Extremely Resistant	Resistant
Greater than 5,000 (less than 7,000)	Susceptible	Resistant	Resistant
7,000 to 10,000	Extremely Susceptible	Resistant	Susceptible

NOTES:
- This table applies to altitudes above approximately 20,000 feet.
- Departure resistance is considerably increased at lower altitudes.
- At 40-43 CPU (31 to 34 degrees AOA) at 0.5 to 0.76 Mach number, departure resistance is decreased over that stated. The table presents the overall departure susceptibility, considering the low probability of remaining within the limited region of instability.

You may deduce from table 1 that it is highly desirable to maintain asymmetry below 5,000 ft lbs to preclude departures, but the Eagle is still spin resistant with 10,000 ft lbs asymmetry.

Examination of another table covering air-to-air stores and their contribution to asymmetry adds more to the picture.

Table 2

Store	Location	Asymmetry (ft lbs)
Gun	Rt Wing Root	1170
Lima	Outboard Shoulder	2090
Lima	Inboard Shoulder	1590
Sparrow	Fuselage Mounted	2300

Now you can see that your 2,400 ft lb left wing fuel asymmetry is being offset by a 1,170 ft lb moment from the gun on the right side. The overall result is a moment of 1,230 ft lbs, left wing down.

A natural question at this point might be: "If the real enemy of lateral stability is asymmetry expressed in ft lbs, then why does the dash one express the restriction as a 200 pound fuel imbalance." A reasonable answer to that question is that we wanted to relieve you, the pilot, of a requirement to perform math problems

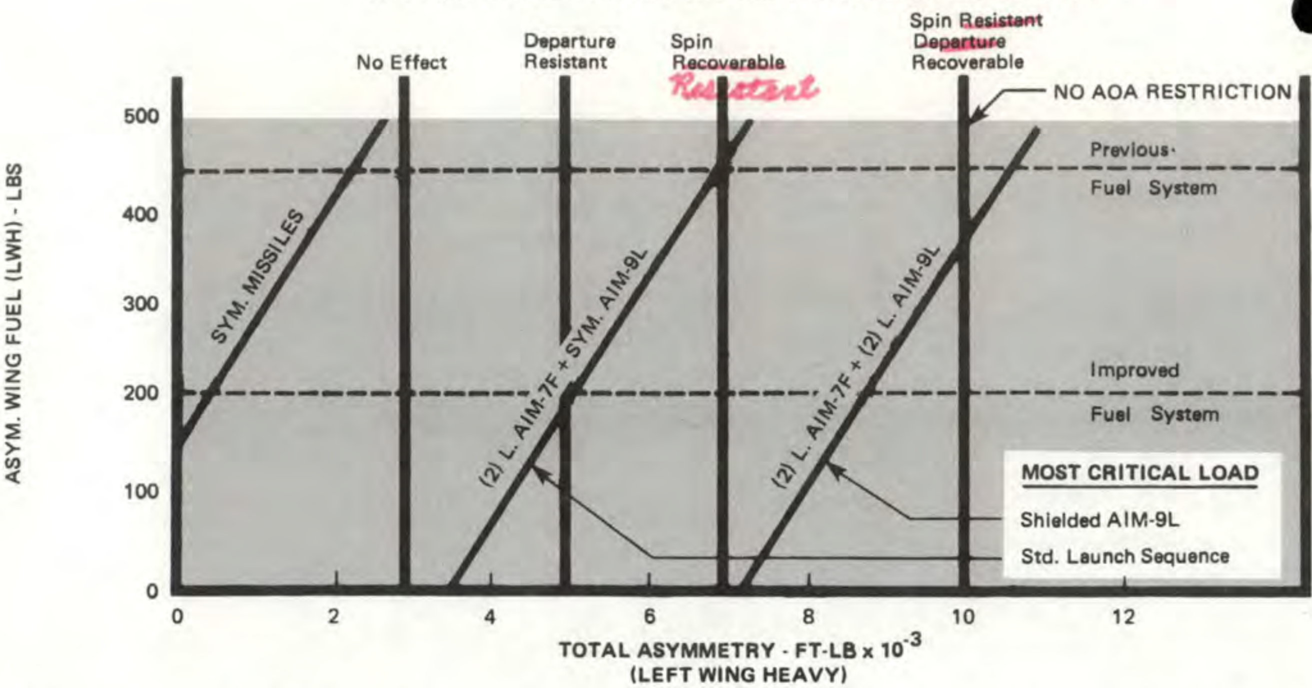
GLOSSARY OF TERMS

AQ Symbols: acquisition symbols
TDC: target designator control
VSD: vertical situation display
FEBA: forward edge of the battle area
CPU: cockpit units

See correction page 23, Nov 82 Flying Safety

FIGURE 1

F/TF - 15A LATERAL ASYMMETRY DUE TO WING FUEL AND MISSILES



while airborne, knowing that with fuel limited to this level, you are protected against worst case missile asymmetry. This is why the tolerance on the internal wing transfer pumps was reduced from 450 lbs to 200 lbs. Another chart clarifies this rationale and also shows the affect of the 1,230 ft lb force computed in the previous paragraph. See Figure 1.

Inspection of this chart reveals that the improved transfer specification is designed to keep you below 10,000 ft lbs asymmetry. In the worst case, you start the mission with wall to wall missiles, launch two Sparrows in normal sequence (rt fwd, rt aft) and two Limas off the right inboard armament pylon (this assumes the Limas were not fired in normal sequence due to shielding). As you can see from the chart, even with 200 lbs fuel imbalance (heavy left wing), you still remain below 10,000 ft lbs asymmetry which places you to the left of the "SPIN RESISTANT/DEPARTURE RECOVERABLE" line.

correction page 23 Flying Safety NOV 82

Don't forget to read the information at the top of the chart which addresses departure/spin susceptibility. Caution: If you have a single centerline tank and 7,000 to 10,000 ft lbs asymmetry, the F-15 is extremely susceptible to departures and susceptible to spins (reference Table 1).

So, what is the line pilot to do with all the neat poop on asymmetry? Hopefully, you should have a better understanding of the Eagle's performance characteristics. When you find yourself fragged with a specific load, you can use the charts to review the affects of the stores and anticipate the influence on performance for various configurations, while enjoying a cup of coffee on the ground. If the day arises that you're flying combat and experience a situation similar to that covered in the introduction, you'll be better equipped to "make the other SOB die for his country." You have more potential to accomplish that end if you know how to control your aircraft. However, if you do lose it one day, remember these important words on departures.

Departures should not be encountered below 30 CPU regardless of external stores configuration *or lateral asymmetry*. When operating above 30 CPU, departure susceptibility is increased by lateral asymmetry from stores or fuel. Above 30 CPU presence of a centerline tank increases the likelihood of a departure. *Under any configuration, if controls are neutralized at the first indication of a departure (large uncommanded roll or yaw) the aircraft will recover immediately*. Spin susceptibility is very low; however, large lateral asymmetry can produce a spin above 30 CPU if departure is not promptly recovered. *Neutralizing the controls when the departure warning tone begins will recover the aircraft from all departures.*

Happy Hunting!

PART TWO—
LATERAL STABILITY

As mentioned previously, this part is a bit technical. If it's just not your bag, press on to Part Three. For those willing to endure a few aero terms, we think you'll enjoy it. For the hard core aero specialists who can handle complex formulas and stability derivations, we apologize

F-15 AERODYNAMICS continued

in advance for this simplistic approach.

Stability

In general, aircraft stability falls into one of three categories: longitudinal stability (pitch), lateral stability (roll), and directional stability (yaw). This discussion will be limited to lateral stability with a mention of directional stability as it applies to a departure. One term that is used to explain lateral stability and control is dihedral effect. Simply stated, if you step on the right rudder and the airplane rolls to the right, the aircraft exhibits positive dihedral effect (roll due to sideslip). Old Phantom drivers will recognize this as the normal way to turn a hard wing F-4 at high angle of attack (AOA).

Lateral Stability/Dihedral Effect

In order to understand lateral stability in the F-15, each of the contributing components must be inspected. Refer to Figure 2.

The principal surface contributing to the lateral stability of any airplane is the wing. The effect of geometric dihedral of a wing is a powerful contribution to lateral stability (reference figure 2, top drawing). Since wing dihedral is so powerful in producing lateral stability, it is taken as the common denominator of the lateral stability contribution of all other components and the term "dihedral effect" or "effective dihedral" is used. As the F-15 has no geometric dihedral, this discussion will be directed towards the other components which contribute to "dihedral effect" in the Eagle: namely, the fuselage-wing combination, the swept wing, and the vertical tail.

