AEROSPACE
# SAFETY
UNITED STATES AIR FORCE

FEBRUARY 1966

AEROSPACE SAFETY

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**AFRP 62-1 FEBRUARY 1966 VOLUME 22 NUMBER 2**

# *FALLOUT*

### WHERE THE ACCIDENT BEGINS

"Where the Accident Begins" (in the November issue), was a timely article on a promising procedure which I believe will soon become standard at least for Century Series aircraft. However, your artwork was in error in that it depicted the GCA unit as sited adjacent to GPIP. In fact the GCA or precision component is sited not less than 2201 feet farther down the runway from GPIP. Your artist should have drawn a radar reflector at GPIPs instead of the GCA shack.

I highly recommend that you obtain a copy of "Report of Operational Evaluation of Relocated Glide Path Intercept Point," 1st CEG, Barksdale AFB, La. This comprehensive report evaluates the findings of AFCS, 2AF and 1st CEG, following B-58 testing of the methods described in your article. The test took place from 16-20 August 1965 at Little Rock AFB, Ark.

**Capt Clyde M. Slade**
**AFCS, Tinker AFB, Okla**

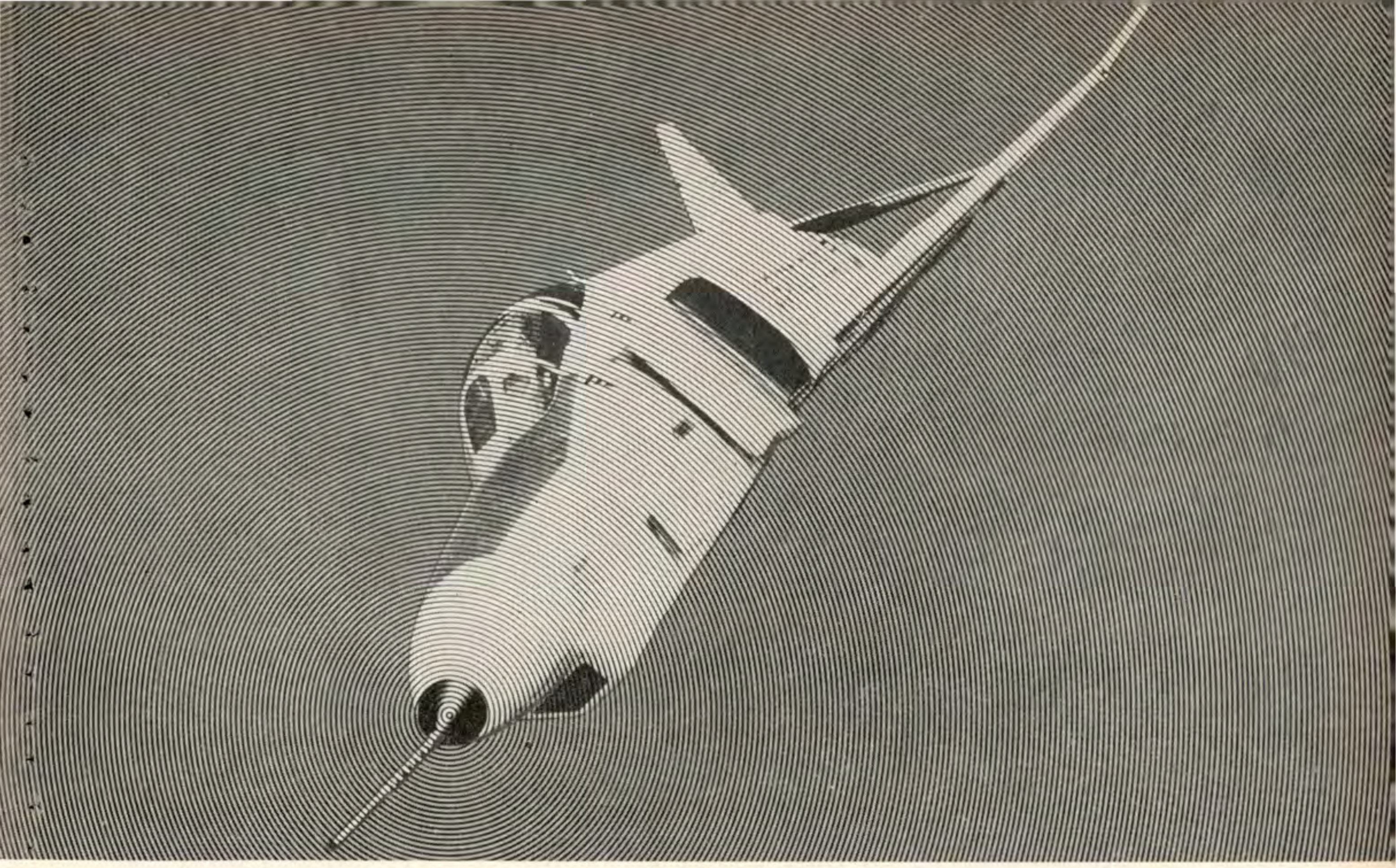
*We are aware of the tests you mention. Thanks. As for the GCA shack—artistic license.*

### HURRICANE HUNTERS

The drama of a handful of men pitting their aircraft and skill against the fury of a hurricane and penetrating its eye to learn its secrets has been the subject of radio and television programs, movies, books, magazine features and thousands of new articles.

Since 1946, that's what the "Hurricane Hunters" of the 53 Weather Reconnaissance Squadron have been doing—providing the Armed Forces and the U.S. Weather Bureau with around-the-clock hurricane warning information, along with their other weather gathering missions.

Last November 30 marked two decades of storm reconnaissance for the USAF Hurricane Hunters. During the 20 years the squadron used six different types of aircraft in flying thousands of hours without a major aircraft accident during these flights. Many flight crews, maintenance and support people made this record possible. We salute them.



# SPINS

By Captain Don Engen, USN

Reprinted from APPROACH Magazine, April 1959

Pilots have been spinning airplanes since shortly after Orville Wright first took to the blue at Kitty Hawk. Prior to about 1916, the spin usually ended fatally. This was primarily because the recovery controls required were unnatural to what the pilot felt was required. He was diving toward the ground and back stick was all that he knew would prevent his descent.

Around 1916 it was discovered that forward stick and opposite rudder were effective for recovery and spin fatalities decreased. The spin became an ordinary maneuver. As soon as the first pilot used a spin as a defensive maneuver in WWI and his opponent watched in satisfaction only to see him recover, it lost all tactical use forever. (This writer, after having conducted spins in many types of airplanes and after chasing spin demonstrations, would like nothing better than to see an opponent in a spin and would be waiting for him at the bottom.)

About 1919, the airplane design theory having changed, spins again began to take their toll of pilots. The flat spin was encountered and the hitherto effective recovery controls would not suffice. This flat spin had a high rotation rate, as high as one turn per second, and an attitude of within 10 to 20 degrees of the horizon. Research provided reasons for this spin and it was endeavored to design the flat spin out of a new airplane by increasing the vertical tail area. This was not totally effective.

Pilots continued to spin airplanes intentionally and unintentionally during the 1920's and 1930's and dur-

# Spins

**Spins in early aircraft were usually fatal. Recovery technique was discovered in 1916 and remained essentially the same through WW II. Flat spins, however, took their toll and improved design partially solved this problem.**

ing this period recovery techniques varied little. Opposite rudder, forward or neutral stick, and neutral ailerons proved the optimum technique. The WWII years produced rapid airplane design improvement. However, the same recovery techniques continued to be applicable. Increased engine power was destabilizing and retarding the throttle for spin recovery was required.

With the advent of the jet engine and the thinning of wings for decreased drag, more and more weight (mass) had to be concentrated in the fuselage. By 1953 it was readily apparent to all pilots that the spin had once again taken on new modes and that past recovery procedures were not obtaining the desired results. The spin was becoming violent and oscillatory about all three axes and, in addition to the known classical spins, now horizontal gyrations occurred. These latter were first encountered on tailless airplanes and in NACA high speed research airplanes. As a result of NACA (now NASA), industry and military efforts, new recovery techniques were established and preventives in the form of control restrictions were used.

It is in this spin era that we find ourselves today. We know how to recover most airplanes from spins. There are some configurations of airplanes that are extremely difficult and sometimes impossible to recover from spins. This article does not attempt to promulgate the final all-encompassing and last word on spins. The intent here is to supplement the Flight Manual with general background information and to discuss the spin as it is known today. General recommendations will be made that apply to most present day airplanes.

### RELATED FACTORS

It is not intended to discuss in detail all of the factors that affect a spin. The following facts are stated in brief. The character of a spin entered at 45,000 feet does not differ greatly from one entered at 25,000 feet. However, the equivalent airspeed at which a spin is entered does affect the violence of the spin and spins entered at high equivalent airspeeds feel more violent to the pilot. As the center of gravity of an airplane moves aft the static longitudinal stability decreases and the tendency to pitch up increases. Directional stability deteriorates as the stall is approached, and as the airplane stalls the yawing moment required to initiate a spin may be imparted, though it is not necessary to stall to have this happen. It should be noted also that the exact stall in most high performance airplanes is sometimes hard to define. The airplane is more prone to enter the spin and the rotation rate will be higher in this flatter spin. The airplane will recover with greater difficulty from a flat spin.

With the advent of in-flight refueling higher gross weights are obtainable at altitude. High angles of attack are required to maintain the required lift at these gross weights and the heavy airplane may spin. More energy is acquired in a heavy gross weight spin and a spin of this type will be more difficult to recover from.

It is axiomatic that safety is gained in spinning airplanes at altitudes sufficient to allow complete recovery by 10,000 feet.

# ERECT SPIN

Contrary to popular belief, swept wings differ little from straight wings in aerodynamic effect on an airplane in a spin. The F-104 has similar pitchup characteristics to several swept-wing airplanes. As airplanes have progressed through the years the trend has been to concentrate more mass along the longitudinal axis. Fuel, landing gear, electronic equipment, and heavier jet engines are now concentrated in the fuselage. This has a pronounced effect upon the inertial qualities of an airplane in a spin and the recovery procedures.

## THE INCIPIENT PHASE

There are three phases to most spins. These are the incipient phase, the spin, and the recovery. All airplanes do not have the incipient phase and some airplanes will not spin. Chance Vought coined the term "post-stall gyration" for the F7U-3.

This airplane never entered a classic erect spin but rather tumbled about all three axes. The motion of the F7U-3 in the post-stall gyration might be considered to be like the incipient phase of a spin. The incipient phase is defined as that transient motion of the airplane between the stall and the fully developed spin.

As the airplane passes through the stall angle-of-attack the flow of air over the control surfaces breaks down and static stability rapidly decreases. After the stall the control surfaces are essentially ineffective and the airplane will pitch about any one or all of the three axes.

During this incipient phase of the spin the pilot will be subjected to varying vertical, lateral, and horizontal load factors. It may be possible for the pilot to recover from this phase. However, abrupt control deflections, either the prescribed spin recovery controls or abrupt control deflects to counter the motion of the airplane, probably will cause the airplane to enter the fully developed spin.

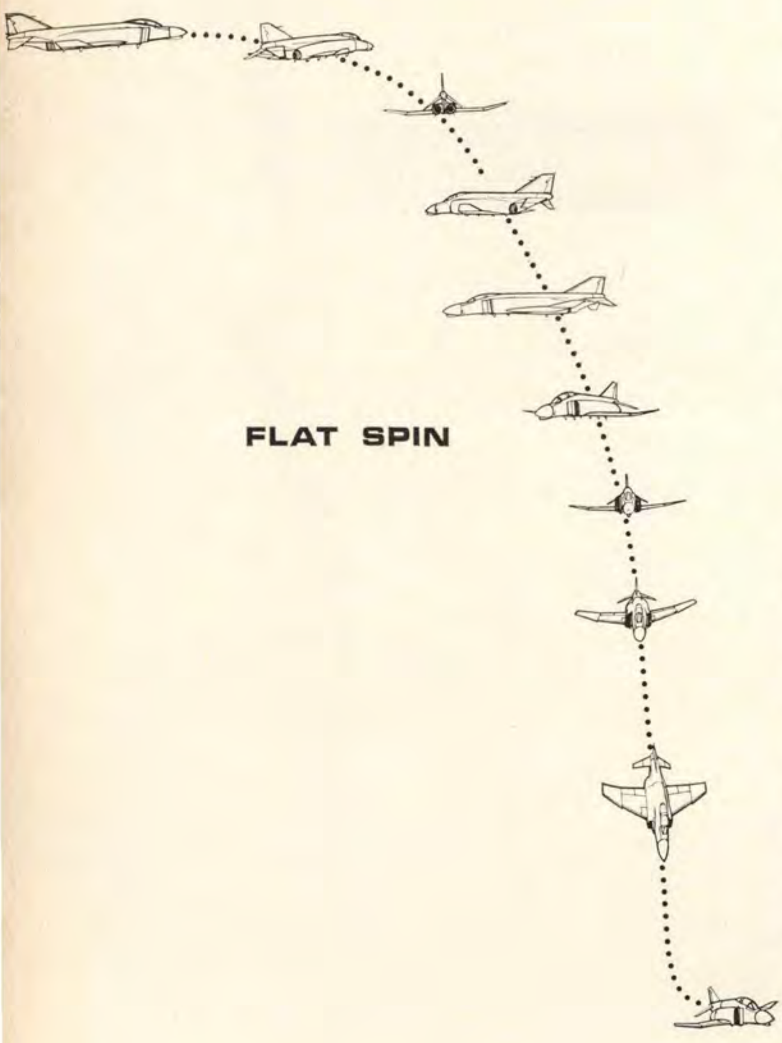
Generally speaking, if the pilot can detect the incipient phase he should release the force on the control that most likely caused the incipient motion and neutralize the other controls and let the airplane fly itself out. Caution must be exercised to not mechanically throw in spin recovery controls.