The contribution of the fuselage alone, on most aircraft, is usually quite small depending on the location of the resultant aerodynamic side force on the fuselage. However, the effect of the wing-fuselage combination is significant since vertical placement of the wing on the fuselage can greatly affect the stability of the combination. A low wing may contribute an effect of negative dihedral while a high wing may contribute a positive dihedral effect. The high wing of the F-15 produces a positive dihedral effect.

The contribution of wing sweepback to dihedral effect is important because of the nature of the contribution. The swept wing in a sideslip has one wing operating with an effective decrease in sweepback while the other wing is operating with an effective increase in sweepback (reference figure 2, middle drawing). If the wing is at positive lift coefficient, the wing with "less sweepback" has an increase in lift, and the wing with "more sweep" has a decrease in lift. In this manner, the swept-back wing contributes a positive dihedral effect.

The contribution of sweepback to dihedral effect is proportional to the wing lift coefficient as well as the angle of sweepback. It should be clear that the swept wing at zero lift will provide no roll due to sideslip. Thus, the dihedral effect due to sweepback is zero at zero lift; and, the effect increases directly with lift coefficient. Additionally, large angles of sweepback result in high dihedral effect at lower speeds (high coefficient of lift/high AOA).

The vertical tail can provide a significant contribution to dihedral effect. With a large vertical tail, the side force produced by sideslip may produce a noticeable rolling moment as well as a yawing moment (reference figure 2, bottom drawing). The F-15 induces this effect. The large twin tails are necessary to maintain directional stability, and they also contribute significantly to dihedral effect (roll due to sideslip).

Lateral Control

Lateral control in the Eagle is achieved through the ailerons, rudders and differential stabilator. At higher AOA, the mechanical system washes out ailerons and commands pro rudder and differential stabilator while the CAS (control augmentation system) fine tunes the system to produce desired roll. This alleviates the need for the pilot to monitor AOA during an air battle. With right stick, the airplane rolls to the right regardless of longitudinal stick position.

Now that we have reviewed lateral stability and dihedral effect, let's apply it to a special case.

Departures Out Of The Heavy Wing

If we take an Eagle jet and put it into a left bank, "wind-up" turn (ever increasing AOA) with a fuel load of 1,000 lbs left internal wing, zero lbs right internal wing, the airplane is susceptible to departure somewhere above 30 CPU, and when it departs, it will flip out to the right. Right? ☞

F-15 AERODYNAMICS continued

Well, maybe you're not exactly convinced about the direction, but recalling what you've read in Part One, you recognize that the airplane is susceptible to departure under these specific conditions. Remember that 1,000 lbs on an approximate 8 ft moment arm results in a moment of approximately 8,000 ft lbs. Also, recall that the gun on the right side produces an 1,170 ft lb moment, so in this case the net result is a moment of 6,830 ft lbs left wing heavy, hence, departure susceptible.

In order to explain the departure out of the heavy wing phenomenon, we'll supply an academic model. Assume the following conditions: the airplane is clean with GW = 32,000 lbs, the entry speed is 350 KCAS, the pilot uses stick only (feet on the floor) to maintain a constant left bank, and the airplane is going to depart at 42 CPU/6. 5G/300 KCAS. As the pilot applies back stick to perform this decelerating turn, the heavy left wing will have a tendency to drop. The pilot applies right stick to maintain the constant left bank and because he's at low G/low AOA, the flight controls respond with left aileron down/right aileron up. This changes the camber of the wings and offsets the asymmetry. As the stick moves aft, the AOA and G are increased and the airspeed is decreased. The flight controls wash out the ailerons and begin to feed in rudder and differential stabilator to maintain the constant bank angle, per the pilot's command. The nose shifts to the right, and we get all the strong positive dihedral effects from the sweepback, the high mounted wing, etc., mentioned under lateral stability.

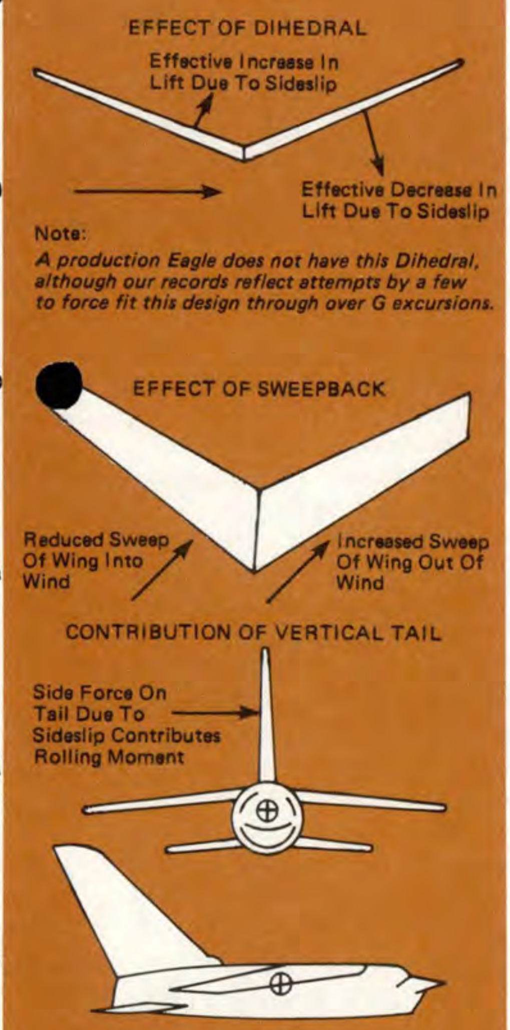
As the pilot applies more aft stick, he continues to increase right stick pressure. This yields more sideslip and more dihedral effect. Finally, at 6.5 G's (the agreed upon departure point for discussion purposes), the left wing is generating considerably more lift than the right wing to compensate for the heavy left wing. With the left side of the aircraft generating so much more lift than the right side, the airplane would depart to the right if it were not for the directional stability provided by the twin tails.

Directional stability or "weathercock" stability, if you prefer, is what keeps the pointy end going forward. The vertical twin tails of the F-15 are the primary source of directional stability. As the angle of attack increases, there is a corresponding decrease in vertical tail effectiveness. This is due to the fuselage blanking the flow of clean air to the tails and basically replacing the laminar flow with disturbed fuselage boundary layer air flow. So, as we increase AOA, we decrease directional stability. Finally we reach an AOA where there is no longer sufficient air across the twin tails to keep the Eagle from departing. When it does depart, the greater lift generated on the left "heavy" wing causes the airplane to depart to the right (out of the heavy wing). Realize that at the point you lose directional stability, you will get a yawing moment to the right as well as an increase in sideslip;

The F-15, USAF's first line fighter, is operational in USAF, PACAF and the CONUS. It's maneuverability, speed and armament are a fighter pilot's dream.

so, it becomes a yawing/rolling departure to the right. Right? Right.

FIGURE 2



Contribution of Components to Lateral Stability

PART THREE— HANDBOOK CHANGES

This part covers information that will be contained in the new Dash One which should reach the field in the early spring.

Auto-Rolls

An auto-roll produces a rolling and yawing motion with neutral cockpit controls, and it is sustained by residual rudder surface deflection and inertial coupling. The residual rudder surface deflection remains following some roll maneuvers due to the yaw CAS operation and control system friction. From the pilot's viewpoint, it appears to be an out-of-control situation, but in reality, it is not a true out-of-control because the airplane is responding to the flight control inputs (residual rudder). A positive G auto-roll follows a rudder roll or other maneuver which produces significant sideslip at an AOA of about 25 CPU and a speed of about 200-250 KCAS. An auto-roll differs from a spin in that the AOA is much lower. The AOA in an auto-roll is 20-25 CPU while in a spin the AOA is 60-80 CPU. Also, the auto-roll is primarily a rolling maneuver with a small yaw rate whereas yaw rate predominates in a spin. Because of the low AOA, it is not a true out-of-control situation and will slowly dampen out and self terminate. The positive G auto-roll can be terminated quickly by applying rudder pedal against the roll. A negative G auto-roll can be terminated by neutralizing the cockpit controls or releasing them if trimmed at 1.0 G or above.

Positive G Auto-Roll

During a positive G auto-roll, roll and yaw will be in the same direction. The turn needle will fluctuate from side-to-side and cannot be used to determine direction. The roll direction will be obvious using outside references; however, the ADI is reliable and can be used to determine direction of roll. The departure warning tone may or may not sound since the yaw rate will be slightly above or below 30°/second, the point at which the beeping tone begins.