In most aircraft the incipient phase, if the pilot can detect it, may last from .2 to 10 seconds and ¼ to 3 turns of what may progress into a fully developed spin. Motions that can occur during this phase are snap-rolls, high yaw rates, pitch-up or any combination of these. If neutralizing the controls does not bring about the desired results and the fully developed spin results, it is wise to allow the spin to steady down before recovery is attempted; recovery action cannot be taken until the maneuver is analyzed.

## THE SPIN

The fully developed spin has been defined as a motion in which an airplane in flight at some angle of attack above the stall descends towards the earth while rotating about the vertical axis. The angle of attack of the airplane greatly affects the type of spin since the static stability varies from positive at low angles of attack to negative for high angles of attack. It must be remembered that the angle of attack is meas-

# Spins



FLAT SPIN

ured from the relative wind to the wing chord line. An angle of attack of 80 degrees can be had in a spin where the attitude is relatively flat in relation to the horizon.

Angles of attack beyond the stall but less than 60 degrees are considered to be low angles of attack and any angle above 60 degrees is considered to be a high angle of attack in spins. Most airplanes will average 45 degrees in the spin. When the spin is fully developed the airplane is at its highest angle of attack with a high rotation rate. If the average angle of attack is decreasing in the spin the airplane is tending to recover. The angle-of-attack indicator, as installed in current airplanes, will be of no help in determining whether a spin is a high or low angle-of-attack spin. It is not installed to indicate this information.

The first turn of a spin can be violent in nature if it is entered at a high equivalent airspeed. The airplane may pitch to a higher angle of attack, oscillate in roll, and/or yaw violently. The second and subsequent turns usually tend to steady down to a continuous oscillatory motion that is characteristic for each airplane design. In the spin the pilot will be thrown left or right. In a spin oscillating in roll and yaw, he will not necessarily be continually forced toward the outside of the spin. Normal load factor will vary with the type of spin. The accelerometer will indicate positive values for erect spins and negative values for inverted spins. In many past spins the accelerometer has been the only available visual reference to determine the type of spin. The pilot must school himself to rely on the turn-and-bank indicator and accelerometer to determine direction and type spin he is in.

### THE RECOVERY

The recovery is that phase of the spin from the time recovery controls are initiated until controlled flight is obtained. Each airplane differs in this phase as they do in other phases. Some speed up in rotation rate immediately after recovery controls are applied, others slow up immediately, still others continue in the same manner of spin up to three turns and then recover.

As much as 12 seconds of recovery control has been required on some models before some indication is had that the airplane is going to recover. That is a long time and it is eternally long to the pilot in the spin. Normally some indication of recovery is given the pilot in 3-6 seconds. The pilot must continually analyze his position and not panic in this crucial phase. Allow the airplane to respond to the prescribed recovery controls and then fly it out. There are of course models which recover in less than one turn.

The rate of descent in a spin varies widely and the pilot will probably have to use at least 8000 to 12,000 feet in the recovery phase. All pilots should have an altitude fixed in their minds below which they will leave the airplane. A good rule-of-thumb for current airplanes is to at least be in a diving attitude in controlled flight when passing 10,000 feet above the ground or abandon all attempts to recover and leave the airplane.

Because of the high inertial forces present in the spinning of current airplanes, as discussed previously, the controls used for recovery vary somewhat. Because of the ineffectiveness of the rudder, primarily due to turbulent airflow, another control was needed to aid in recovery. Ailerons were found to offer large enough values of yaw on some aircraft to appreciably aid in recovery. Spoilers have not been found to be effective for recovery from erect spins; they are effective in inverted spins.

The primary use of the elevator is to prevent the airplane from entering an inverted spin from an erect spin and vice versa. The rudder should be used judiciously in the recovery to prevent a continuing spin in the opposite direction. In some airplanes the rudder must be neutralized as soon as the turn needle comes off the stops to prevent this. Each airplane has carefully determined recovery procedures. The pilot must know the proper recovery procedures for the airplane he is flying. His life depends on it.

### ERECT SPIN

The three phases are found in the erect and inverted spins. The erect spin is one that is evidenced by positive normal load factors. Since the pilot is now located farther from the center of gravity, he may be subjected to greater longitudinal forces. These forces generally will not exceed 2 to 2.5G. The spin is oscillatory in nature for all current fighters. Generally from 2000 to 4000 feet may be lost in each turn, and the rate of rotation will generally be 3-5 seconds per turn.

### INVERTED SPIN

The inverted spin is defined as a maneuver in which an airplane descends towards the earth while rotating with an angular velocity about a vertical axis with a negative load factor and with a negative angle of attack which is greater than that at which the inverted stall occurs. As stated before, many times the pilot's only means of telling whether a spin is erect or inverted is by his accelerometer. There are as many modes to an inverted spin as there are to an erect spin. The airplane may not remain on its back but may roll through 360 degrees during one or several turns. This makes it difficult for the pilot to analyze the spin correctly. The nose of the airplane may remain above the horizon during the entire spin or it may alternate between steeply nose down and up. An inverted spin of this latter type will have high transient negative G and appear to be much "rougher" to the pilot.

In our current aircraft the inverted spins may be oscillatory about all three axes. The pilot is subjected to forces from 0 to -3.5G. It is difficult but possible for the inexperienced spin pilot to overcome these forces and apply the correct controls for recovery. He will most probably not be aware of the high forces exerted on him until the day after the spin when he will become aware of body soreness from lap belt and shoulder harness restraint. On occasion, military and contractor pilots conducting spin programs have broken small blood vessels in these body areas and have had extremely bloodshot eyes for periods up to a week. These have disappeared and no apparent permanent injury or disfigurement has resulted.

High energy spins (continuous high rate of rotation) are more difficult to recover from. It is generally easier to recover from spins that hesitate during each turn. If recovery is initiated just before or during one of these hesitations recovery will probably occur sooner.

### ROLL DIVERGENCE

An article on spins would not be complete without discussing roll divergence, or yaw coupling, which can result in a wild and destructive ride. The term "horizontal spin" for this maneuver is a misnomer. Most current airplanes have roll restrictions placed on them, limiting them to 180 degrees to 360 degrees of roll and certain aileron deflections at high equivalent airspeeds. This restriction is probably one of the most important to the military pilot. It is a restriction on his ability to maneuver his airplane tactically but one that must be adhered to.

The placement of the mass of the airplane closer to the longitudinal axis has increased the inertias in yaw and pitch creating undesirable moments. To the pilot who exceeds the roll restrictions for his airplane, it will become apparent that the airplane will accelerate in roll rate coupled with yaw and if continued – pitch. At some point this will become divergent and the pilot may be on a wild destructive ride from which he will be lucky to escape. Roll divergence can be encountered at high equivalent airspeeds and mach numbers after exceeding the allowable rate of roll. Restriction in angle of bank is expressed in the flight manual since angle of bank is more easily judged than rate of roll. If the placarded angle of bank is exceeded while at a high rate of roll, it allows the pitch and yaw moments time to produce divergence.

Unfortunately as most airplanes accelerate in speed they *appear* to become more directionally stable. The airplane will feel directionally stiff to the pilot and lull him into a false sense of security. The rudder becomes less effective when flying at high mach numbers and when directional stability rapidly deteriorates roll divergence can develop and the rudder is not effective to stop the roll. The elevator may not bring about the desired effect because the airplane may have pitched beyond the angle of attack for controlled flight. The experienced or inexperienced pilot when confronted with roll divergence may apply the wrong recovery control as the pre-1916 spin pilot did, and aggravate the situation.

### PSYCHOLOGICAL AND PHYSIOLOGICAL ASPECTS

Spins are demonstrated in most Navy airplanes by contractor pilots in order that proper spin recovery techniques will be determined. It is one thing to spin an airplane intentionally and a completely different thing when an inadvertent spin develops. During intentional spins the pilot is keyed up and is aware of

# Spins

or suspects the modes of motion that will result. If he is a contractor pilot commencing a new spin program, he has a great amount of engineering data available and conducts his program in a buildup manner, and as he progresses he amasses means of combating physiological factors and overcomes the psychological. This is not without risk but he is prepared, as well as can be expected (including spin chutes), for the ensuing spin. By the time the demonstration is undertaken he is accomplished in recovery techniques.

The pilot thrown into an inadvertent spin is generally immediately disoriented. The immediate surge of adrenalin following an uncontrolled maneuver is followed by a moment or moments of disorientation dependent upon the nature and the violence of the motion. In this period the pilot must reorient his thinking from his just past and intended attitude and flight path to analyze the ensuing incipient spin or spins.

*The spin is not a maneuver to be feared. It is to be respected.* Most tactical military airplanes are spin demonstrated and spin recovery techniques should be well known. Many pilots have conducted spins, intentional and inadvertent, and pilots will continue to spin airplanes with successful recovery. The following comments may sound awe inspiring but they are included to inform the inexperienced spin pilot just what he might expect. *They seldom would all occur at one time and expecting them will enable the pilot to combat them.*

The fluids in the inner ear, the primary balance organ, are subjected to unusual forces and sometimes transmit false signals to the brain and thence to the motor reflexes. The sensory stimuli from the eyes, muscles and skin of the pilot also send signals to the brain and when unnatural forces are experienced the brain might not cope with this myriad of conflicting information *unless the pilot is trained to combat them.* Orientation in the spin is difficult at times and sometimes impossible without reference to the turn-and-bank indicator and accelerometer.

The pilot might be affected by an immediate marked reduction in mental capacity. He might not know where to look to determine his position in space. He can experience a tunneling type vision and tend to look at one spot outside the aircraft or one instrument. His mind sometimes might become blank even though he is conscious. He would then experience extreme difficulty in concentrating on the required references for recovery. He probably cannot tell whether he is in an erect or inverted spin without referring to the accelerometer. He may make the correct control movements but in the ensuing aircraft gyrations unknowingly relax the forces required for the proper recovery control position. Know and trust the instruments.

Judgment of time becomes inaccurate. The pilot usually requires more time than he thinks to make the proper recovery control movements and then overestimates the time required for response to recovery controls — a natural reaction. The pilot probably will not be able to count accurately the number of turns — this, of course, depends on the violence of the motion to which the body is subjected and the concentration power of the pilot. The direction of the spin is difficult to perceive. He may not be able to tell if the spin reverses without using the turn-and-bank indicator. Experience has shown that the probability of a pilot choosing the proper direction for application of recovery controls without referring to the airplane's instruments is extremely low.

These physiological and psychological factors, if they arise, create a problem that must be solved before the maneuver can be analyzed and the recovery made.

*When spinning, the pilot can best determine the direction and the type of spin by using the turn-and-bank indicator and accelerometer.* Looking through the forward windscreen will give the next best indication. Looking to the side or rear is confusing. He should mentally fight to stay alert and observe his altimeter as well as the accelerometer and turn-and-bank indicator and then observe the airspeed indicator and altimeter during recovery.

- Once recovery controls are used be sure that they are maintained — don't relax until recovery is assured. Remember that time will seem out of proportion.
- Watch for spin reversals.
- Always be sure you have the proper recovery controls applied.
- Have an altitude fixed in your mind below which, if not in controlled flight, you and the airplane will part company.
- Use the flight manual that applies to your model airplane. The proper spin recovery techniques are there and if you fly your airplane as outlined you can recover from the spin.

Above all remember that your airplane is a weapon with a mission. You cannot afford to compromise the effectiveness of your airplane through ignorance or fear of spins. ★

The item "The D-Ring Is Back," page 12 January issue, was contributed by Charles E. Carroll, Project Engineer, SEG., Wright-Patterson AFB. Sorry his byline was omitted.

# THE IPIS APPROACH

By the USAF Instrument Pilot Instructor School, (ATC) Randolph AFB, Texas

**Q.** The method of determining lead points for intercepting an arc from a radial as outlined in AFM 51-37 is based on a rate turn. Do you recommend using rate turns for arc interceptions?

**A.** No. Use a normal turn for your aircraft. Select the rule of thumb (one-half of one per cent of ground speed for three degrees per second, or one per cent of ground speed for one and one-half degree per second) most applicable to the actual rate produced by your normal turn.

For those aircraft equipped with a Mach indicator, another rule of thumb works fine when wind is not a large factor. Use Mach number minus two as a lead point in miles. For example, Mach .6 minus two equals four miles lead point. If you are not blessed with a Mach indicator, use miles per minute TAS (or ground speed if available) minus two as a lead point. For example, a 360 KTAS is six miles per minute, minus two equals four miles lead necessary for beginning turn to intercept the arc.

### POINT TO PONDER

The new AFM 51-37, INSTRUMENT FLYING, is like the latest airplane that is obsolete before it is flown. It's a darn good airplane but someone is already working on a better one. So it is with "The Manual." It has been rewritten, rearranged, added to, cut from and, overall, updated. Yet, hardly a day goes by that we don't wish we could stop the presses and add this or cut that. What has been the philosophy behind the rewrite?