Do not use aileron against the auto-roll or you will proceed directly to "spin city" as a result of this pro-spin (aileron against roll) input. Do use rudder against the roll (other controls neutral), and the roll will terminate in 2-4 seconds. Following an auto-roll recovery, there is a tendency for the Eagle to nose tuck. Therefore, anticipate that considerable aft stick may be required to prevent a negative G pitch over when the roll ceases. The negative G pitch tendency increases with higher initial roll rates. Or, the faster the auto-roll, the bigger the "Ya-Ha" at the end.

Negative G Auto-Rolls

During a negative G auto-roll, roll and yaw will be in opposite directions which is different from the positive G case. A negative G auto-roll can be entered from a negative G roll maneuver if the stick is maintained well forward. Roll and yaw rates are low and the departure tone will not sound. Rudder is effective in ter-

continued on page 28

flying safety

■ To mark the return of this magazine to the title of *Flying Safety*, we are reprinting a few selected articles from the era before the original *Flying Safety* became *Aerospace Safety*.

The articles were selected to provide a perspective as to where we are now in relation to where we were then. The difference may not be as great as we think. The hardware has changed; procedures are more refined; the equipment and systems of all types are more sophisticated. Yet many of the same old problems exist, waiting for the unwary, the complacent, the careless or unknowing aircrew to make a mistake of judgment or execution.

Colonel Francis Gabreski, one of our leading aces, points out, in a February 1953 article, the need for strict adherence to the checklist and the importance of knowing your airplane and the dash one (in combat or training). He also touches on a number of other considerations just as important to aircrews today as when the article was written in 1953.

A pioneer in studying the effects on humans subjected to high G forces, Colonel John Stapp was not satisfied that instrumented dummies could provide all the knowledge he desired. So he offered himself as a test subject, undergoing high acceleration/deceleration tests in which he was subjected to such high G forces that several of his bones were broken.

In the article titled "Whooossh," from the June 1954 *Flying Safety*, Colonel Stapp describes some of the action. Next time you climb into your ejection seat, you can say a word of thanks to a courageous man who risked his life to protect the lives of aircrews.

The possibility of a midair collision between an Air Force aircraft and commercial airliner has been and continues to be one of our greatest concerns. The Air Force demands that all concerned, from aircrew to support and training people, give this possibility highest priority. Shortly after some collisions between USAF and airline aircraft in 1958, General Curtis LeMay, former USAF Chief of Staff, wrote on the subject in the September 1958 *Flying Safety*.

We are very conscious of the midair collision potential today. It is interesting, though, to look back and see that the problems then were very much the same as those today. Looking through the old issues of *Flying Safety* reminded us of our heritage that began at Kitty Hawk. We all share in a legacy that changed and created history. If there is a spirit of Kitty Hawk—and we believe there is—it has been perpetuated by the Gabreskis, LeMays, Stapps and countless others past and present. Our finest technology is ultimately the product of human effort and creativity.

For some mysterious reason we mortals are fascinated by our failures. There is a tendency for safety publications to dwell on the negative side of the aviation ledger. We publicize them, study them, record them faithfully, and, unquestionably, we learn from them. Regrettably, the most careful analyses of our failures yields only a partial answer to our problem. Success often goes unnoticed. It is essential that we study our successes with equal fervor. We are trying to learn more than how to not fail—we are trying to learn how to succeed.

As we close the cover on *Aerospace*, we thought young Eric Johnson's simplified explanation of aerodynamics would serve as a footnote to the old and preface to the new:

> "Lift is like if you let a piece of paper and a paper ball fall down because air slows down the paper because the spread out wings make it go slower before it hits the ground. Drag is partly like lift because the front part of the wing is tilted up and if tilt up too much the plane goes backwards. Gravity makes the plane go down. Trust makes it go forward."

You're right, Eric—in fact, trust makes most things go forward.

Have we progressed, Yes! By any statistical measurement we are improving. The year-to-year comparisons are encouraging—although the progress is sometimes subtly measured in fractions and decimals, it is there. In a more practical sense, even the skeptics have come around. Some of you may not believe it, but it wasn't that long ago that insurance companies considered the military pilot an uninsurable risk. They have changed, and so have we.

There is a spirit of Kitty Hawk, and it lives in the winners. ■

Brig Gen Leland K. Lukens
Director of Aerospace Safety

An Ace Looks At Flying Safety

By **COLONEL FRANCIS S. GABRESKI,** USAF Ret.

■ At 0655, when the briefing was over, Colonel George Jones, commanding officer of the 51st Fighter-Interceptor Group, sent us out to the ships 15 minutes early with instructions to give everything a careful final going-over, paying particular attention to a thorough cockpit check of instruments and switches. And he also cautioned us about our post-takeoff check.

Takeoff at 0715 was uneventful. Twenty-five minutes later we were over Mig Alley at 38,000 feet; weather, thin and scattered; no activity at the moment.

Suddenly Tiger Red Leader broke radio silence. "I've got a flameout . . . no thrust . . . fuel pressure and rpm down . . . heading home . . . I hope!"

He immediately broke formation and headed in the direction of the U.N. lines, many minutes away.

We got the full story later. Here's what happened.

As soon as Tiger Red Leader felt his flameout he started emergency procedure for an air start. Realizing that he was too high for a successful start, he established his glide, but held off trying a start until he got down to about 18,000 feet. Then he tried to fire-up. No soap. He ran another cockpit check to try and locate his difficulty.

On this second cockpit check, he discovered that his emergency fuel boost was turned on. He had missed it during his post-takeoff check, and it had been on for the entire duration of the flight.

He turned it off, pulled up the nose to let the excess fuel drain out of the tailpipe, and then, at about 9,000 feet (still high enough to elect to eject or ride it down) he tried again. This time it took, and he made it back to the airstrip OK. But . . . the squadron was short a plane during the rest of the mission.

During his climb to 38,000 feet, using high power, Tiger Red Leader's emergency fuel boost never got that final push to set it in operation. But . . . when he reached his assigned altitude, and throttled back to cruise, the emergency fuel boost automatically cut in, and poured an excess of raw fuel into the combustion chambers to give him a rich flameout.

If Tiger Red Leader had made a complete cockpit check after takeoff he would have found the emergency fuel boost still in the "on" position and would have turned it off according to routine procedure . . . flight safety procedure. But he didn't.

Knew Procedure

The fact that he managed to come out of the deal all right is testimony to the fact that at least he *did* know his emergency procedure well, and that he kept calm and found out what was wrong. Another flight safety factor contributing to his eventual success, was the fact that he tried his second airstart at an altitude where he could still eject or plan a crash landing. He would have been in king size trouble if he hadn't been well informed as to what to do, and had the presence of mind to make the second cockpit check that revealed the emergency fuel boost still turned on.

That's where carefully cultivated flight safety habits prove their insurance value.

This particular example of both pro's and con's of flight safety practice has a happy ending. That's not always the case.

I guess there may be a few pilots who have the idea that flight safety is a term that applies primarily to Stateside . . . or peacetime . . . flying. Maybe they have the mistaken idea that once they get into combat some form of magic takes place. Maybe they believe that because of

An Ace Looks At Flying Safety continued

the stepped-up tempo of combat flying, the functional and mechanical hazards of flying conveniently bow out of the picture to make room for the hazards of Mig 15's.

If that *did* happen, it would be swell. It would take a load off the minds of pilots, maintenance personnel, commanding officers, and everyone connected with the operation.

But it doesn't happen!

Regardless of whether you are flying in the States, Europe or Korea; whether you pilot F-86s, B-29s, B-47s or what-have-you, the principles of flight safety keep right on being vital to the success of each individual mission—combat or otherwise.

Any pilot who forgets that automatically relegates himself to the ranks of "Those most apt to run into trouble."

Gadgets Still There

Nothing much changes about your airplane when you go into combat. You don't leave that flock of gadgets and gages, switches and buttons, on the ground when you take off. They stay right there, and they still have to be checked and double-checked. Those "routine" cockpit checks are never "routine" in terms of consequences. The engine that powers your airplane in combat is just about the same engine that you used in training. You'll have some of the same problems . . . get about the same performance . . . need about the same amount of maintenance.

And right here and now, let me explain something about maintenance—even though I know most pilots are already aware of it. In combat areas crews have done, and are continuing to do a remarkable job of taking care of ailing airplanes under some of the toughest conditions you can imagine. It gets mighty uncomfortable and difficult to work on an airplane in a revetment, with the temperature down at the bottom of a thermometer. If it isn't cold, the wind is blowing and the dust is flying. If the wind isn't blowing the sun is beating down on the airplane, making parts hot enough to scorch your hands. Those are problems of nature.

Add to those problems the fact that spare parts and special tools are sometimes slow in getting to the forward areas. Consider the amount of improvisation that the crews are forced to dream-up to get the job done. All these things make the job of field maintenance a tough one, and magnify the reasons why you must check, double-check, then check again.

The crews are turning out splendid work, but field maintenance just can't be compared with the formal maintenance possible at a Stateside depot. Remember that, and make flight safety practices and procedures pay off for you.

Pilot's Best Friend

After all, you are the only guy in the world who has the maximum of personal interest in being satisfied that your airplane is ready. You are the guy who will put it to the test. You are the one who wants to ride home in that same cockpit.

Even if it's just for review, take down your T.O. book every once in a while. It's a good habit. Regardless of how well you know your airplane, modifications and new fixes are coming out all the time. Your dash one will help you keep posted on what's new. As far as I'm concerned, I like to go into these changes carefully. I'm not satisfied with someone giving me a verbal rundown on a new installation, or fix. I'm going to fly the airplane, and I'm the one who has to know what to do. I try to study modifications so that I

F-86 Sabre jets taking off from PSP runway in Korea during the Korean war.

understand *why* they were made, what they mean in terms of performance and safety, and what to do if something goes haywire.

I think it's a mighty good idea to talk over any changes with your crew, too. I like to make sure we all know what we are talking about, how the changes are going to be made, and what effect they will have on the airplane.

Another important point. . . .

The pilot who doesn't know his emergency procedures backward and forward is about as smart as a guy who thinks a fast game of Russian Roulette is a dandy rainy day game for the kiddies.

If an emergency does occur, whether it calls for an airstart or ejection, the pilot with the best chance of beating the rap is the one who knows exactly what to do—and what to do *first!* You need a full understanding of your airplane, equipment, and characteristics when payoff time comes. Don't leave it to chance. That's where study, curiosity and T.O. review come into the picture. I hope the phrase "panic button" is on the way out! Your best insurance against panic is *knowledge*. You won't need a "panic button" if you know what to do! If you know what's wrong you can try to correct it. If it won't fix, you can decide whether to crash land or get out. And you can come to your conclusion *fast*—if you have knowledge.

The briefing is not the end of combat flight planning by a long shot. Things can get pretty well confused once you get under way. It's still up to you to do some careful flight planning on your own.

Always anticipate the "unexpected." Always be prepared for worse weather than you were briefed to expect. Study your maps. Know where your alternates are in terms of your flight plan. Double check your predicted fuel consumption and reserve. Anticipate that you may turn up with less fuel than the experts say you should have. Make sure of whatever navigational aids you may have. Think ahead. Anticipate! Your flight doesn't always go according to Hoyle.

How Far Can You Go . . .?

We've lost some fine pilots—just because they went a little too far in trying to make a successful pass at an enemy plane, a hilltop installation, a road. Be sure you know and understand both the capabilities and the limitations of your airplane. Stay alert! Don't get sucked into a maneuver that you can't get out of with safety. Don't let yourself get put on the spot. We've had some pretty brutal and permanent examples of what happens if you let your airplane get ahead of you.

Sure, it's true that few pilots ever exceed flight limitations *intentionally*. But the fact that the mistake was *unintentional* doesn't alter the consequences. Anticipate the reaction your plane will have to every move you make. Keep your flight limitations in mind every minute of the trip. There's no victory if you can't pull out of a high speed dive, or if you pull off a wing trying!

And don't forget your own capabilities and limitations! Excessive Gs and lack of oxygen are still high on the list of combat flying errors.

In combat it is frequently impossible or mighty inconvenient to try to check your accelerometer when you're tangling with a Mig or when you're strafing or dive bombing. Yet *something* has to warn you if you are getting in a tight spot in terms of speed and Gs. I suggest you practice *sensible* G maneuvers in your spare time, using the accelerometer as a check, and develop your own personal *feel* for the symptoms of high Gs and indications of your own tolerance. Don't flirt with blackout. You can't control it and you have no way of knowing in advance just how serious your "blackout period" may prove to be. Use your anti-G equipment and be sure it's in good condition. Fly within your own limitations.

You'd think that enough has been

Two early jet fighters. An F-80 flies by F-86 parked on a Korean air base.

An Ace Looks At Flying Safety continued

said and written about oxygen. Yet every once in a while we lose a pilot and an airplane due to lack of oxygen. Certainly your cockpit check includes your oxygen equipment and supply. How anybody gets set for takeoff without a full supply of oxygen . . . I don't know. As a matter of fact, I think we must assume—in some cases—that although the oxygen supply was adequate, the oxygen equipment was faulty. Make sure you check your mask, your hose, and your connections. If your oxygen system fails, or if, for any reason you start feeling woozy, don't wait around at high altitude while you try to trace your trouble. Get down first—then check your equipment. If you're up around 30,000 feet, you only have a few seconds of consciousness without oxygen. Get down to an altitude where oxygen isn't necessary, then find out what's the trouble.

Another physiological thing worth bringing up again—. Keep yourself in good physical condition and stay on the ball. Nobody wants a wingman with a hangover, or with his mind cluttered up with a lot of personal problems. Flying is serious business and takes all the powers of concentration you have.

This article doesn't have all the answers. I don't have all the answers. I wish I did. But the things I mentioned are things that I know about and that I think will bear repeating again. I think they represent some of the most important things to keep in mind. Let me summarize them for you in checklist fashion:

- Learn everything you can about your airplane and about your emergency procedures. Keep posted on any modifications or changes and be sure you understand *why* they are made and how they will affect you and your airplane.
- Be sure you know the capabilities of your airplane and yourself, and make it a point never to exceed them.
- Never put yourself "on the spot." Anticipate! Plan ahead! Keep alert!
- Preflight carefully. Always double check your cockpit switches and your instruments. Remember your pitot cover.

Col Gabreski was a double ace (WW II and Korea) credited with 37½ enemy aircraft.

- After takeoff, check and double check again. Sooner or later your post-takeoff check will reveal something important that you overlooked.
- Be ready for weather or other changes in your flight plan. Be sure you allow for an alternative. *Always* assume that you will have to use one.
- Develop cockpit procedures that are suited to you, but make sure they include *everything*, and be sure you understand exactly what you are accomplishing by making your checks.
- Always stay on top of the situation. Keep calm, particularly in emergencies. It's then that you need all the concentration you can muster. Knowledge of your airplane and knowledge of proper emergency procedure are the best safeguards against panic.
- Keep in good physical condition and keep your mind free of cobwebs. Keep your mind on your flying.

Sure, I know. You've heard all of this, time and again. OK. But both you and I know that before the week is out, we'll hear about some guy cracking up an airplane because he either forgot or ignored one or more principles of flight safety. Here's hoping it isn't you—or me. ■

About The Author

Colonel Gabreski was assigned as Chief, Combat Operations Branch, Office of The Inspector General, Norton AFB, when he wrote this article. Former commanding officer of the 51st Fighter-Interceptor Wing in Korea, Colonel Gabreski became history's eighth "jet ace" on 1 April 1952. Later he shot down an enemy aircraft that brought his total number of jets destroyed to 6½, and his total number of aircraft of all types shot down to 37½.

Colonel Gabreski entered pilot training in July 1940. He went to England in 1942 as Liaison Officer to the Polish Air Force, flying 20 missions with them. In February, 1943, he was assigned to the 56th Fighter Group. He was shot down over enemy territory in July, 1944, and remained a prisoner of war until May, 1945. During his tour in Europe, Colonel Gabreski flew 166 combat missions, and was credited with shooting down 31 enemy aircraft.

Wooooosh!

By **COLONEL JOHN P. STAPP**, USAF Ret.

■ The aircraft company ads picture needle-nosed ram jet jobs with wings like sweptback ears. They headline them as the "Fastest, Highest Flying Contribution of the Look-Mom-no-wings Aircraft Company to America's Air Supremacy." But, even the superlatives hardly do justice to their products. They are stuck with the simple truth because it would be too much work to think up anything more fantastic, and besides if an aircraft engineer tried to tell a whopper he might be breaking security on a rival company's latest model.

If you don't believe it, look at the progress of aviation in just 50 years—exponential, no less. Where will it end? Very likely with some chief test pilot going into outer space propelled by light beams and grumbling because the universe affords no faster source of power.