First, we have tried to include answers to problems that you have been haunting us with by phone and letter. For example, the age-old question of "Do I make my missed approach from a GCA at the indicated altitude or should I level off and fly to the visibility minimum?" We have heard it a thousand times and although there is always a lot of talk about leveling off we find no practical reason to do so. If visual references are insufficient to land from a precision approach when minimum altitude is reached, a missed approach is performed. You say, "if visual references are insufficient?" Yes, here again we have tried to face realities. We could say you must have reference to the surface, lights, runway, or overrun but the result is going to be the same—*you, the pilot, will decide.* Your opinion, formed by using all available sources of information, is going to boil down to whether the landing can or can not be made.

This brings up the subject of *judgment.* You will notice in areas like course interceptions, maintaining course, missed approaches, circling approaches, holding, etc., there are limits and, we hope, a good discussion of the factors involved, but there is also room for judgment. Consideration of the factors discussed will enhance the decision process. In the final analysis we have avoided restricting the pilot whose knowledge and experience allow him to perform better, if he can add to the effectiveness of procedures and techniques with good judgment. We hope judgment is not restricted or inhibited in these areas for the sake of standardization or ease of evaluation.

Enough of the philosophy — what should you look for that is changed or new? First of all, note the distribution block — *every* pilot on flying status is authorized a manual. Make sure you get yours! Read the Foreword by the Chief of Staff, USAF. The message is straightforward and the shoe fits most of us who tried it.

The table of contents will show that two completely new chapters have been added. Chapter 6 is Angle of Attack Systems and Chapter 7, The Integrated Flight Instrument System (IFIS). The IFIS chapter encompasses both the flight director and the vertical scale instruments. Most of the remaining chapters have been changed extensively either by rewrite for clarity, added information, or procedural changes. Procedural changes should be noted in the following areas: Course interceptions, maintaining course, holding, procedure turns, penetration, missed approach and unusual attitudes. Added information includes cockpit check, enroute penetration, TACAN malfunctions, runway markings, fix to fix navigation (TACAN), localizer only ILS and many others.

Drafts of the manual were sent to every major command. Each command got its licks in and all approved it and *improved* it. It is your manual, written by us, finalized by you, and endorsed by your command. If you have suggestions for improving it, send them in. Chances are excellent that they will be included in a future revision and you will be able to point with pride to your idea in print. By the way, if you haven't received your copy by the time you read this, look for it real soon. ★


# LET 'EM LEARN!

**Capt James E. White**
**3525 Pilot Training Wing**
**Williams AFB, Arizona**

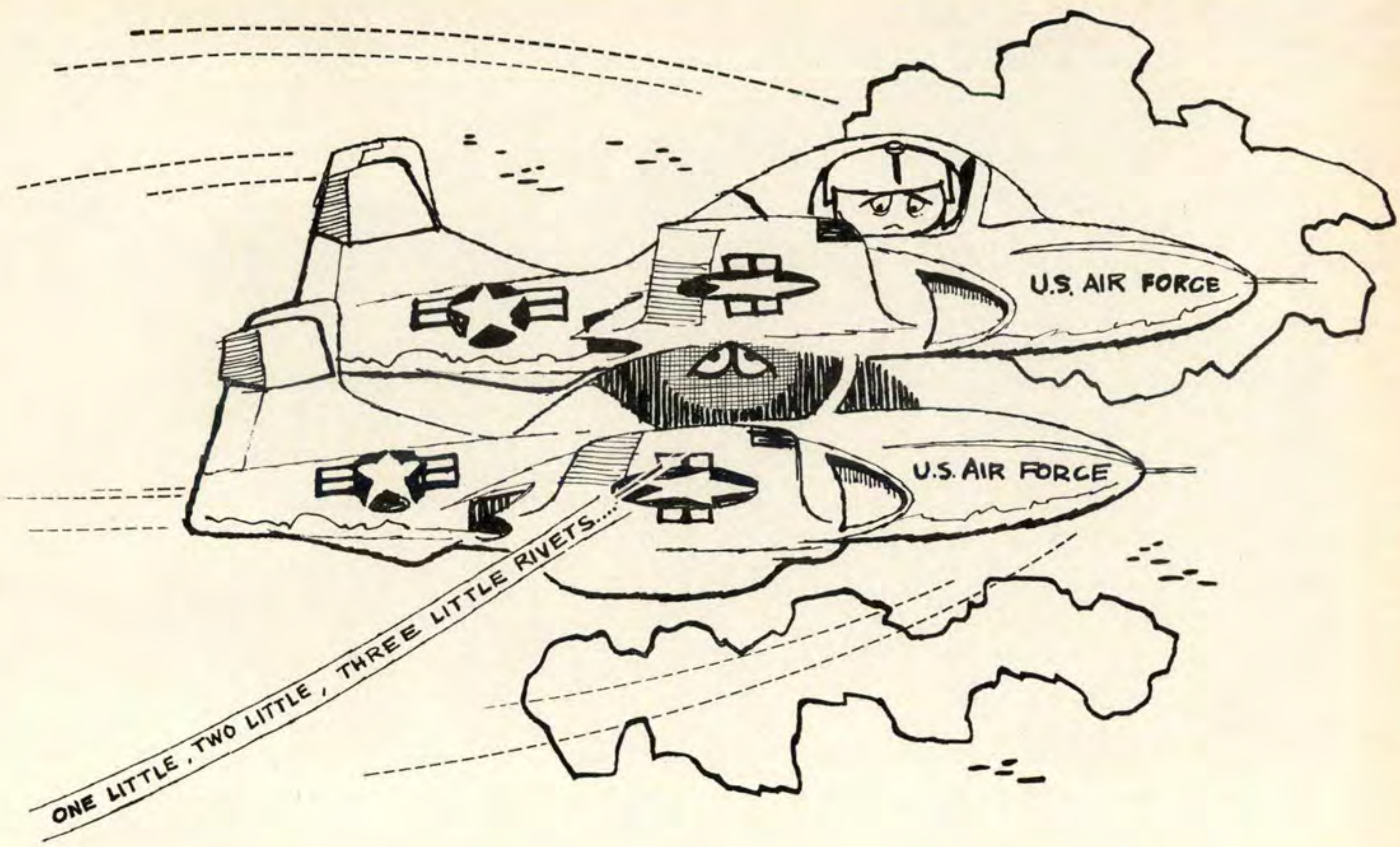
As a student, I felt that my instructor never would let me learn for myself. He was always correcting me *before* I knew what I was doing wrong. So, when I became an instructor, I had one firm conviction: I was going to let my students learn for themselves.

Thus, after 83 hours in BIS, I found myself riding down final in the back seat of a T-Bird. My student was sharp. The final was good, roundout smooth, airspeed pegged. But, we were sitting just about 10 feet too high, and I'm muttering, "Well, any minute now he should be realizing he's too high. Airspeed's getting a mite low. I'VE GOT IT!" Oh, well, what's a few popped rivets? Bet that's the last hard landing he'll ever make.

A few missions later, I'm riding number three in a four-ship join-up out of traffic. I've got a solo on my wing and a good student in the front seat. We're making a real fast tiger join-up. But this tiger was fast getting out of hand. We're closing like a sledge hammer and I'm thinking, he's getting too far ahead of his line. He'd better pull off some power, take some bank out – "I'VE GOT IT!" Power back – "Blue 4, stay low" – zzzzooom . . . missed 'em. Naturally, the lead instructor had a few thousand choice words for me about how far to let a student go. Any other mulehead would have listened, but not me. You see I knew what I'd done – I'd taught a student what a REAL overshoot was like.

Once again I'm riding along wondering just how well my student remembers his vertical recovery procedures. So, back on the stick, in with 5G 'til straight up, "Okay, Lieutenant, you've got it." Wonder what he's doing up there? Airspeed getting pretty low. "Power to 100 per cent." He'd better start rolling soon. "Power, roll to the nearest horizon." Airspeed's getting real low – oh, no! "I'VE GOT IT!" Let's see, throttle idle, rudders neutral, stick full aft . . .

Being exceptionally sharp and highly intelligent, I was getting an idea that maybe I was letting things go just a bit too far. Besides, the old man was beginning to wonder why all my students wanted to SIE (self-initiated elimination). But, just about the time I




had things under control, they grabbed me by the ears, yanked me out of the T-Bird and plunked me into the right seat of the Tweety Bird. Now I had students with only 35 hours, and a few who had never been in an airplane. This was a real opportunity to practice my Golden Rule: "Let 'Em Learn."

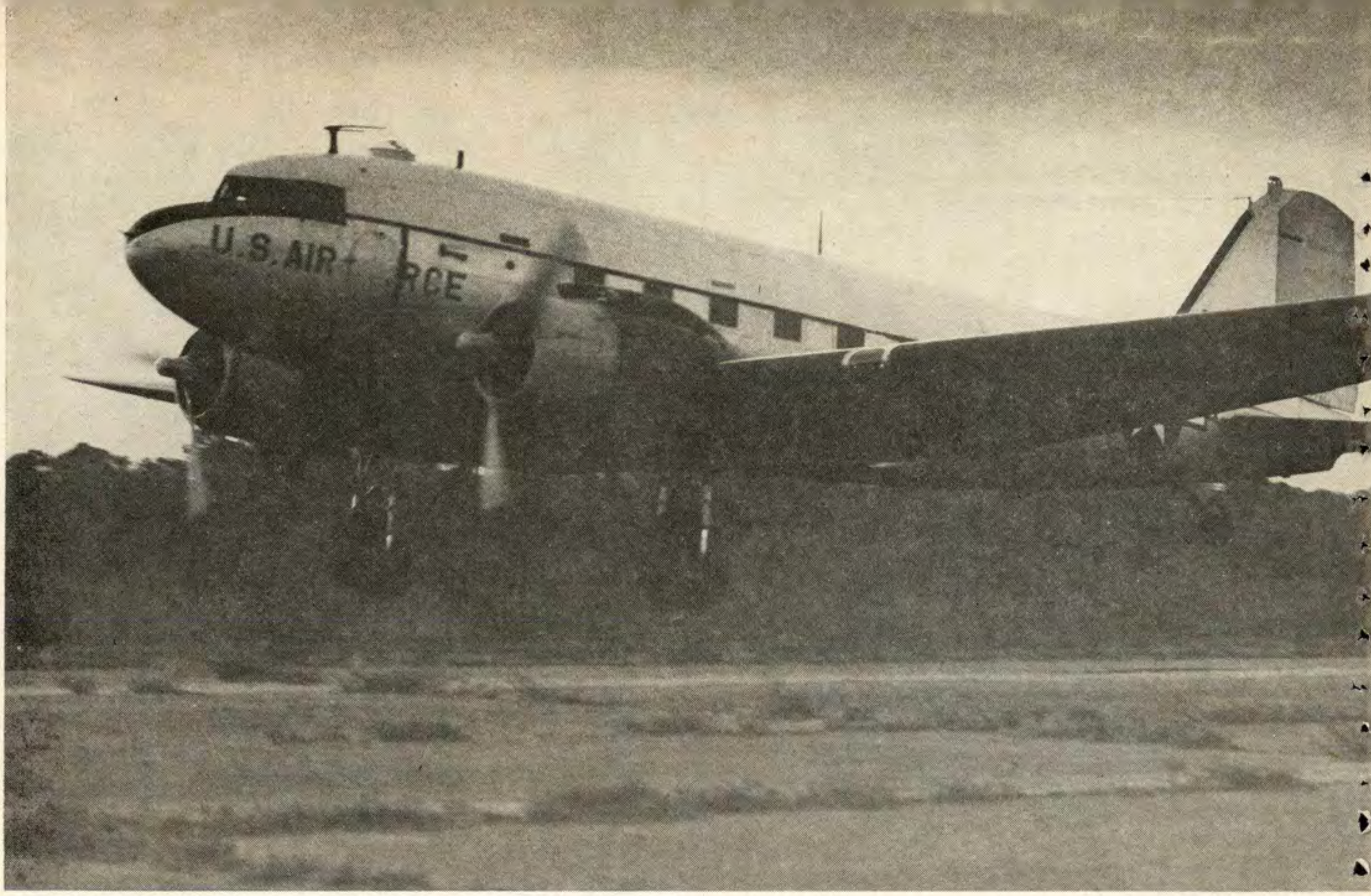
I'm tooling around the pattern with a student who's having trouble with first one thing and then another. Now we're working on a pitch-out. He's got the idea, but his altitude control is poor. So, I've challenged him to see just how close he can hold his altitude in this next pitch. As I said, he's having problems, but he tries so hard that you just can't help going all out to help him. In fact, he's so earnest that he listens very closely, and then devotes 100 per cent of his attention to whatever you've stressed. Into the pitch we go – 10-20 degrees of bank, power back nicely, 30-40 degrees, back pressure excellent, 50-60 degrees, altitude frozen, 80-90 degrees, more back pressure, 100-120 degrees, altimeter unwinding, 130-140 degrees, still rolling, Mobile's screaming, 160 degrees—"I'VE GOT THE AIRCRAFT!"

Again I'm in formation, but this time with a foreign student in the left seat. Automatically, we've got a language problem. But, to add to it, this boy was a champion weight lifter in his own country. You know, the kind of guy who lifts you three inches off the ground just shaking hands? Well, he's doing pretty good – a little rough, but holding position. However, the Tweety Bird has a big, beautiful reference for holding position. The flap hinges extend well below the wing surface; so if you just line up Lead's outbound flap hinge with his helmet, you can't miss – unless you stare at only this reference and lose your depth perception, which is just what happened. We got closer and closer. Finally, something moved. My student suddenly realizes we're much too close. This scares him and he starts pulling back on the stick. "I'VE GOT THE AIRCRAFT!"

But, I don't have that airplane. Sure, I'm pushing on the stick, but it isn't moving. At least not in the same direction I'm pushing. Now I've got both hands on the stick. I'm counting rivets on the other bird. In my normal calm, steady voice, I rupture his eardrum with "I'VE GOT THE **!!ZZ???*|| AIRCRAFT! *?ZZZ|! TURN LOOSE!"

Well, this gives him a big clue about why the stick is so sluggish and he lets go, with me pushing on that stick with every muscle I can muster. Two and one-half negative G later, I regain control and start looking for Lead.

Time has passed and, believe it or not, I'm still hanging on to my convictions to "Let 'em learn." But, if you could listen in on me and my student, you'd hear something like, "No, no, Lieutenant. You've got it all wrong. Start over again. Now start down, smoother, half roll to the right and back up, a little more pressure, now roll to the right, pull it tight. Excellent! Now we got your boots laced, let's go flying." ★




# C-47 Short Field Landings

**Maj Curtis L. Messex**
**1st Air Commando Wing**
**Hurlburt Fld, Florida**

The procedure for a minimum run landing is the same as for a normal power-on approach power-off landing, *except for the following differences:*

Under *most* minimum run landing conditions, it is preferable to make a wheel landing rather than a three-point landing.

**CAUTION**

*Caution should be exercised when using this technique on sod fields since the possibility of locking a wheel and digging in exists.*

Retract the wing flaps immediately upon contact with the ground. This will prevent the aircraft from leaving the ground again and thus make the brakes more effective.

Current C-47 pilots will recognize the above information from T.O. 1C-47-1. This is not much guidance for the low time, newly assigned Gooney Bird pilot. Fortunately, we were able to locate an experienced pilot who instructed and was also officer-in-charge of the C-47 flight training section, Det 8, Forbes AFB. Major Messex took the time from his busy schedule to pass along some of his C-47 experience.

There are two basic techniques for landing the C-47 on short fields. They are considerably different and the selection of the appropriate technique should be based on the mission, the field involved and the prevailing wind conditions.

The most commonly used technique is similar to that which is very sketchily outlined in the C-47 Dash One. This involves a tail-low attitude at touchdown. The type of approach used to get to the touchdown will vary with individual pilot proficiency and preference, but it should generally be a fairly steep, low power approach with full flaps. The steep, low power approach is much safer, due to the power-on stall characteristics of the airplane which generally involve a snap roll one way or the other and a relatively short stall warning period. A high power, flat approach can more easily be terminated with a touchdown at a given spot, but it also involves the very definite risk of a power-on stall precipitated by a wind sheer.

The steep approach can also run into a wind sheer stall, of course, but the power-off stall will fall straight through and give the pilot some margin for recovery. Another disadvantage of the flat approach is that many back country strips are laid out across the tops of ridges and thus come equipped with a built-in down draft right at the approach end. The pilot with a flat approach will frequently find himself looking up at the runway quite suddenly with only a few hundred feet to go. This is disconcerting.

For training purposes, an airspeed of about 75 knots on final with anything from power off to 12-15" manifold pressure to about 50 feet from the runway (vertically), followed by a power off round out and touchdown on the wheels at the selected spot will work out rather well. The airspeed has a small margin built into it, for the benefit of the IP, and with increased student proficiency it can be lowered a bit more if desired. However, with the heavier loads likely to be encountered during operational use, 70 knots is about as low as you want to go on final unless you know the airplane pretty well.

Touchdown on the wheels, rather than three-point, is usually preferred because the touchdown point can be more precisely controlled by pilots with relatively low experience. In addition, when the airplane is carrying a load the wheel landing is less likely to overstress the tail wheel. Generally speaking, the wheel landing will also use up less total distance (air run plus ground roll) from the last obstacle cleared to the final stop, even though the ground roll may be less with a three-point landing. This last point can be argued either way, however, since there are enough variables to make an individual landing go either way.

The length of the ground roll is determined mostly by the condition of the brakes, the type of surface, its slope, and of course the weight and speed at touchdown. The most critical controllable factors are the speed and the condition of the brakes. Anyone who intends to use a C-47 on short runways should be thoroughly indoctrinated in how to taxi with a very minimum use of the brakes, and maintenance facilities should check brake adjustments on a daily basis. A pilot who sets his throttles at 1000 rpm and rides the brakes to control his taxiing can effectively wipe out a set of brakes just getting out for takeoff on the average airfield. Unfortunately, it usually seems to be the next pilot to fly the aircraft who winds up in the boondocks on the short field.

Assuming good brakes and a good touchdown speed, there remains the question of runway surface and *the possibility mentioned in the T.O. of digging in and nosing over.* Judging by rather extensive experience, the possibility appears to be rather remote under most conditions. A stubborn individual can nose the airplane over by locking the wheels on a strip with good braking action, but full up elevator will counteract maximum braking on hard dirt down to between 25 and 30 miles an hour and the tail will promptly drop when the brakes are released. Grass fields allow the airplanes to slide and you generally can't get the tail to even start up. A very soft surface does present the possibility of digging in and nosing up, but when the surface is soft enough to present a hazard, there isn't much need to use the brakes in the first place. In two cases, at least, the airplane has been landed on fields that allowed it to sink in over the tops of the wheels, and in both cases, full up elevator prevented the nose from striking the ground although in one of the two cases it did bend the pitot tubes. Total "roll" in both incidents was about 300 feet without brakes. An uneven or unprepared surface presents the major hazard. Dropping a wheel into a hole or ditch while braking hard will almost certainly result in disastrous gyrations of one kind or another; pilots should always drag unfamiliar strips before landing to locate such hazards.

Assuming reasonably good braking action, it isn't difficult to stop a 30,000-pound airplane in around 1500 feet of ground run. On the other hand, a grass field with morning dew still on it might take 2500 feet with the brakes locked all the way. The same field an hour or so later might be done in 1500 again. A rainstorm on a clay strip can double the required stopping distance. The question of whether the brakes should be locked probably will not have occurred to pilots accustomed to hard surface operations. Rolling friction is greater than sliding friction on hard surfaces, but on most dirt fields, a sliding tire will be plowing a shallow trench and as a result, will usually be generating more resistance than a rolling tire. A second consideration is that C-47 brakes are usually incapable of generating the optimum 25 per cent rolling slide for any significant distance but can keep the wheels locked, if they are locked before the full weight is on the wheels. Generally speaking, average pilots in average conditions can operate safely on 2000 feet of runway with gross weights up to

**The C-47 is still going strong and its crews are operating out of some marginal fields that require utmost in pilot ability.**

**Special techniques are also required during takeoff from rough short strips.**

# C-47 Short Field Landings

about 30,000 pounds. Proficient pilots can do with less under favorable conditions, but the question is not so much how much runway is used as it is how much margin of safety you wish to allow. A good deal of uncommon sense must also be exercised to avoid committing people to untenable operations, especially when the determining factor, such as weather, is not under the control of the commander.

The second technique for getting into short fields has a rather limited practical application since the airplane can be put into fields it can't possibly be flown out of without the use of JATO. The basic idea is to make a power-off approach at about five knots above power-off stall, terminating the approach with a rather abrupt flare-out which places the airplane in a three-point or slightly tail first attitude just above the ground. Done properly, the resulting touchdown will usually be rather firm. If the flare is started too high the plane will fall through to a solid impact on the gear, and if the flare is started too low the results are guaranteed to loosen teeth; but if the gross weight is under 26,000 lbs, it takes a really bad one to damage anything other than the pilot's ego. This procedure will get the airplane on the ground and stopped in an absolute minimum distance after passing over an obstacle, but it is not for the novice and there is almost no room for an IP to recover an error. Air run from over a 50 foot obstacle to touchdown can be as low as 300 feet, with no wind. Stopping distances with maximum braking and good surface will be between 500 and 800 feet with the average around 700. Braking techniques are important on this. Best results are obtained by locking the wheels immediately, before the weight on them can prevent it, and allowing the airplane to slide until it starts to swerve, then releasing and reapplying as hard as possible. This can't be practiced on hard surfaced runways, of course — the tires blow. But on dirt they don't even skuff much. Flap retraction is unimportant since the airplane will be almost stopped by the time the flaps get up and retraction does slightly reduce the hydraulic pressure available for braking.

Under some conditions a combination of the two techniques described can be used to advantage. A low power approach to a three-point landing will allow a slightly lower speed at touchdown and result in a somewhat shorter ground run under slippery conditions. For instance, if the pilot is proficient enough to make his touchdown just where he wants it, he can stop sooner than if he touched down on the wheels at the same point. But if he floats a hundred feet trying to get the three pointer, he has thrown away all his advantage and then some.

A note on takeoffs. The procedure in the T.O. has its disadvantages. The tail low attitude will give noticeably less effective rudder control than can be obtained with the tail up. It will also yield more stone damage to the elevator fabric on gravel fields and gives pretty marginal lateral control at lift-off in crosswinds, as well as some rather interesting moments in gusty conditions. A more satisfactory performance can be obtained by setting the flaps in advance to a little over one-fourth, (on *rough* fields any setting made at 39 knots is a WAG) running up to full power with the wheel held full back, releasing the brakes, getting the tail up near level ASAP and rotating at the selected airspeed. There is rarely any need to select an airspeed under 60 for the rotation but this is dependent upon the airfield. With this technique the airplane breaks ground cleanly with positive control and the ground run won't be measurably different from the T.O. procedure.

Initial climb out is usually done at 76 knots for obstacle clearance. Lower airspeeds may be used if necessary, of course, but engine failure below single engine minimum control speed is a hazard that must be considered. There is also the possibility of forcing the airplane into a power-on stall if the nose is brought up too far too soon. (This is where rotation is accomplished around 55 knots and the nose is pulled up past a three-point attitude.)

The T.O. technique has its place on very soft ground where the lift generated by the tail-low attitude helps get the plane out of the mud to where it can accelerate faster. On extremely soft ground, starting a deliberate bounce on the roll will sometimes let you pick enough speed between impacts to stay airborne, but you better have a lot of field to run on if it takes that technique. While on the subject, it is worth noting that there is probably more hazard of nosing up on takeoff than there is on landing. All it takes is a hole, a ditch, a pile of dirt or snow to make the nose bob enough to catch the props, and it doesn't take much of an impact to cause the props to separate from the engine at max power. The left prop may come through the cockpit in such cases and kill one or both pilots. ★

# A CASE FOR EAVESDROPPING

**Maj Thomas A. Bond**
**118 Air Transport Group**
**Berry Fld, Nashville, Tenn**

This is a true tale and has a moral. It is an event that happened to me as a civilian, but it could have happened and does happen to any airspace user, civilian or military.

For three years, starting in 1956, I flew as captain with a small scheduled airline. One rainy, dreary, chilly day in February – a typical winter situation – I started a trip just like hundreds of others I had started. Same trip number, same crews, same airways, approaches, radio beacons, ILS frequencies and sometimes even the same passengers. I flew one Convair trip per week and two DC-3 trips per week over the same basic route structure. This particular day's flight was a DC-3 schedule that made eight stops. After the first stop and while taxiing out for the 46-minute IFR flight to the next stop we got the same old clearance; "Southeast 102 cleared to the North Moonshine radio beacon, V-115, maintain four thousand." Enroute WX was forecast to be two to four thousand broken, five thousand overcast with occasional breaks in the overcast.

Takeoff was typical except for one item; while still on ground control frequency before takeoff we heard another airliner, a Convair, receive his clearance; "Blue Ridge 618 cleared to the North Moonshine radio beacon, V-115, maintain five thousand." Readback went like this: "Blue Ridge 618 cleared to the North Moonshine radio beacon, maintain four thousand." This shook me, but since we were ready to go we changed to tower and leaped off. I told the copilot to get the matter straightened out with Departure Control after we were airborne. After changing to Departure Control, the copilot asked them to verify 618's altitude as being five thousand. The controller came back in the affirmative, that he had been assigned five thousand and had read it back as such and was just now airborne at 1437. I guessed then I had misunderstood the Blue Ridge pilot's readback so forgot the incident for the time.

After we completed our after-takeoff call on company frequency, Departure Control cleared us to contact Moonshine Approach Control when we reached a certain fix in the area, then all was quiet. Now my thoughts started to drift back to the Blue Ridge plane and I found myself almost unconsciously easing over to the extreme right side of the airway and mentally computing the time he would overtake me and also wondering if he really was at five thousand. By virtue of knowing both planes' true airspeeds and that we were both getting the same 20 knot headwind component, it was easy to lay out on the Jeppesen Avigation Chart the exact point along V-115 where the Convair would overtake me. By this time I was well to the right of the airway and there were a few breaks in the overcast. The sun was visible at times.