The design engineers save their real gripes, however, for one stubbornly unchanging item peeping forlornly from among the titanium rivets—Man, M-1, the same, yesterday, today and forever, fallible, vulnerable, incurably addicted to errors, and above all pathetically mortal.

Some time ago I was project engineer for a series of tests completed at Edwards Air Force Base, California. There it was experimentally demonstrated that the properly suspended human body can survive, uninjured, exposure to crash forces well beyond the material strength that can be built into an aircraft which can still get off the ground. It looked like a good place to rest the case but now it appears to have been only the beginning. I submit a paraphrase of the kind of talk that we are getting from these insatiable design engineers: "Doc, we are working on a few of the bugs of our model—you probably know all about it, the super Rocket Zilch 1313.

"It goes to Thermal 2—we call it 1313 because any time you go through the Thermal Barrier twice, you've had it two times over. What Mach number? That's for squares still fooling with jets; we're already doing preliminary test on Thermal 3. Confidentially, doc, we've got problems.

"In going up to Thermal 2 or in coming back through it, we have accelerations for durations and magnitudes that you Aero Med people don't have any figures on yet. If we stay at Thermal 2 for very long, we expose the crew to temperatures that look like the thermometer on my wife's electric stove.

"You medics don't have any suits to keep them cool in that range. Doc, how about making up some kind of an asbestos suit and moving the seat on your rocket sled to a position just behind the rockets where you'll be sitting in the flames. I know you can't push a sled up to Thermal 2, but if you can decelerate at 50G for about 10 seconds I think that will simulate most of the factors."

That's no time to smile—you'll find yourself sitting in the back seat of Rocket Zilch 1313 without a canopy, and look who's laughing. Tell him it is impossible? Not on your life, or you'll be forever haunted with the specter of a dewey-eyed eager beaver taking off in the first RZ 1313, waving farewell as he shoots from view—without the asbestos suit.

I guess we'd better put in a long distance call to Johns-Manville and ask them if they have any 8-Ply asbestos cloth, ready for delivery by return air express. "And one more problem, doc. How is he going to

Woooosh!

continued

bail out? Can we still use the open ejection seat or do we have to go to the ejection capsule?''

About that time I start thinking about the last resort—Titanium Halo M-1, to be adjusted during the last slow roll as the pilot passes through the pearly gates. Oh well, in my business you don't worry about your hat, you just try to hold onto your head.

Perhaps the foregoing is a slight exaggeration, but the mission of the present (1954) program of research in Biodynamics (effects of mechanical force on living tissues) at Holloman Aero Medical Field Laboratory is directed to find the limits of human tolerance to decelerations, windblast and tumbling such as may be encountered in escape from very high performance aircraft.

These experiments are performed on a rocket sled which, in the maximum velocity configuration, operates at the equivalent of pushing a 2,000-pound vehicle with 54,000 pounds of thrust.

The subject, strapped in a seat, can be exposed to linear decelerative forces equivalent to that experienced after abrupt exit from an aircraft flying at 1,800 mph and at 40,000 feet. By abruptly opening large doors in the sled windshield, the loss of a canopy at maximum speed can be simulated and a bungee actuated seat, mounted on gimbals, can tumble the subject head over heels at 180 rpm or less during the application of deceleration and windblast.

The equipment has been delivered to Holloman ADC, and to date nine proof tests have been accomplished, including two tests of the quick-opening windshield doors. We have not personally worked out on the tumbling seat, as yet.

The seventh proof test was a conservative trial to determine suitability of the equipment for human experiments. Project engineers always come first on such occasions, purely to improve the morale of the other subjects. This test was also to serve as a control on windblast tests by exposing the subject to all factors of the acceleration and deceleration that would be experienced except those of windblast.

Anyway, on the morning of the 19th of March at 0615, I had a cup of coffee and an orange and then drove from my house in Alamogordo, where I live alone and lump it. I carefully obeyed all traffic rules en route to my office at the Aero Med Field Lab at Holloman AFB. After signing a few papers and looking over the morning mail, I went to the lab room where Major Dave Simons, USAF (MC) is second in command at our shop. He's a Flight Surgeon whose Space Biology research is concerned with vertical rather than horizontal rockets. We went through all the steps required in the pre-run physical.

The electrocardiograph showed a fast pulse, my blood pressure was up just a little, and I was perspiring some, although the room temperature was not high.

When we were through I put on a sweatshirt and standard wool blue flying coveralls. I picked up the black gum rubber mouthpiece made to a cast of my dental arches by the base dental lab. Major Jackson, Dental Surgeon, called it a "bite block." I jumped in the car and let Major Simmons drive us to Baker 3, where the 3,500-foot track is located.

We arrived at 0830 for last minute arrangements. The run was scheduled for firing at 1000 hours. Jack Superata, Northrop lead mechanic, and his crew were checking out the last details of pre-run preparations. Lieutenant Leonard and Lieutenant Hack, officers in charge of the Track Unit, were calling back and forth over the intercom from the blockhouse getting all set for that 10 seconds of supreme coordination when cameras, telemetering transmitters, Sleran time-distance recorders and a host of other devices would clock in the right sequence to make the precious records of all the intelligence, the analysis of which provides the end product of the run. Six channels on the sled would broadcast to a truck at a relay point, which would retransmit the signals to Tula Peak, 12 miles away, for recording.

I climbed into the sled, remarking quite honestly that I didn't look forward to this run. The shoulder straps, the lap belt and inverted-V leg strap were positioned and clamped in place. I put the mouthpiece in my mouth. My hands were tied between my knees with webbing. A string to start one of the two cameras mounted at my feet and pointing at my face was handed to me and I was told to pull it at the count of five on the firing sequence.

Almost everybody walked off and left me at the count-down of X-5 minutes, except one instrumentation man doing last calibrations. He was switching over from external to sled-borne power on the transmitters, and two airmen were checking the rocket firing circuits. They soon left. X-3 minutes. I was no longer nervous or worried. Just pull that string at X-5 seconds. X-1 minute—two red flares and siren signalled from the blockhouse. X-45 seconds. I gripped the bite block, swallowed, moved my head forward and shifted my knees together. X-30. My heart rate was picking up. X-15—here it comes—in a few seconds all hell will break loose but don't forget to pull that string at X-5. Then the count-down. 10, 9, 8, 7, 6, 5,—I pulled the string and heard the camera whir—4, 3, 2, 1 FIRE! A brief blasting noise, like an engine blowing off steam, as six rockets, totalling 27,000 pounds thrust, came on simultaneously and the sled seat rammed against my back with an explosive surge.

My head sank into the five-inch thick cushion of rubberized boar's hair. One, two, three, four, five. The sled screamed forward with the most terrific sustained pick-up I've ever experienced. The 26 rides I took in previous years at Edwards AFB on the 2,000-foot track had nothing to compare to this. For a fraction of a second, the speed was 421 mph. Then at burn out, the force was suddenly reversed.

For about a second, the rail friction on the sled slippers and the wind drag slowed the sled down with a force equal but opposite to the pickup of the first five seconds. I was slewed forward in perfect position for the water-brake deceleration which was to follow. Unknown to me, the headrest cushion flew off at this time and gave one horrified spectator the impression that my head had come off. Then the water brakes . . . A smooth, abrupt loading of pressure against the shoulders and hips as I was pushed into the harness, held for noticeably longer than any deceleration I had previously experienced.

The initial surge of deceleration was 22G with a build-up of 500G per second. The subsequent maintained level of force felt perfectly smooth to me, but the records show that in .59 seconds I oscillated 17 times in a sine wave of amplitude diminishing from 10 to about 5G, a pressure change against the harness of about 1,700 pounds dwindling to 750 pounds at 30 cycles per second. But I didn't know it and could only take the recording oscillograph's word for it afterwards. During this time the sled slowed down from 313 mph to 157 mph in 200 feet. Less abruptly, the pressure eased off the harness, and after a few seconds, there was a brief impact as the sled hit the emergency water brake and came to a halt.

The water scoops under the sled had knocked out masonite dams and scooped up the water between them, throwing it up 50 feet in the air throughout the deceleration, but I wasn't even wet.

I pulled my right hand out of the webbing and waved an okay. Jake Superata and Major Simons came running up and looked me over anxiously. I took out the mouthpiece and grinned. About that time, my poor confused circulatory system, doing its best to keep the right pressures at the right places through the rapid changes of the last eight seconds, lost its way just a little and I felt a bit woozy, but no different than after many a ride on the centrifuge.