It was now 1447 and the critical moment was 1452; each three minutes the Convair was covering nine miles, and we were covering six miles. Occasionally I would tell myself that my feelings were ridiculous but my thoughts kept returning to the fast overtaking Convair. It was now 1450 and we momentarily broke out into the bright afternoon sunshine, then back into the clouds again. 1451 – out of the clouds again and into quite a large clear area; 1452 – the time had arrived. Now I really wanted to see that Convair, so bad I could almost taste it. 1453 and coming up again soon would be more clouds. Finally, there he was, a good minute and 30 seconds late, that big beautiful blue and white Convair eased on by me about 300 feet to our left. I know the Blue Ridge crew saw me but the fact that I almost knew I would see him and that he didn't expect to see us surely brought about a much different reaction in the two cockpits. Much relieved now, we continued on to destination where I filed a violation against the Blue Ridge flight and he against me. About eight months later I received a letter from the FAA stating that the tower was at fault in not catching the erroneous readback of Blue Ridge 618.

It really paid off for me to be nosy enough to listen in on somebody else's radio transmission and to this day I attempt to keep track of all aircraft in my area by constantly monitoring their radio conversations. ★


# Rex Riley
## CROSS COUNTRY NOTES

A FRIEND of Rex's was in a confessing mood the other day. Here's his story.

Flight plan was from Norton AFB to Sheppard at 37,000 feet, in a T-33. The aircraft had been standing in the rain for two days so draining the stick wells momentarily crossed my mind. However, at the aircraft my copilot said, "You take the top and I'll take the bottom." Preflight completed, we set sail for Sheppard. Half way there I noticed the ailerons were difficult to

move and asked him if he had turned my boost off. He replied "negative," so I assumed there was ice in the stick well but that it should thaw once we were below freezing level. Aileron control did return at 4000 feet.

After we were turned over to Sheppard GCA, a descent of 500 fpm was established at 120 kts. Then I noticed that I had no back stick left. I asked the copilot if he had anything lodged behind the stick and he said he hadn't. Since I didn't relish smashing into the runway at 500 fpm, I asked him to get on the stick with me in an attempt to get it back farther. We both jerked at the same time and the stick broke free. I made my normal hairy landing and taxied in. After we parked the bird, the Sheppard T/A personnel got to work chopping ice out of the stick wells. Two hours later they were still chopping.

Looking back on the incident, I asked myself what I would have done if I had been alone. I know I couldn't have broken that ice by myself. The answer was clear, and I probably would have thought of it on go around: simply pull up the flaps and make a no flapper. I had enough stick travel to round out without flaps. Better still though, on preflight I'll say, "You get the top and I'll get the bottom." That's easier anyway.

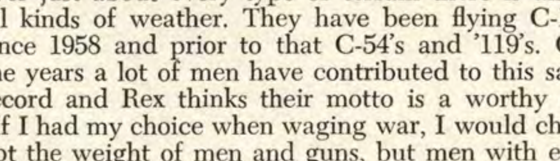
AFTER WATCHING a transient pilot give special care to his T-Bird and then take off, Rex heard someone remark, "He looked like he was freezing to death, shivering in his summer flying suit as he knocked icicles off the tiptanks." Then a bull session developed around the question "Why the summer flying suit in a winter environment?"

That transient pilot in summer clothes was risking not only his fine young neck, but also his reliable old T-Bird. Suppose the bird's heating system had failed? A cold pilot is a flying hazard. Suppose this one had a punchout? He might face the same plight that a crew of six experienced a few years back when they bailed out over mountainous terrain during a freezing weather. Some made it okay; those who didn't were found within a few hours. Their stiff bodies in summer flying clothes were direct evidence of the cause of their deaths.

It has been repeated so many times but because of that shivering T-Bird pilot who attracted attention: *When flight is planned over or to a cold area, dress for it!* February weather is cold weather at many bases.

SAFETY MARK – Rex takes his hat off to the 21 Troop Carrier Squadron. The outfit has flown 150,000 hours without an accident and has won just about every safety award in the books. In fact, the unit's last accident was 'way back in 1952, during the Korean War.

The 21st operates out of Okinawa and its crews fly over just about every type of terrain there is and in all kinds of weather. They have been flying C-130's since 1958 and prior to that C-54's and '119's. Over the years a lot of men have contributed to this safety record and Rex thinks their motto is a worthy one: "If I had my choice when waging war, I would choose not the weight of men and guns, but men with esprit de corps."




MAINTENANCE had just been completed on a B-52 and an MA2 tow vehicle was being used to tow the aircraft back to the ramp. The ramp of the nose dock where the work had been performed was wet with patches of ice. While the aircraft was being backed, the right wingtip struck a water truck parked nearby, causing minor damage to the truck and a damaged wingtip on the bomber.

The tow crew was properly positioned and the team chief had a checklist, but he was not on interphone to the man in the cockpit.

Prevention of these mishaps seems obvious, but somehow the word doesn't always get around and these little accidents cost the Air Force a lot of time and dollars. Instructions now include a requirement to remove all equipment needed for a job from the immediate area as soon as the job is completed.


TURN IT ON . . . to . . . TURN IT OFF. Rex recently noticed the following item in North American's Operation and Service News and is passing it on for the edification of all T-39 drivers.

Ironically, sometimes you have to do just that – turn it on to turn it off. Here is a case where an on-off control could not do its job because the necessary power was not available. The T-39A was cruising at about 94 per cent rpm when the pilot noticed the Nr 1 engine increased to 97 per cent. He retarded the left engine throttle. However, the throttle had no effect. The same throttle was then stopcocked. Still no effect, and the engine continued to run along at a steady 97 per cent. Next step was to turn the engine master switch OFF. This surely will kill the stubborn beast, thought the pilot. But alas, he might as well have turned on the windshield wipers, for the fuel fail caution light did not come on and the engine continued to maintain 97 per cent. Next, the pilot pulled the left fuel boost pump circuit breaker while thinking: If we can't choke it off, we'll starve it to death. This time, the fuel fail caution light came on, but that was the only change in the situation, for what the pilot hadn't figured on was that reliable engine-driven fuel pump which was maintaining fuel flow at 1800 pph, and the engine continued to run a steady 97 per cent.

Finally, the pilot pulled the left fire pull "T" handle with one hand while he grabbed the microphone with the other. The engine did not respond, but the radio did, and the Wing Command Post advised the crew to check that all circuit breakers were set (in). It was then noticed that the engine master switch circuit breaker was popped. The circuit breaker was promptly reset, and the speeding engine died immediately.

The airplane descended and made a safe single-engine landing; it was then determined that the primary cause of the unusual incident was a failure of the left aft push-pull throttle control assembly rod (Part Nr 265-437016-21). All pilots at the base where this airplane is assigned were briefed on the incident, with particular emphasis on the fact that the engine master switch circuit breaker must be set to ensure that electrical power is available to accomplish engine shutdown with either engine master switch OFF or either fire pull "T" handle pulled. In fact, any time an inflight abnormal condition exists, it is a good practice to first check your circuit breakers.


# Snow Guide

Winter is well established by now so a reminder to prepare for it would be a little late. However, new guidance, on winter protection in the form of an interim operation guide has recently been distributed to Air Force commands and all bases probably have not seen it yet. This guide, *Snow Removal and Ice Control*, contains a wealth of information and will be available as an official Technical Order by September 1966.

Current publications, AFR 90-6 and AFM 85-8, have been the standards for ice and snow protection for many years. The new guide contains more information and will undoubtedly be welcomed wherever arctic-like conditions prevail during the winter months.

While we can't print the whole thing here, a brief rundown on the contents, with particular attention to some areas, seems worthwhile.

Certainly one of the first steps toward effective winter protection is organization that will assure that the task will be accomplished effectively. The guide calls for formation of a Base Snow and Ice Control Committee and is specific as to its membership. Chairman is the Base Deputy Civil Engineer who is directly responsible to the Base Commander for base snow removal activities. The guide then spells out the responsibilities of each member of the committee.

Basically, members of the committee are responsible for planning and preparing prior to the onset of winter, defining responsibilities and jurisdiction of involved activities, and generally providing plans and schedules that will permit maximum safe operation of the airfield and the base area.

To illustrate the scope of responsibilities, consider those of the DCO.

- Runway serviceability inspections.
- Declaring aerodrome surfaces serviceable or unserviceable for flying activities.
- Advising priority requirements for clearing aerodrome surfaces.
- Advising alternate procedures to be used in the event of a flying emergency.

**Effective Snow and Ice removal programs require careful planning, mobilization of all resources.**

• Promulgation of orders and instructions in respect to:

1. Vehicular traffic and communication procedures on aerodromes areas.

2. Parking of aircraft and restriction of unnecessary flying in order to facilitate snow and ice control operations.

• Providing meterological services (weather forecast).

For maximum effectiveness and control of the various activities involved, a central Snow Removal and Ice Control point will be established under the supervision of a Work Center Controller, who is responsible for scheduling, control, and coordinating functions.

Pre-season preparation will prevent a lot of winter headaches. Those who wish to avoid eating a lot of APC's will prepare by:

• Selecting and training equipment operators at least two months prior to the onset of winter operations. Selection should be on a basis of desire and ability, not on random grabbing of bodies. Training should be well thought out and include specifics such as duties, when, whom and where to report to, base familiarization, the equipment being used and its characteristics, communications procedures and techniques, and procedures for snow and ice removal and compaction.

• Conditioning and storing of equipment. This should begin for the coming winter season at the termination of current winter operations, and no later than June 1. The job should be done, according to the Guide, by September 1 at northern bases and October 1 at other bases.

• Acquiring proper snow control materials such as sand, chemicals, markers, stakes, snow fences, etc. Materials should be stockpiled by September 15, with adequate reserves and provisions for reorders.

• Preparing aerodrome and road surfaces and facilities. Hazards should be eliminated or marked, boundaries of runways, taxiways, ramps, roads and walks marked, pavement repaired, overruns cleared and graded, etc.

### SNOW REMOVAL

There are a variety of techniques and types of vehicles that are employed in snow and ice removal. Factors affecting the selection of techniques and vehicles to be used include geographical location, wind velocity and direction, snow characteristics (wet or dry), the equipment available, types of aircraft and others. For example, when a rotary sweeper is available and the snowfall is light and dry, removal should begin with the start of the snowfall and continue until it quits. When these sweepers are not available, other techniques are necessary:

• After two inches of snow have fallen and there is a forecast for continued precipitation of at least three inches;

• Immediately after snow has stopped falling, regardless of depth, and there is no indication of freezing rain; and

• When drifting conditions make emergency operations hazardous.

The appropriate procedures and equipment are spelled out in the Guide for almost any condition that can be foreseen.

### ICE REMOVAL

Ice is formed in many ways and once it has reached any appreciable thickness, it is difficult to remove from runway surfaces. The Guide lists some precautions that can be taken to reduce or prevent ice formation. These are:

• Maintain the closest liaison possible with the Base Weather Office to ensure receipt of the latest weather forecast information;

• Commence sweeping operations as soon as precipitation of any kind begins;

• Provide and maintain adequate drainage facilities; and

• Restrict aerodrome traffic to essential and emergency requirements.

Methods of treating ice covered runways and other surfaces used by vehicles are discussed in detail. The spreading of sand, water over sand, and the use of chemicals approved by USAF are effective means of treating ice covered aerodrome surfaces depending upon circumstances. Proper use of snowplows and rotary sweepers is also effective, again depending on circumstances. Chemicals are effective on ice not exceeding one-fourth inch in thickness, when used at the proper temperatures and when properly spread. Since chemicals alone won't do the job, and mechanical means must be employed anyway, sweeping and plowing are the primary means of ice removal. Other factors are the cost of chemicals, their corrosion properties and spalling effect on concrete.

### COMMUNICATIONS

If there is anything that makes operations people nervous it's the

# CHEMICAL DE-ICERS

The tremendous cost of ice and snow removal from surfaces used by aircraft has caused the Air Force and civil airport operators and users to search vigorously for some magic elixir that would instantaneously, economically and effectively perform this task.

Alas! There is no magic elixir. At least not so far. But there have been developments that show promise.

On the face of it, developing such a chemical may seem relatively simple. Common rock salt does a very good job of melting ice. But rock salt is very corrosive to many metals. Chemists have come up with many other formulas, but few have met these tests:

- Must be non-corrosive.
- Economical.
- Easy to store and handle.
- Lack deleterious effects on concrete and asphalt.
- Easy to apply.

De-icers currently being used are alcohol and urea. The Air Force is studying at least six fluid and four solid chemicals. Those approved for use will be listed in the forthcoming ice and snow control technical order.

In a study for the FAA, Monsanto Research Corporation investigated a number of chemicals with de-icing properties. They found that a mixture of 75 per cent tripotassium-25 per cent formamide was effective and that it possessed good corrosion control properties.

De-icing chemicals are a distinct aid, but mechnical methods still must be used to clean the runways and other aerodrome surfaces. For this reason, and the cost of chemicals, snow plows, rotary sweepers and other mechanical methods continue to be the primary means of ice and snow removal. ★

sight of a lot of ground vehicles operating on runways, taxiways and ramps. This concern can be mitigated somewhat when effective communications with the operators of these vehicles is assured. When snow removal vehicles are operating on the airpatch, good communications is absolutely necessary. Standard phraseology is required, unnecessary chatter between vehicle operators must be eliminated, there should be provisions for communications failure, for emergency clearing of the active runway and for permission to enter a runway. Light signals must be understood and drivers must be on the lookout for such signals.