Major Simons says that I was just a little bit pale for about half a minute, but immediately snapped out of it and sat through the picture taking. About that time Colonel Haney, acting CO of the Center, and his staff came up. There was much talking and picture taking. I was happy about the whole thing. I call it survival euphoria and try not to be too ridiculous about it. Finally we got in the car and went back to the lab for the post-run physical. Everything checked out all right. The electrocardiograph was slowed down to normal rate; my blood pressure was back down to 130 over 86, and later to 124 over 80. I wrote up the subjective report, answered some phone calls and started wondering when we would go to lunch. It couldn't come too soon.

The 64-dollar question is, of course, why do it? Why not just use dummies? My answer is that aircraft are still flown by people and if a slightly plump 44-year-old flight surgeon can take it, why can't you? ■

About The Author

Colonel Stapp was called to active duty in October of 1944 and served in various medical assignments as well as attending several schools of aviation medicine.

He has many research achievements, including high altitude unpressurized flight tests of a liquid breathing system; studies on the effect of windblast, including a flight in an F-89 with the canopy removed at 570 mph; and human deceleration studies. The last took in 73 human experiments on a rocket powered sled which was decelerated from speeds of 150 mph by mechanical brakes.

He was a volunteer for 26 of those tests, culminating in an exposure to forces of 46.2G during a quarter of a second.

During those experiments he sustained numerous injuries, including several broken bones, but succeeded in exploring human tolerance to crash-type forces, establishing human limits considerably in excess of aircraft strength specifications.

Colonel Stapp tested the limits of man's ability to withstand high G forces.

AIR TRAFFIC

By **GENERAL CURTIS E. LeMAY,** USAF Ret.

■ . . . It is also an abundant resource, but it is not unlimited. In fact, when one takes into account the growing demands of organized air commerce, private flying and the military, the air space over the land and sea, is becoming highly congested. This is particularly true along the great trading routes, and it will become more so in the years ahead.

In recent months, midair collisions between Air Force aircraft and civilian airliners have understandably focused increased attention on air operations and air traffic control. These air collisions, wholly apart from their grievious cost in human life, have had what I consider a most regretable side effect. Long before the circumstances could be thoroughly investigated, the implication was publicized that the military is using the air space wantonly. Our jet pilots have been likened to "hot rodders" by one critic; another referred to military pilots "careening recklessly" through commercial airlanes. Still another stated that military planes ought to keep out of the main airways unless specifically cleared for flying there.

Everyone, of course, is entitled to his own opinion, but the most valid opinions are always based upon unprejudiced and careful examination of the facts. Improvement in air safety can only be attained if the many aspects of the air traffic problem are fully understood, carefully analyzed and proper and positive action is taken. All users—the commercial airlines, the private flyer and the military are vitally concerned and must be considered.

There are three points that I want to stress at the outset:

First, the Air Force has a basic and continuing interest in safe air operations. To do its job, the Air Force must fly and air safety has a direct relationship to how well we do our job.

Second, the so-called civil airways of this country, which some have chosen to call civilian airways, are in fact federal airways available to all aircraft—commercial, private and military.

Third, the flying that is done by the Air Force is essential to national defense. We do not fly for any other reason.

A flying Air Force is essential for defense, and as I've stated, flying is the Air Force's primary business. The commercial airlines fly to perform a necessary transportation service for the nation. The private pilot flies for business or pleasure. The Air Force flies to keep its crews trained so that we can maintain an adequate combat capability and fulfill continuing military logistic and transportation requirements.

In addition to the pilots who are directly assigned to combat positions, we have other pilots performing staff and command functions who must maintain flying proficiency. We in the Air Force know from experience that commanders and staff officers who are responsible for making decisions concerning flying and the nation's military airpower must maintain a continuing up-to-date knowledge of flying problems.

To maintain the combat readiness stature that the Air Force needs to perform its mission, we flew over seven million hours within the U.S. during the Calendar Year 1957. This is approximately twice as much flying as all of the domestic scheduled air carriers accomplished the same year. In fact, at any given moment of the 24-hour day, 1100 to 1200 USAF aircraft are airborne worldwide. This volume of flying is necessary if we are to continue to maintain our combat readiness and perform our role as a deterrent to war.

When one measures the amount of Air Force and other military flying against the 158,000 miles of airways in this country, it is obvious that the military has to use the airways. In this respect, I must point out that practically all Air Force bases are on or very near airways. I would like to point out further that many of these airways were commissioned long after the air bases themselves were built.

There are several types of airways—low frequency airways, VOR or high frequency airways and high altitude routes. Some of them lie one above another and their locations are generally the shortest routes between two radio aids to navigation. A glance at the various types of aeronautical charts shows that the federal airways literally form a three-dimensional web over most of the United States.

There are two types of conditions under which air traffic operates:

First, under Instrument Flight Rules which require close control of aircraft by ground stations to assure safe altitude and time separation between aircraft.

Second, under Visual Flight Rules which do not require close control by ground stations. In the latter case, the ability of pilots to visually observe other aircraft is essential for safe operations. Normally, cloud cover and visibility determine the conditions under which a flight must be made.

The control of air traffic on the nation's airways is a mammoth job—and one that grows ever larger as the air traffic density increases.

During the last three years, the air traffic control system has improved through the provision of more funds, more personnel and more facilities. Nevertheless, it is presently inadequate for the job and will be for some time.

Mr. Pyle, the CAA Administrator, has pointed out that the system can handle roughly 17,000 flights per day operating under instrument flight rules, as traffic is now distributed. He has also stated that there are well over 200,000 flights of all types

The control of air traffic on the nation's airways is a mammoth job—and one that grows ever larger as the air traffic density increases.

operating daily in the United States. Obviously, then, if it were directed tomorrow that all flights, civil and military, were to operate under instrument flight rules at all times—all aviation in this country would be slowed to a comparative standstill just as it is under extremely bad weather conditions. This, our country cannot afford, thus the solution does not lie in such restrictions to flying.

There is one other point I'd like to make with regard to the airways.

Federal agencies such as the Civil Aeronautics Administration and the Civil Aeronautics Board promulgate regulations covering the operation of aircraft on these airways. These regulations are followed by all pilots, military as well as civilian. I want to make it absolutely clear that we do not claim any exemptions from these regulations, and we are not accorded any except for urgent military necessities which the CAA acknowledges have not led to abuse. In fact, Air Force pilots, in many cases, are subject to even more stringent rules than those which apply to civilian pilots. Air Force pilots who violate either CAA or Air Force regulations face disciplinary action.

The Air Force's interest in safe air operations is not only a question of the essential flying we must do to fulfill our national defense responsibilities. It is also a question of individual self-interest. A man at the controls of a military aircraft is just as concerned about completing his flight safely as is any other pilot or air passenger. It is human nature to want to live, and military pilots are impelled toward safe operations by the same natural instincts that motivate all others who fly.

Furthermore, from first-hand knowledge I can assure you that Air Force pilots are well trained, emotionally stable and responsible individuals. I will match them against any group of pilots anywhere in the world. The Air Force's contribution to safety in the air—not only for our own people but for all the other users—begins with our having highly qualified people in the cockpit.

Over the years, the Air Force has devoted more and more time and effort to the solution of the flying safety problem. In the selection of our pilots and the development of our equipment and facilities, the principle of air safety has played a major role.

One indication of our progress is that the USAF major aircraft accident rate for 1957 was less than one-third of what it was in 1947, and about one-fifth of the rate in ☞

AIR TRAFFIC continued

1937. We are working hard to achieve greater air safety but we are well aware that one factor—human error—can never be positively and permanently eliminated.

In achieving greater air safety, we have worked in close cooperation with governmental and civil aviation organizations for the mutual welfare of all who use the air space. The Air Force has long supported the policy of developing and operating a common system of air traffic control for civil and military flying. We have backed this program in a practical manner by sharing the fruits of our progress with civil aviation.

As one of the means toward improving the control of air traffic, the Air Force has continuously advocated the use of radar. Through joint effort with the CAA and civilian aviation interests, the expanded use of radar has proved to be one of the most singular means of providing improved safety and efficiency within our air traffic control system.

As early as 1946, we made available to the CAA one long range search radar and three short range ground control approach units. The long range unit is still in service here in Washington. The three GCA units were installed at Washington National, LaGuardia in New York, and Midway Airport in Chicago. These units provided radar service for several years, but more importantly they served as a basis for the development of improved systems and techniques.