## SAFETY

No one pretends that snow removal is the safest occupation in the world. In fact, there are many ways in which a snow plow or sweeper operator can get hurt or killed. Therefore, safety precautions are a must during these activities. The Guide presents a long list of precautions for operators. If these are followed and the safety people exercise good supervision of safety practices, the number of accidents can be lessened considerably. Extracts from the list of precautions are included at the end of this story, since winter conditions will exist at many bases for several more months and because they constitute a handy checklist for both safety officers and vehicle operators.

While much of the contents of the Guide is not new and most of the snow removal methods have been in use for years, there is some new material and the Guide is much more detailed and specific than current publications. Much of it is based on an RCAF document and you've got to admit that the Canadians ought to know quite a bit about ice and snow control. We hope we've whetted your appetite and that the new T.O. will arrive in time for planning next winter's program.

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## OPERATOR(S) INSTRUCTIONS AND PRECAUTIONS

Know and observe all safety rules and regulations pertaining to the movement of vehicles and equipment on aerodromes, roads, and other ground surfaces.

Keep vehicle cab well ventilated at all times to prevent the accumulation of dangerous gases.

Use safety belts at all times where provided.

When working on a vehicle or equipment do not permit anyone in the cab or at the controls.

To prevent personal injury, keep vehicle running boards, steps and cat walks clear of snow and ice.

Always obtain clearance from the Aerodrome Controller, via R/T transmission or telephone, prior to commencing operations on aerodrome areas. Also obtain clearance as necessary during the course of operation and when departing from these areas.

When required to operate non-radio equipped vehicles or equipment on aerodrome areas, refer visually to the control tower at frequent intervals for warning and clearance signals.

Allow aircraft the right of way at all times, and where necessary bring vehicle or equipment to a complete stop well clear of the runway or taxiway.

Keep the speed of equipment down to a minimum when operating in the vicinity of aircraft, vehicles and other equipment.

Maintain safe distances at all times when operating in conjunction with other snow and ice control equipment.

Be constantly alert for aircraft, other vehicles and equipment, and for obstructions such as heaved surfaces, expansion cracks, raised sewer coverings, curbing, aircraft chocks, mats, and other loose or fixed obstructions that may cause serious damage to equipment.

When operating high speed types of equipment, ensure that speeds are reduced in sufficient time to allow for safe control at all times, particularly when turning.

Use extra caution when towing high speed rotary sweepers on slippery surfaces. Refrain from sudden stops, harsh braking and fast turns, as this practice will cause the sweeper to jacknife, which can result in damage to both pieces of equipment. ★

# Key Points for Snow and Ice Removal

• Ensure equipment is overhauled and ready to go well in advance of expected snow season.

• Keep snow and ice control vehicles in heated garages for carefree starting and maintenance. Indoor parking of this equipment should be given precedence over less costly vehicles such as staff cars, station wagons, panel and pick-up trucks.

• Be sure that lights on the snow handling machines are high enough to clear the plows.

• Have chains ready for all wheels of trucks or rubber-tired tractor units, but don't use them until wheels begin to spin or side thrust develops.

• Keep sufficient stocks of fast moving parts on hand to carry out running repairs to equipment being operated.

• Prior to the snow season inspect and ensure that all unpaved areas where equipment will be required to be operated are free of rocks and other foreign debris.

• Prior to the snow season ensure that adequate markers are installed to indicate the exact location of all obstructions which may become snow covered and hazardous.

• Provide heated accomodation for stockpiling of sand. If required to stockpile outdoors keep it covered with tarpaulin.

• Where possible keep at least two sanding vehicles fully loaded and readily available in heated storage, to meet emergency requirements.

• Keep informed on the latest weather data so that operators and equipment are prepared to meet forecasted conditions.

• Keep snow off the operational runways, fire, ambulance and access routes. It has to come off some time so keep it off currently.

• Turn the runway lights on day or night when the snow starts. Their heat will help to prevent snow from covering and obscuring the lights. They also help to define the areas to be cleared, and provide a source of guidance for operators, particularly when operating at night and when adverse weather conditions prevail.

• Keep width of runway open and slope banks at the most one foot in 20 feet. Rolling snow outside the cleared areas will help to prevent drifting.

• Keep the sides or shoulders of taxi-strips, runways, ramps, tarmarcs, overshoot areas, roads, etc., clear of snow far enough back to eliminate hazards to the operation of both aircraft and mobile equipment.

• Maintain good visibility over snowbanks at all intersections.

• Keep operating surfaces free of frozen lumps of snow, ice, sand, and other foreign debris which may constitute a hazard to the operation of both aircraft and vehicles.

• Keep snow removal areas free of equipment such as aircraft chocks, tow-bars, run-up mats, etc., when not in use. Failure to do so can result in costly damage to snow removal equipment, particularly rotary snowblowers.

• Provide sufficient area of traction to enable safe control of both aircraft and mobile equipment when conditions of ice and compacted snow are encountered.

• Mark the location of all water drainage channels and ensure that they are free to function after every snowstorm.

• Where snowplows are used alone, be sure to open a sufficient width on the first plowing to permit piling subsequent snow inside the banks.

• When two speeds are available on rotary snowblowers, use slow speeds on heavy wet snow and high speeds on dry snow.

• Be sure that warning (blue and red) flasher lights are turned on at all times when operating.

• If weather forecasts indicate that a freezing rain is imminent after a snowfall, allow the snow to be left on the surface for absorption purposes.

• Have all equipment correctly operated, by the most competent personnel. All operators are not good operators, and many dollars in repairs can be avoided, as well as better results obtained.

• Start clearing operations or other processing of snow in conformity with the storm, and ensure that operations are continued until the snow is under control.

• Complete secondary snow clearing requirements between storms or during quiet periods as quickly as possible to prevent serious situations that can arise should storms recur at short intervals.

**Lt Col J. D. Oliver, Jr**
**Directorate of Aerospace Safety**

# GIVE THE BRAKES A BREAK

It is easy to cause brake problems in any aircraft: just put a few pounds of lead in your shoes, taxi for awhile at freeway speed limits, roll up and down the runways a few times to make sure the brakes are working before you commit yourself to flight. Depending on the bird, the weight and how much lead you put in your boots, you can melt down a few wheels, vaporize the tires and guarantee that the brakes will heat up the coffee pot in nothing flat.

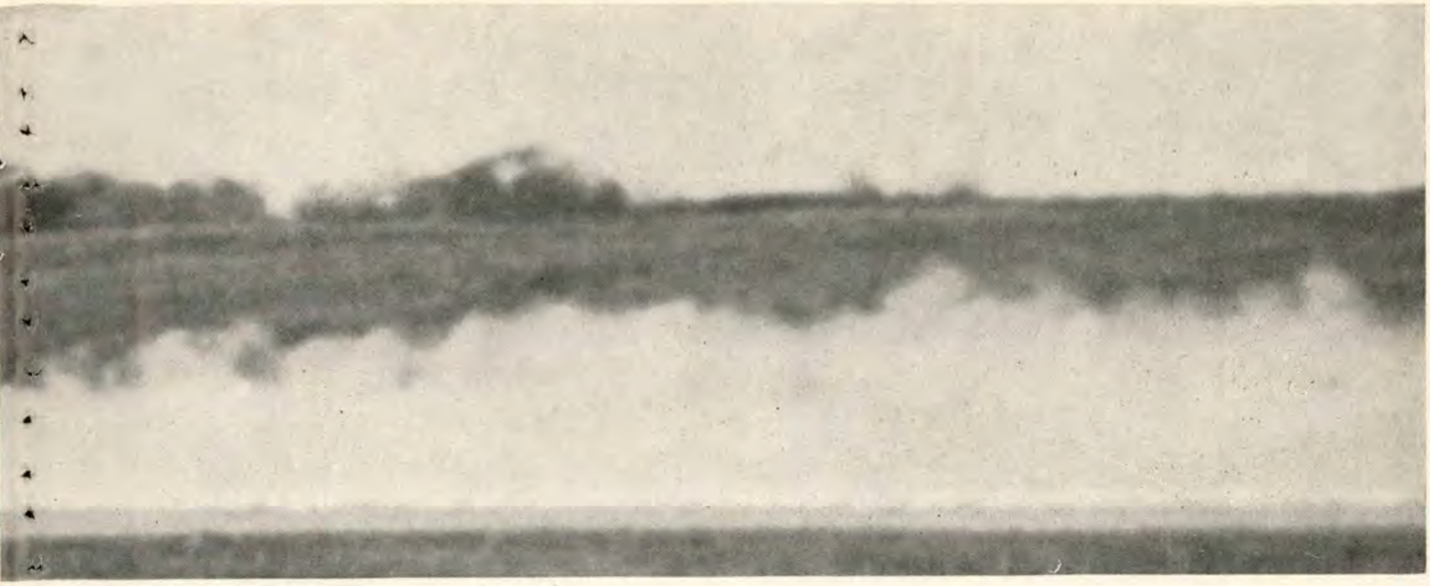
Every safety pub hits brake problems frequently and with good cause. Here's ours for this month. It concerns three incidents, all in the same type aircraft, in which braking, or the lack thereof, was a factor. But as you will see, the malfunctions weren't in the machinery on the airplanes but, rather, in the mechanism between some individual's ears.

### HEAT AND HEAVY WEIGHT LANDING

The first incident resulted in a wheel and tire fire with damage to the underside of the fuselage, wiring in the right wheel well, inboard trailing edge of wing and right wing flap. The aircraft was scheduled for a functional test flight following a T.O. compliance. During taxi-out wheel brake operation was normal with no evidence of grabbing or dragging. After 30 minutes of flight, the aircraft entered the traffic pattern for a full stop landing. Final approach gross weight was 16,000 pounds, approach was flown at 119 knots, with touchdown at 110 knots approximately 100 feet past runway threshold. Flaps were raised and intermittent brake pressures were applied. Directional control and braking action were normal.

Just before turning off at the end, both pilots felt what they thought was a rough spot in the runway. Then, shortly after the aircraft cleared the runway, a golfer ran out of an adjacent golf course waving his arms and pointing to the underside of the aircraft. The pilot notified the tower, stopped the aircraft, and deplaned with hand fire extinguisher to find the right wheel and tire on fire. The extinguisher controlled the blaze somewhat until the fire department arrived to extinguish the fire.

Investigation at the scene and query of the golfer revealed the fire started at about the time the aircraft turned off the runway. A teardown was performed on the wheel and brake assembly, but it was impossible to determine the condition of some components prior to the incident. As far as could be determined all components were functioning properly. Pilot braking technique was normal throughout the landing roll with moderate, steady braking just before turnoff. Neither pilot could account for the rough spot because the runway is smooth. A dragging or grabbing brake could cause this sensation, but the rough feeling was only momentary and there was no evidence to the pilots of brake malfunction.



**Brake problems continue but sometimes the malfunction is caused by the human factor.**

It was concluded that no single factor was responsible for this incident. A combination of lack of complete brake cooling during the short flight, heavy gross weight landing and additional brake heat generated during landing roll all contributed to the ultimate result, an overheated brake and subsequent tire fire.

### NO FLUID, NO BRAKES

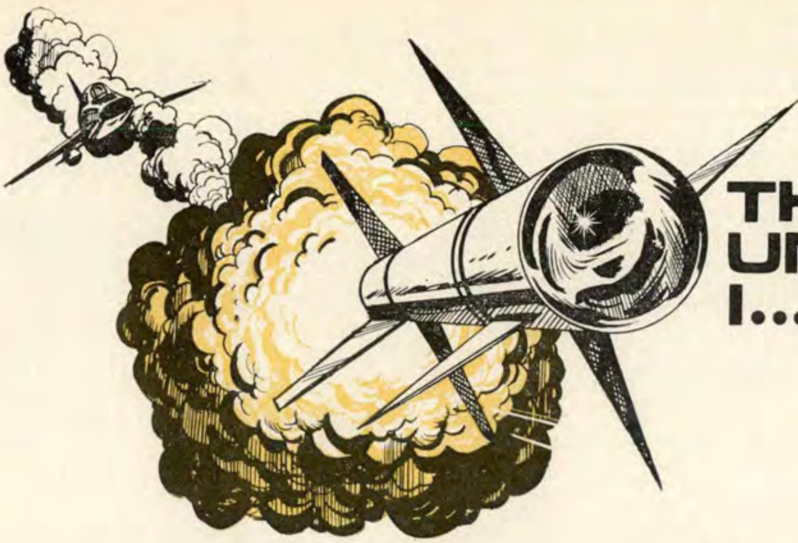
Sloppy maintenance created our next brake incident. A T-39 was being guided, by transient alert, into a parking spot after cross-country flight. Operation of the hydraulic system had appeared normal until brakes were applied to stop. Normal brakes did not work and the aircraft continued rolling until it hit the transient alert truck. The pilot reported that the hydraulic power off warning light did not come on at any time. Ground investigation disclosed that the hydraulic reservoir cap was completely off the reservoir and the reservoir was empty of hydraulic fluid. The system was checked and the lack of fluid in the hydraulic pump had caused it to fail. The complete loss of pressure occurred too late for the pilots to diagnose the problem and use emergency brakes before hitting the transient alert vehicle.

### CHECKLIST

A T-39 had parked and shut down engines to offload passengers. After the passengers deplaned, the aircraft was to be moved to a new location for departure. The engines were started and a hard right turn was initiated, but, due to the limited ramp area, the turn could not be completed. Engines were shut down and the aircraft was rolled backward to provide more turning room. The engines were restarted by the crew chief who then left the cockpit. The pilot taxied the aircraft forward and entered a right turn. Then when a left turn was attempted, there was no nosewheel steering. The pilot tried the brakes but they didn't work. He then went for the emergency brake handle and pumped the brakes to get pressure. Too late – the aircraft hit a two-strand fence. Five posts were knocked or pulled over before the aircraft stopped. Total distance from start of emergency brake action to stop was approximately two aircraft lengths, but that was far enough to produce a dented intermediate slot and dents in the sheet metal on the right nosewheel door and right wing.

*Cause of this brake failure was failure to use the checklist.* During engine starting, the pilot and the crew chief both missed the hydraulic pump switch. Thus the pump never got turned on. No pump, no pressure, no brakes.

Brakes are subject to enough problems without adding to them by an unprofessional approach to crew duties. Why land from a test flight at heavy gross weight? A lighter fuel load on takeoff or fuel dumping could easily have prevented that one. A few extra moments spent insuring proper fit of the reservoir cap would have kept the hydraulic fluid where it belonged, providing pressure for the brakes, and there would have been no accident. Memory can never replace proper use of the checklist, and until crew members learn this we will continue to have such incidents and accidents. ★



# THE UNSEEING I..........R

**Willie Hammer**
**Directorate of Aerospace Safety**

Guidance failure of infrared (IR) homing systems is a common cause of incidents involving air-to-air missiles. Missiles involved in such incidents are destroyed either by a self-destruct system or by impact with the ground, making it impossible to determine whether the failure was due to malfunction of the missile's electromechanical devices, or to one or more of the detection system performance limitations being exceeded. This article presents basic information on conditions which affect and limit employment of infrared homing systems.

Three elements must be considered in any homing system: the target, the detection and guidance system, and the medium between the two. Infrared equipment in air-to-air missiles is designed for "passive" homing: the radiation which it detects is generated and emitted by the target itself. Unlike radar, infrared systems do not depend on a reflected signal originated by the attacking missile or aircraft.

All bodies having temperatures above absolute zero contain heat energy and emit infrared radiation (electromagnetic radiation between the region of visible light on one hand and ultrashort radio waves on the other). Expressed in wavelengths, this range is from about 0.70 to 750 microns. IR guided air-to-air missiles operate with radiations having wavelengths up to 15 microns.

The temperature of any body is not absolutely uniform; therefore, it radiates at all wavelengths up to that for the highest temperature present. As the temperature of the body is increased, radiated power increases at all wavelengths, but the increase is proportionately greater at the shorter wavelengths. As the temperature increases, the maximum intensity of radiation emitted will occur more and more towards the lower wavelengths. As Fig. 1 indicates, the sun, with a surface temperature of 10,000° F., has its maximum intensity of emission at 0.5 micron, while a body at 80° F. has its maximum at about 10 microns.

The amount of radiation emitted by any body is also affected by two other factors: its surface properties and its dimensions. The amount of radiation actually emitted by a body at a specific temperature will not reach the ideal indicated from calculations based on its temperature. Only a "black body" will achieve the ideal, and such bodies do not exist in nature. The ratio of actual heat energy emitted to the ideal emission at that temperature is called the "emissivity" of that body or surface. Dark surfaces have higher emissivities than light; organic surfaces higher than metallic; rough surfaces higher than smooth; and solids higher than gases. Different bodies of the same size and temperature may therefore radiate different amounts of infrared energy. Engineers compare radiation of materials at different absolute temperatures and emissivities by assigning them equivalent "apparent" temperatures. Apparent temperature is that single temperature that a black body would have to maintain to provide the same rate of emissions. The higher the ap-

**Fig. 1. Infrared Radiation Wavelengths at Various Temperatures**

| Object | Approx. Temp. °F | Wavelength of Max. Intensity (Microns) |
|---|---|---|
| Sun | 10,000 | 0.5 |
| Room Temperature | 80 | 9.7 |
| Magnesium Flare | 3,600 | 1.3 |
| Jet Engine | 900-1100 | 3-2 |
| Piston Engine | 750- 900 | 4-3 |
| Engine Covers | 200 | 7.8 |
| Skin of Jet Acft @ Mach 1.5 | 140 | 8.7 |
| Skin of Jet Acft @ Mach 2.0 | 252 | 7.3 |
| Bell X-2 Skin @ Mach 3.0 | 632 | 4.8 |
| Rocket Exhaust | 3000-5000 | 1.2-0.9 |

parent temperature, the higher will be the intensity of radiation from the source.

Size and configuration of a radiating body are important, size because a large body or surface will emit more energy, other factors being the same, than a small one, and a large body can be detected more easily than a small one of similar apparent temperature and configuration.

Configuration relates to the shape of the body. If it is complex and has radiating surfaces that face each other, energy will be reflected back and forth, and little lost. If there are no facing surfaces, radiation will be outward in all directions. However, a detector will be able to "see" only a small portion of the total amount emitted. The surface of importance to the detector is the area which is included within the lines of sight between the target and the receiver. An aircraft viewed headon has a much smaller projected area than when seen from the side.

By considering temperature, emissivity, and dimensions, a radiation pattern can be approximated for any aircraft. Two of these are shown in Fig. 2. Directions from which attacks can be launched for successful results can be seen quite readily from such patterns. If the missile is designed for the detection of radiation in the 2-3 micron band, the jet shown should be attacked only from the narrow sector at its rear. If the missile can detect 3-5 micron radiation, attacks can be made from almost any direction, but most successfully from the rear.

These pattern outlines indicate comparative strengths of infrared radiations at different wavelengths and not the limits at which these radiations can be detected. Radiation is strongest from the hot engines and engine exhausts. It is weaker from the skin of the aircraft where heat is generated by friction and aerodynamic braking of air. The radiation patterns of high-speed aircraft are distorted rearward, compared with piston engine aircraft, because of the long, hot, jet exhausts. Skin effects and power output of any specific aircraft will increase with speed, increasing radiation, and in some respects, make the aircraft easier to detect.


Radiation Pattern of C-47 Due to Engines and Exhausts

Over-all Radiation Pattern of a Jet Aircraft

**Fig. 2. Radiation Patterns of Different Type Aircraft**

## DETECTION AND GUIDANCE

Detection equipment in a missile designed to home on high-speed aircraft must be extremely sensitive. It must pick up small amounts of radiation emitted from thousands of feet to many miles away. And detection reaction must be rapid. Certain types of receivers used in laboratories are extremely sensitive but are impractical for use in air-to-air missiles since their reaction times are too long.

A missile IR detector has the ability to rapidly convert infrared radiation into an electrical signal. The signal produced by the receiver can then be amplified and used to provide guidance to the missile. This type of receiver uses a photoresistor element consisting of a thin, high-resistance film of semiconductors such as lead sulfide, lead telluride, and lead selenide; indium antimonide, and indium arsenide; germanium alloys, and gallium antimonide, each of which has the ability to detect infrared radiation of definite frequencies only, usually within narrow ranges. When infrared radiation hits these semiconductors, free electrons appear in the layer of film. Electrical resistance of the film decreases and the voltage across the receiver drops. The film is connected into a power circuit, and the voltage changes which result are used to modulate downstream units. Reaction time with this type of system is extremely rapid, ranging from a few millionths up to a few thousandths of a second.

Cooling of photoresistors increases their sensitivities so they can detect radiations of longer wavelengths. Detector temperature in an air-to-air missile is reduced by the cooling effect created by an expanding gas. A gas, such as nitrogen or helium, is compressed to an extremely high pressure, at which it may be stored indefinitely. In use, the gas is released through a very fine hole or filter. As it expands, it absorbs energy in the form of heat, causing the temperature to drop and the detector to cool. The chief disadvantage of this method is that the fine holes may be stopped up by contaminants in the gas or by moisture which may freeze. In this case, the sensitivity of the receiver would be reduced, decreasing the range of the system, or eliminated entirely, causing complete failure.

An infrared detection system can determine the strength of the radiation it receives, but not the distance to the source (a large object at a great distance may indicate the same intensity as a small, nearby object). An IR system thus lacks an ability which radar possesses. By use of a suitable electromechanical device, called a modulator, an infrared system can be used to determine *direction* to a target.

The modulator is a rotating disk made up of alternating transparent and opaque areas arranged in a regular pattern. Generally, two are used to provide information on directions along both the horizontal and vertical planes. Radiation received from the target is focused into a narrow beam which hits these modulator disks. If it hits a transparent sector, it passes through to the sensing element; otherwise, it is reflected. The frequency of current which results is a measure of the difference in angle between the lines of sight and flight. Suitable control corrections can then be made. When the missile is on a proper course, the radiation beam will hit a constantly opaque area, the system will be in equilibrium, and no directional change will take place.

The transparency of the missile nose cowling and the atmosphere through which radiation must pass is extremely important. Not all transparent materials will pass infrared radiation. Some of them will pass only certain wavelengths. The substance used for these cowlings, or *irdomes*, must correlate with the wavelengths to be detected. Conventional glass will pass radiation below 3 microns in wave length; other materials must be used for wavelengths longer than this. Arsenic trisulfide will pass about 70 per cent of any infrared energy of 1.5 to 10 microns, and the percentage can be increased by use of special optical coatings. Conversely, the presence of dirt, scratches, finger marks, oil or moisture films, or other foreign material, may degrade the ability of an irdome to pass radiation. A cracked irdome may permit warm air to hit the receiver, which would reduce its sensitivity.

## AIR CONTAMINANTS

Various constituents of air will also act as obstacles to the passage of infrared radiation. Molecules of carbon dioxide, water vapor, and ozone will absorb energy or cause its scattering. Particles of dust, smoke, pollen, salt, bacteria, ice, and drops of water will interfere in the same way. Here, again, the absorption of energy is selective so that certain wavelengths are affected more or less than others. Frequencies at which little or no absorption takes place are called "windows." The atmosphere may absorb as much as 100 per cent of the radiation at other wavelengths. Windows for air at sea level are shown in Fig. 3. The widths of these windows will increase with altitude as the density of air and the amount of water vapor present decrease.

The wavelengths for which an air-to-air missile detection system is designed are therefore critical. The detection ability of a receiver is affected by the lack of windows at those wavelengths, the transparency of the irdome, and the target temperature. A missile designed to detect only low temperature, long wavelength radiation may miss a much brighter and hotter target radiating at much lower wavelengths. For example, a magnesium flare is extremely bright and attractive to the human eye, but its infrared radiation may be unsuitable for homing of a missile.

Similarly, a missile developed for high altitude use, where little air or water vapor is present, may not home on a low altitude target, especially in rain or under high humidity conditions. The range of a missile may be reduced substantially in such cases, far below that indicated in operating procedures under design conditions for that missile. The receiver requires a specific minimum amount of radiation to operate. Radiation received varies inversely with the square of the distance from the source. This means that a missile launched twice the distance from a target, compared with another missile, would receive only one-quarter the amount of radiation.

An infrared detector will steer a missile towards the strongest radiation source within its sight. The sun is so massive that, although its maximum intensity is at 0.5 micron, its output at other wavelengths will generally overwhelm that of any other source. So care must be taken not to point the missile towards the sun. If the missile "sees" the sun for only a short time prior to launch, or "sees" only the area around the sun, any deleterious effect would probably be temporary. Pointing at the sun for a longer period than a single sweep may destroy the receiver's capability. Precautions against exposure to the sun for a missile are similar to those to protect the eyesight for humans watching an eclipse. For the same reason, background radiations which attract a missile should be avoided. These may be reflections of the sun on clouds, radiations from hot stacks or furnaces in industrial plants, or reflections and radiations from hot areas such as deserts in the summer. Such background effects may be especially critical if the missile is fired when the plane is in a dive.

To avoid guidance failures of IR systems, the equipment must operate as designed and employed within its design limitations. When any doubt exists — whether conditions or altitude — range to target should be reduced to the minimum practicable before launch. Irdomes when not in use must be protected by covers to prevent loss of transparency and to avoid cracking. The missile should be protected at all times from moisture which might reduce the receiver's sensitivity or cloud the irdome.

The incident rate will be reduced substantially if ground crews and aircraft commanders are aware of detection systems' limitations. Application of adequate care will help the missile operate as it should. ★

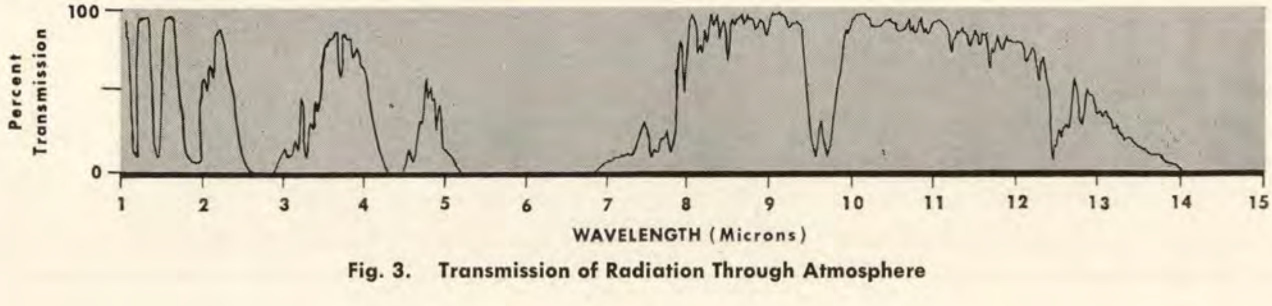



**Fig. 3. Transmission of Radiation Through Atmosphere**

# Missilanea

DON'T KEEP IT TO YOURSELF — Although missile systems and technical data have been undergoing change and modification continually since their inception, almost daily we find additional improvement which is necessary to enhance safety and, therefore, reliability of the systems.