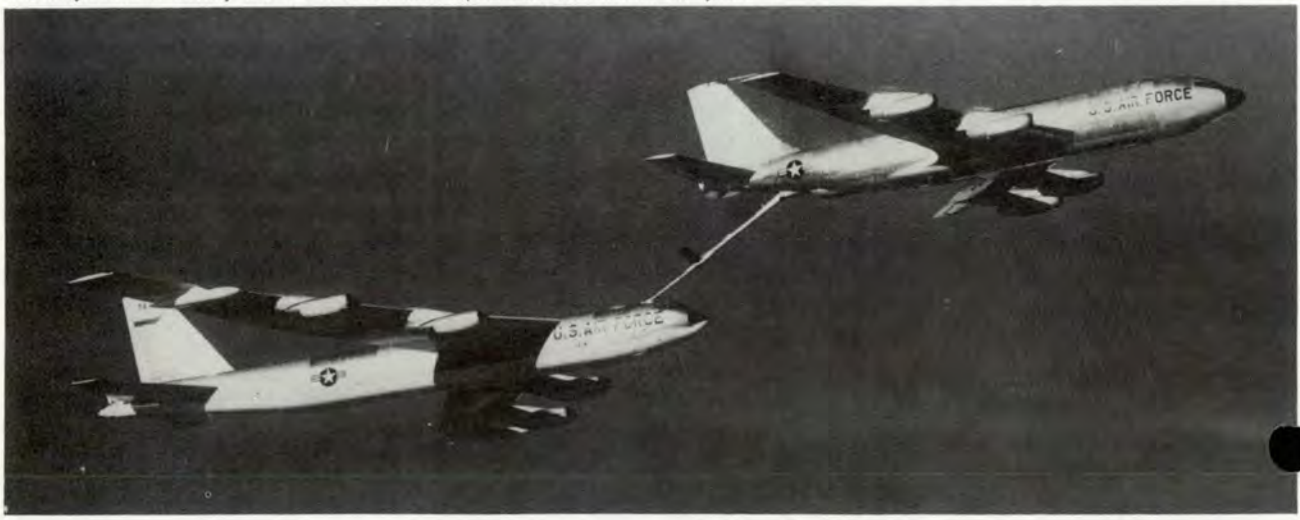
As a result of our experience with this equipment, the Air Force constructed 60 permanent radar approach control facilities in the United States to serve high traffic density military bases. These facilities cost about one million dollars each and are equipped to provide control within the terminal area. At 24 of these locations, where both military and civil air traffic are involved, operational responsibility and authority have been turned over to the CAA.

In the long range radar area, the CAA and the Air Force have agreed upon joint use of 17 long range search radars for both air defense and air traffic control during the fiscal year 1958. Eleven of these radars are Air Force equipment. In the fiscal year 1959, eleven additional Air Force long range search radars (one Navy and four CAA) will be integrated into this dual purpose system.

We have been active, too, in high altitude space control. After extensive inter-agency coordination with the CAA and the CAB, air space above 24,000 feet was designated as controlled air space. This plan went into effect last December. Also, more recently, in the interest of further minimizing possible midair collisions, the Air

Despite the fact that the United States has developed the finest air traffic system in the world, it is not good enough. It must become better, and we have the means to do this.

". . . The Air Force has a basic and continuing interest in safe air operations. To do its job the Air Force must fly. And air safety has a direct relationship to how well we do our job . . ."



Force voluntarily restricted certain jet activities. We did this knowing that such actions would curtail our operations to some extent, but we want to cooperate to the fullest.

At the present time we are in a joint program with the Civil Aeronautics Administration to review other possible ways and means of further segregating, procedurally or geographically, heavy volume jet training operations from civil en route airway traffic. The high density of air traffic makes this a very difficult job.

The increase in midair collisions in recent years is no doubt partially due to the greater speed of modern aircraft coupled with higher air traffic density, the relatively slow human visual scanning capabilities, and the man-machine reaction time.

Our evidence indicates that under high speed closure conditions two pilots must determine that they are on a collision course while they are still miles apart. In some instances, however, when the contrast of the background sky and silhouette of the aircraft is at a minimum, an approaching aircraft cannot be clearly identified even at distances *less* than a mile.

From our continuing studies of midair collision problems, we have, thus far, reached the following conclusions:

- Anti-collision warning devices must be developed which will warn the pilot of any aircraft on a collision course and furnish information that will help him decide on evasive action.

- Traffic control procedures must be modernized to provide the maximum degree of control of all traffic through more extensive use of radar, particularly within high density terminal areas.

- Installation of high intensity anti-collision lights is desirable for all aircraft, to provide better daytime detection.

F-100, shown above with Joshua tree in foreground, was operational fighter when General LeMay was Chief of Staff.

The development of anti-collision warning devices is a difficult problem. We need an anti-collision warning device which will not only identify an approaching aircraft, but present information sufficient to conduct proper evasive maneuvers. Preliminary work done on this problem by the Air Force's Research and Development Command has been turned over to the Airways Modernization Board with whom we are working on the project.

We are also investigating the use of high intensity anti-collision lights, to assist identification in daylight. In addition, we are accelerating a project to mark our non-tactical aircraft with highly visual paint. Our tests show a definite increase in aircraft recognition through this method.

Improved air safety is possible.

I have cited these examples of our efforts and contributions toward safer flying to indicate that the Air Force is dedicated to the solution of this problem.

We shall continue to work in every possible way to improve safety standards in the air.

I believe that a satisfactory air traffic system capable of meeting future requirements can be achieved if all users of the air space make a sincere attempt to recognize each other's problems and exert coordinated effort to attain the desired results.

I recognize that we have a long way to go to achieve the kind of air traffic system and the high level of air safety that we all want.

Despite the fact that the United States has developed the finest air traffic system in the world, it is not good enough. It must become better and we have the means to do this.

Our country has solved some tough problems in the past. If everyone works together, I feel sure that we can solve this one too. ■

Approach And Landing (Safely)

By COLONEL NORMAN J. DE BACK, JR., USAFR
Directorate of Aerospace Safety

■ All of us have flown as passengers/copilots with other pilots who always made good landings. Did you ever wonder why or how this happens? It isn't just luck. Somebody is doing something right. When asked how he did it consistently, some wise guy will say, "Well, you fly the airplane down to about ¼ inch above the ground and level off, then slowly lower the gear onto the runway."

I would like to take a few minutes of your time to talk about the safest way to make an approach and landing in a modern jet transport. No particular type aircraft is in mind. These procedures fit all transports in the Air Force inventory and are derived from flight manuals, regulations, industry publications, and research findings.

Simply stated, the approach and landing is broken into three elements.

1. Stabilized Approach Policy.
2. Landing Operation Rules.
3. Approach and Landing Variables.

Let's define a stabilized approach. The aircraft is:

- In landing configuration.
- On profile path.
- Airspeed +5 to −5 knots target speed.
- Descent rate less than 1,000′ per minute.
- Engines spooled up.
- Approach evaluation at 500 ft above ground: If not stabilized—execute a go-around.

Of course, it isn't always quite so easy. Many times we have variables that need to be figured in. Two biggies of which we were always aware (almost always) are surface wind and antiskid. Remember to add all the gust. For inoperative antiskid, we go to the flight manual to extract limitations.

Other not quite so obvious variables are:

- Wet/icy runway.
- Deviation from approach path.
- OAT deviation (add 4% landing roll distance for each 15° increase above standard).
- Touchdown too far down the runway.
- Runway gradients.
- Threshold height—too high.
- Duck under.
- Touchdown speed—too high.
- Delay in deploying spoilers.
- Improper braking techniques.
- Inoperative spoilers.

When an aircraft is on its proper approach profile the touchdown point should be 1,000′ down the runway with a 50′ height over the threshold. At night this 1,000′ mark would be five runway lights from the end. Just being 50′ too high (100′) adds 1,000′ to the touchdown point (2,000′ from the end). A flat approach (2° or less) caused by using the Mach 2 Eyeball and not using the help provided, i.e., ILS, GCA, VASI or proper altitude over outer/inner marker, increases the touchdown point to 1,500′ down the runway.

A "Duck Under" is something many of us have been guilty of and it is a big no-no. In a duck under maneuver, airspeed is increased from 4-6 knots and the rate of descent increases up to 400′ per minute (750 being average). This results in either (1) landing short, (2) a hard landing, (3) a balloon and float or all of the above.

Runway gradient itself is not much of a factor in landing distances but the illusionary effect it causes may be. For example, sloping terrain down to the runway causes pilots to be high and land long, and vice versa.