Many courses of action are open to us, such as the URs, AFTO 22s, Serious Hazard Reports, etc. All of them have played an important part in effecting improvements. Nevertheless, we often hear of conditions through field visits or even by word of mouth which affect the safety of personnel or equipment but which have not been reported.

The old axiom that "the squeaking wheel gets the most grease," is still true. But, beyond the fact that your squeaking or, more appropriately — yelling, will get a greater and probably quicker response, you'll be warning others of the problem which they may not yet have recognized.

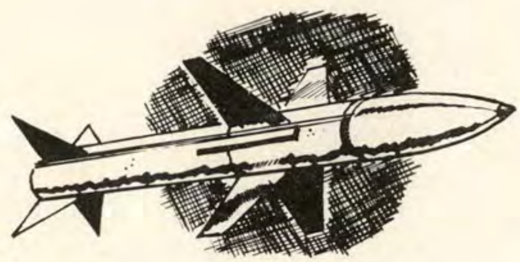
Major K. H. Hinchman
Directorate of Aerospace Safety

AMMONIA STRIKES AGAIN — The AGM-28 had been down loaded from a B-52 aircraft and hung on a storage rack. Final steps, which included the installation of all protective covers, were being taken to close the missile. An airman was attempting to install a dust cover on the disconnect ammonia valve when ammonia began to spray from the valve. The discharged ammonia struck him in the face. Crewmen, working with the airman, rushed to his aid and placed him under a deluge shower. Shortly thereafter, the airman was rushed to the hospital and treated for caustic burns to the left side of his face, forehead, lips and mouth — plus irritation to the respiratory tract.

Investigation revealed that the disconnect ammonia valve (PN 21372-21) was not fully locked. However, the ball check valve was closed sufficiently to retain the system ammonia but opened almost immediately when the dust cover made contact with the valve assembly.

It is recommended that all disconnect ammonia valves be visually inspected to ascertain that the ball check valve is in the closed position. Then — and only then — proceed with the dust cover installation or ammonia servicing operation.

Maj Edward D. Jenkins
Directorate of Aerospace Safety



TO DIG A SPARROW'S GRAVE — Recently a unit experienced several "Dud" AIM-7 missile launches. The missiles were ejected from the AERO-7A launcher but the motors failed to fire. The missiles could not be recovered since they were fired on a water range. The aircraft was checked thoroughly and passed all the required electrical checks. This led to speculation as to cause factor. Many theories were advanced by the experts but since no positive answer was found, the AERO-7A launcher was sent to Raytheon for TDR.

The TDR revealed that the launcher had been reassembled, after maintenance, without the forward and aft accumulator plugs. During static pit ejection shot tests, it was noted that with the accumulator plugs removed, the missile would unlock and free fall from the launcher. The power gas for piston operation was exhausted through the forward and aft accumulator holes and the piston moved down about 1½ to 2 inches from preload spring tension. Full travel of the piston is required to actuate the motor fire switch (LSE1); therefore, under the above conditions, the missile would simply unlock from the launcher and free fall. This is not a bad maneuver if the "unfriendly" is directly below you.

TO 11L1-3-22-3, when followed, seems rather clear on the care and feeding of an AERO-7 launcher.

Maj Richard A. Brown
Directorate of Aerospace Safety

# Aerobits

BARRIER discrepancies was the subject of a recent Operational Hazard Report. Conditions at the base where these discrepancies were noted were as follows:

• The approach end MA1A jet barrier webbing was in the down position, but the cables were not disconnected.

• The location of the anchor plates toward the edges on both sides were not spaced properly. This precludes proper vertical line-up of webbing and raises the cable from the runway surface. This problem can be resolved by installing additional anchor plates between existing plates to allow proper vertical line-up of the webbing.

• The MA1 cable on the approach end was kinked and would not lie flat on the runway surface.

• The BAK-6 cables were not properly pre-tensioned. Several large aircraft (C-135 and C-124) were observed to operate across the approach end BAK-6 cable on takeoff. In one case, the cable bounced an estimated 12 to 14 inches above the runway surface.

An inadvertent approach end engagement of the MA1A could result in a major accident.

Barriers are extremely useful and have prevented many possibly serious accidents (see "Barrier Success Rate," page 27). It would be ironic if these fine accident preventers were to be the cause of a disaster.

ALTIMETER CORRECTION CARDS—Situation: Routine cross-country flight. Enroute: near miss with a civil airliner. Investigation: Pace flights showed fighter off by as much as 400 feet, civil airliner off another 250. At the flight level of occurrence, 1000-foot separation was the rule. Actually as little as 350 feet existed. Considering the separation and the element of surprise, it's no wonder somebody started hollering *NEAR MISS!*

Some aircraft have altimeter correction cards and some have not. Those that have, need them. Some of those that haven't, also need them. A program to provide accurate flight test data for these aircraft altimeter correction cards is under way.

The criterion for installation of cards is a total altimeter indicating system error in excess of plus or minus 250 feet. To correct this condition, common or fixed system errors are determined by flight tests and entered in the handbook and on the altimeter correction card.

You as a pilot may tend to think that a few hundred feet are not important. If you're the only aircraft up there, you're right. But, if you're not and you meet someone else with altimeter errors in the opposite direction, and that pilot shares your opinion, you'll wind up trying to share the same airspace! Crowded airspace with 1000-foot separation isn't too bad, but with no separation, it can become very exciting.

Check the T.O. list on your aircraft for the requirements of an altimeter correction card. If the T.O. says yes, and there's none in the aircraft, stay home! Don't make a planned mistake.

Lt Col Richard R. DeLong
Directorate of Aerospace Safety

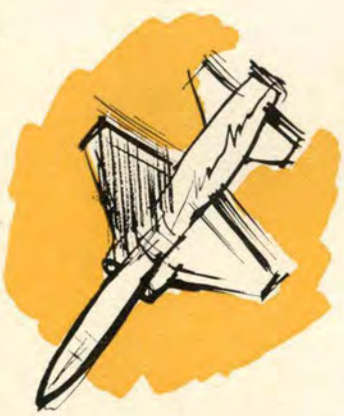
PATTERN FLAMEOUT—GET OUT! —At the conclusion of a recent single engine flameout accident, the accident investigation board recommended that the Flight Safety Division publicize the accident circumstances, and that significant findings be brought to the attention of all fighter pilots.

After executing a go-around and establishing a normal downwind leg, the pilot of a Century Series fighter experienced a flameout. He announced the flameout to the tower and stated that he was making an airstart. Mobile Control advised him not to delay ejection too long. The pilot reported he couldn't get an airstart and was again advised to get out. He ejected at a very low altitude with a high rate of sink and received fatal injuries.

The board wanted to highlight the facts that multiple airstart attempts are not recommended when flameout occurs at traffic pattern altitude. Zoom should be used to trade airspeed for altitude, and pilot survival is the primary factor for consideration under these circumstances.

All of us in the Fighter Branch of Flight Safety agree wholeheartedly that it is unlikely, once the engine winds down, that there will be sufficient time to make the start and get enough power to start flying again prior to impact. When the engine flames out at 1500′ and airspeed is low, get out!

**Lt Col Eugene P. Sonnenberg**
**Directorate of Aerospace Safety**



STANDARDIZED! Many times malfunctions experienced by pilots cannot be handled "by the numbers." Situations occur where there is no "School Solution" and the pilot must handle the problem with the knowledge he has of his aircraft systems. While close adherence to, and emphasis on, procedures is quite necessary, it is a poor *substitute* for knowledge of the aircraft system.

• Aircraft was on a routine training mission, constant airspeed and RPM, when one engine RPM went to zero. Assuming a flameout, the pilots shut down the engine and completed a single engine landing. All other instrument indications were normal. Cause: (For zero RPM) tach generator shaft failure.

• Aircraft was in normal flight when one engine EGT began fluctuating from zero to 900 degrees. The engine was immediately shut down and a single engine landing accomplished. All other instruments: normal. Cause: malfunctioning EGT system.

**Maj Jack R. Pulliam**
**Directorate of Aerospace Safety**

BARRIER SUCCESS RATE. Figures on barrier engagements for the first nine months of 1965 reveal that hook arrestments, including pre-planned approach end arrests, have been very successful. Conversely, non-hook engagements (MA-1) leave much to be desired. Here's the box score.

| | | |
|---|---|---|
| Total Barrier Contacts | 227 | |
| Successful | 209 | |
| Unsuccessful | 18 | |
| Per cent successful | | 92% |
| Hook Engagements* | 197 | |
| Successful | 194 | |
| Unsuccessful | 3 | |
| Per cent successful | | 98% |
| Non-hook Engagements | 30 | |
| Successful | 15 | |
| Unsuccessful** | 15 | |
| Per cent successful | | 50% |

* Pre-planned approach end 13 successful, 1 unsuccessful.

** Eight too slow speed for engagement.

**Harrie D. Riley**
**Directorate of Aerospace Safety**

# Aerobits

WHERE'S THE STREAMER?—Another set of F-106 armament doors were damaged beyond economical repair because someone (not necessarily the crew chief) acted in haste. The pilot and crew chief were making the preflight, and after examining the armament configuration, the pilot told the crew chief to close the armament doors. The crew chief visually checked the bays, then closed the doors. A loud crashing noise was heard! Inspection revealed the left front door lock was still installed. No streamer was attached.

The crew chief was assessed personnel error for failing to remove all six locks before closing the doors. Current procedures were considered adequate so all personnel were rebriefed.

• Why didn't the pilot insure that the locks were removed prior to telling the crew chief to close the doors?

• Where did the streamer for the lock go?

• Current procedures were considered adequate (if followed) but were changed to provide for the doors to be closed except for loading, unloading or performing maintenance.

Suggest the F-102 and F-106 units survey their loading and preflight inspection procedures to determine whether their armament doors are in danger.

OVERSEAS LANDING AREAS. Increased flow of air traffic to overseas areas results in aircraft landing at airfields which do not meet minimum Air Force safety criteria. Adding to this potential hazard is an increase in the tempo of operations because of the urgency of mission requirements. Here is a case in point.

The aircraft arrived over the terminal and prepared for landing. Approach control couldn't be contacted and GCA was on standby. The result was a 25 minute delay. Two surveillance approaches were made without success. After finally getting lined up, the pilot was told that runway lights on the right side had just gone out. After a landing on the extreme left side, the pilot taxied into the parking area, where fuel was observed leaking from the left wing. Inspection disclosed a hole in the underside of a fuel cell and Nr 1 prop blades chipped. During the investigation it was learned that weapons carrier personnel had driven a truck without lights alongside the runway toward the POL area. The truck had stalled and was being loaded along the runway shoulder. Damage to the aircraft resulted from the left wing and Nr 1 propeller striking the truck during landing rollout.

Incidents involving congested ramps, lack of wing walkers, absence of adequate runway markings and lighting, ditches, obstructions near runways, vehicular traffic on the airfields and other hazards are becoming more frequent.

It is of utmost importance that all aircraft commanders on rotational assignments be alert to the above cited accident producing causes prevalent in overseas landing areas. ★

**Directorate of Aerospace Safety**
**Harrie D. Riley**

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# WELL DONE

## CAPTAIN CHARLES E. SHELTON

**15 TACTICAL RECONNAISSANCE SQUADRON, APO SAN FRANCISCO 96553**

Captain Charles E. Shelton was accomplishing an annual instrument proficiency flight check in an RF-101A. After one hour and thirty minutes of flight, he lowered the landing gear for an instrument approach. The right main gear and the nose gear extended normally, but the left main gear remained in the up position. Captain Shelton used all emergency gear extension procedures but the results were negative. Knowing that a landing with one main gear retracted would cause a loss of directional control after touchdown, Captain Shelton elected to place the aircraft in a main gear up and nose gear down configuration. This would allow touchdown on the two empty drop tanks and the extended nose gear. This particular gear configuration required increasing airspeed to exert high airload pressures on the nose gear assembly to prevent its retraction, while at the same time placing the gear handle in the up position to retract the right main gear. Once this was accomplished, the gear circuit breaker was pulled and the gear handle was returned to the down position. This procedure gave the desired gear configuration for landing. With adequate time to prepare for a gear up landing, firemen laid a 3500-foot foam strip on the runway. A normal final approach at 170 knots was flown and touchdown was made on the empty drop tanks and nose gear. The aircraft slid to a stop in 3200 feet and sustained only minor damage to the wing flaps. A total of 31 manhours was required to repair the aircraft and return it to flying status.

Captain Shelton's intimate knowledge of the RF-101 aircraft and his demonstration of outstanding airmanship enabled him to minimize the seriousness of this mishap and prevent what might otherwise have resulted in a major aircraft accident and personal injury. WELL DONE! ★


**NOTE:** A poster appeared in November which had steps 2 and 3 reversed. The sequence shown here is the correct one. "Beat the system" *does not* apply to aircraft utilizing the seat with integrated harness. Applicable dash one procedures will apply in this case.