Excessive airspeed. How about this one? Let's add 5 knots for the wife and kids and 5 knots 'cause I'm kind of rusty. Well, my friend, too much speed causes either of two problems. If your target speed is 132 knots and you are 10 knots fast, add 300 feet landing roll distance (1% increase in speed = 2% increase in landing roll distance); however, if you elect to bleed the airspeed off prior to touchdown, add 2,800 feet to the touchdown point.

As the aircraft is gently placed on the first 1,000′ of the runway, good technique is to smoothly and quickly lower the nose wheel to the runway and use your three drag devices—aerodynamic drag (wing flaps and ground spoilers), thrust reversers and brakes in the correct amounts and order.

Holding the nose wheel off the ground (1) decreases weight on the main gear because of increased lift, (2) increases possibility of the tail striking the ground, (3) provides no nose wheel steering (necessary for cross wind landings), (4) decreases forward visual scan, and (5) increases landing roll distance.

The second decelerating force, Engine Reverse Thrust, is most effective at high speeds, decreases at 100 kts and is nil below 80 kts.

Lastly, we have braking action, proper use of antiskid, and avoidance of hydroplaning. Don't get on the brakes until below 100 kts (on a long 10,000′ plus runway they may not be needed at all) or until turn off. If max braking is needed, remember your antiskid is most effective when brake pedals are fully depressed (provided you have the late model antiskid). Trying to use antiskid like car brakes causes the system to cycle and release, adding much distance to the landing roll.

If you are unfortunate enough to be flying in inclement weather and must land on a wet runway, remember hydroplaning, of which there are three kinds:

Reverted rubber, caused by too heavy braking causing the tire to be isolated from the surface by a film of water. As the water heats it turns to steam. This type of hydroplaning can occur down to 5 kts.

Viscous hydroplaning is on a very thin film of water (1/1,000 inch) and occurs only on a very smooth surface such as the ends of runways where rubber from many touchdowns has collected. However, the end of the runway is a very poor place to lose speed control.

Dynamic hydroplaning is the one we are most familiar with and most likely to experience. It is associated with a very heavy rain, as when a thunderstorm is over the field (1/10 inch of water), and lifts the tire off the surface of the runway. Again, hydroplaning is not likely to occur if brakes are not used until below 100 kts.

Remember, good landings don't just happen. They are planned outside the outer marker. Use a stabilized approach, observe landing rules and proper stopping techniques. ■

F-15 AERODYNAMICS continued

minating the maneuver; however, it must be applied with the rolling motion. The negative G auto-roll is *extremely disorienting* because of the combined effects of negative G and longitudinal G. Neutralizing the controls is sufficient but rudder application will speed the recovery somewhat.

You may wish to think about this one a little. Knowing that you can release the controls (provided you're trimmed for 1.0 G or better) and recover, do you really want to bet the ranch that you'll correctly analyze this extremely disorienting situation and apply proper rudder simply to "speed the recovery somewhat?"

Spins

Below 30 CPU AOA, the aircraft should not depart at any altitude, airspeed, or loading configuration. Departure resistance is greatest at low altitude and low airspeed. Departure resistance is reduced above 30 CPU by lateral asymmetry from external stores or fuel. Above 30 CPU, presence of a centerline tank *with no wing tanks* (missiles/pylons/rails are not a suitable substitute) reduces departure resistance, and if combined with lateral asymmetry, markedly increases the likelihood of a departure. If controls are neutralized at the first indication of a departure (large uncommanded roll or yaw), the aircraft will recover immediately. Spin susceptibility is very low due to high departure recoverability; however, large lateral asymmetry can produce a spin above 30 CPU if departure is not promptly recovered. Recovery is good with application of recovery controls.

Departure Tone

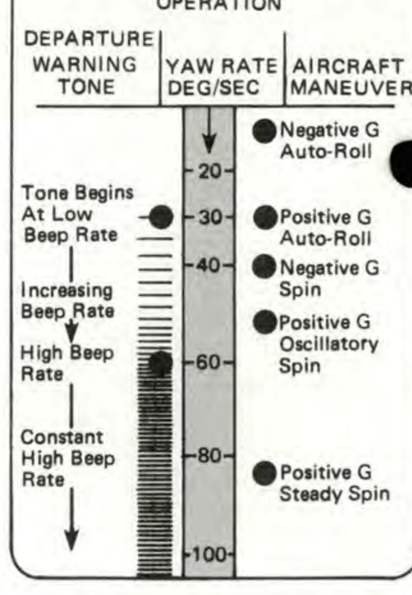
The departure warning tone informs the pilot that the maneuver he is performing has taken the aircraft beyond its effective operating range and that if he persists, a spin could result. By noting the change in beep rate, he also knows whether the situation is worsening or improving. Between 30 and 60 deg/sec yaw rate, the beep rate varies directly with the yaw rate. This range of operation includes negative G spins and positive G oscillatory spins. Persistance in a positive G maneuver at this point can drive the aircraft to a high yaw rate steady spin during which the beep rate will be high and unchanging.

Neutralizing controls immediately when the warning tone begins will recover the aircraft from all departures. If controls are neutralized at any point within the increasing beep rate phase, the aircraft will recover from all negative G and most all positive G out-of-control situations (depends on stores and lateral asymmetry). When the tone is sounding at a constant high beep rate, the aircraft is either in a positive G steady flat spin or has a high probability of progressing to this condition. Recovery requires lateral stick with the yaw. Decreasing beep rate is an indication that the aircraft is recovering. When beeping ceases, neutralize all controls and allow all large oscillations to damp.

The departure warning tone has much less significance for auto-rolls; the negative G auto-roll yaw rate is too low to trigger the tone and the positive G auto-roll yaw rate may be either above or below the point at which the tone begins to beep. The tone, therefore, may or may not be heard in a positive G auto-roll.

A summary of the departure warning tone indications for various out-of-control situations is displayed in graphic form at figure 3.

FIGURE 3
DEPARTURE WARNING TONE OPERATION



We hope the information in this article will add to your success in the new year. The more you know about flight characteristics of your jet, the better equipped you should be to hack the mission. ■

The author wishes to acknowledge appreciation to Mr. Clarence Mongold, Aerodynamics Branch Chief, McDonnell Aircraft Corporation, St Louis, MO, for his assistance in preparing this article. Also "Aerodynamics for Naval Aviators," H.H. Hurt, Jr.

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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.

FIRST LIEUTENANT

Douglas P. Whitworth

95th Fighter Interceptor Training Squadron

FIRST LIEUTENANT

Michael J. Baldwin

49th Fighter Interceptor Squadron

Tyndall Air Force Base, Florida

■ On 2 April 1980, Lieutenant Whitworth was instructing Lieutenant Baldwin, a student pilot, during a T-33 target training sortie. After the intercept training was completed, they were returning to base for practice instrument approaches. After a descent to FL200, 25 nautical miles southeast of Tyndall AFB, the engine flamed out for no apparent reason. Lieutenant Whitworth quickly selected the gang-start switch and retarded the throttle to idle. With no engine response and no indication of a restart, he set up a 180 KIAS max range descent direct to Tyndall. He left the battery on for the entire flight as it was his only means of attitude information and navigation. Upon reaching FL180 the crew encountered total IMC conditions and decided to glide back to Tyndall. If the runways were not sighted at a point where a flameout pattern could be safely entered at or about 3,000′, then the aircraft would be turned South toward the Gulf of Mexico and abandoned. Still under IMC, the crew was able to navigate to within four miles of Tyndall using TACAN until the ground was sighted at 8,000 feet. Using ground references from this point on, Lieutenant Whitworth was able to locate Tyndall AFB two miles to the east as the aircraft descended through 6,500 feet. The aircraft was flown directly toward the field, and a flameout pattern was established at 4,500 feet. Because the pattern was entered 1,000 feet lower than the optimum altitude, Lieutenant Whitworth delayed configuring until base leg. When he lowered the gear which bled the already low wind-milling hydraulic pressure to zero, the aileron boost, which provides hydraulic assist at a rate of 15 to 1 to the ailerons, failed and the gear all indicated unsafe. Using 15 times the normal amount of pressure to deflect the ailerons, Lieutenant Whitworth was able to complete the final turn while Lieutenant Baldwin activated the emergency hydraulic pump until all three gears indicated down and locked. Lieutenant Whitworth then landed the flamed-out aircraft from the rear cockpit. Their superb analysis and decisive actions saved a valuable aircraft and possibly their lives. WELL DONE! ■