SHOULD I QUIT?

removing the smoke screen

UNITED STATES AIR FORCE • APRIL 1969

Aerospace SAFETY

THE MAGAZINE DEVOTED TO YOUR INTERESTS IN FLIGHT

Thunderbumpers

time for a refresher

ARE WE RIGHT SIDE UP?

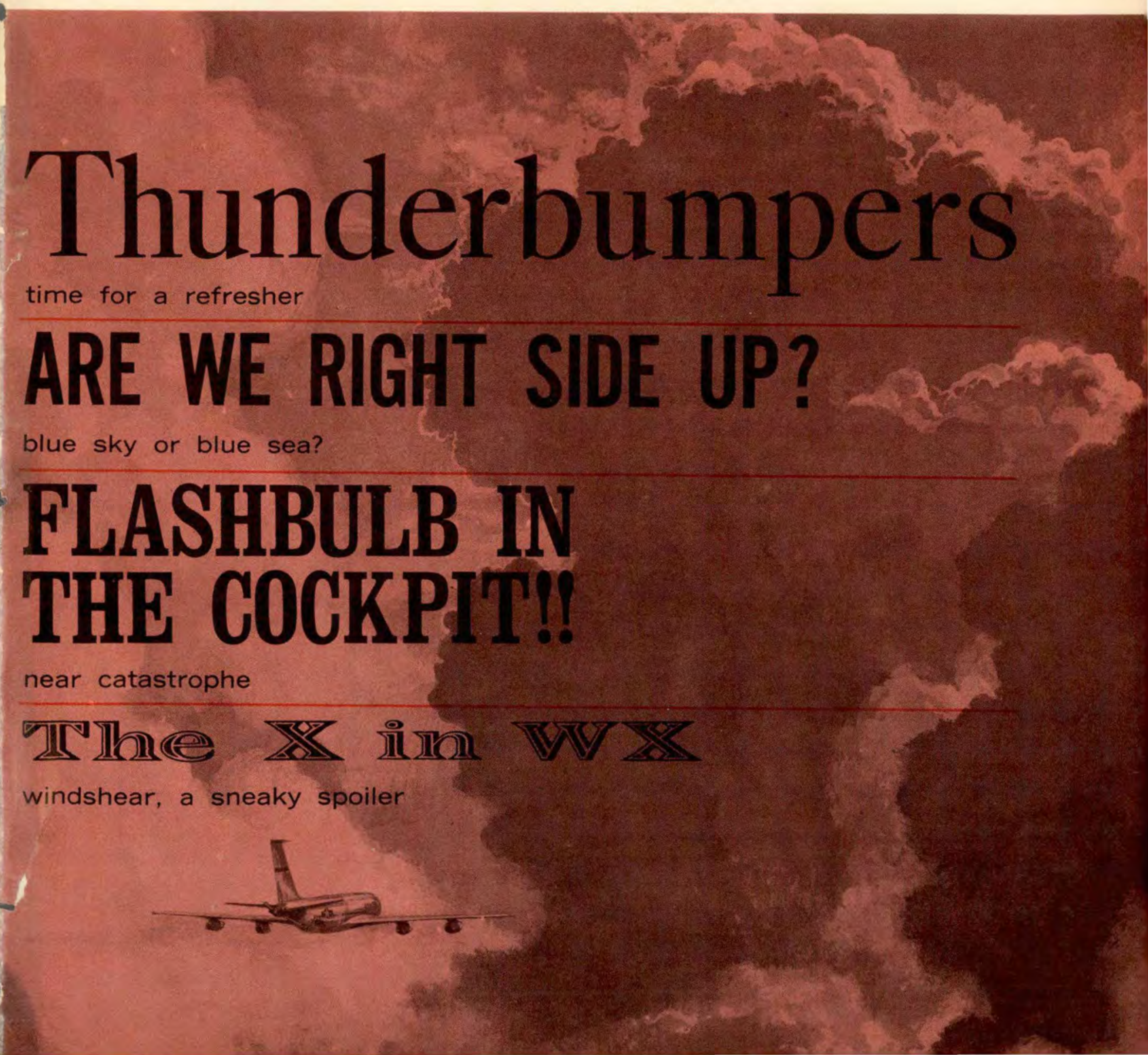
blue sky or blue sea?

FLASHBULB IN THE COCKPIT!!

near catastrophe

The X in WX

windshear, a sneaky spoiler



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APRIL 1969 AFRP 62-1 Volume 25 Number 4

SPECIAL FEATURES

REGULAR FEATURES

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PREFLIGHT

Along with the longer, more exciting, or at least more flying oriented, articles in this issue is a modest little piece titled "Should I Quit?" Our astute readers no doubt will associate this title with smoking, which is exactly on centerline, on glidepath. Lt Col Bob Bonner, one of the flight surgeons in the Life Sciences Group of this directorate, wrote the article and promised to answer his own question with a "*Yes.*"

Your managing editor made this a New Year's resolution beginning in 1961. So there's really nothing to it, except the exercise of a little bit of iron self discipline. He made the grade on 1 Jan 1969. Now, after some eight weeks of abstinence (from smoking) his habitual bad humor is atrocious and he's about twice as crabby as usual. Nevertheless, he hails the benefits of inhaling fresh, smokeless air. This is true only because the seemingly perpetual rains this winter in Southern California have kept the smog away.

Now you should know that giving up smoking results in a couple of inflationary conditions. One of these, of course, involves the abstainer's waistline, and the other refers to his pumped up virtue. He feels like a saint—preferably of the knight-in-armor type—strong of limb as well as character. Only trouble is that the daily savings won't quite match the bill for new—and larger size—clothing for several months. Meanwhile, one bends over to pick up dropped objects very carefully.

WE LIVE IN FAME

Lt Col D. K. Stephans, 35 TFW

On March 10, 1966, Major Bernard Fisher, *with complete disregard for his personal safety*, landed his A-1E on a tiny dirt strip in the Ashau valley while under heavy fire from 2000 enemy soldiers and rescued Major "Jump" Myers. So reads the citation awarding the Medal of Honor to Major Fisher. The phrase "with complete disregard for his personal safety" captures the essence of the military ideal. Past generations have thrilled to, "Sir, we have not yet begun to fight!" "Damn the torpedoes; full speed ahead!"

All these cries of defiance have expressed for their own time the spirit of the soldier who, undaunted by personal peril, still presses aggressively at the enemy. They represent the unique value of indomitable courage which has attracted most of us to the military profession. Indeed, what else could it have been? Wealth? Security? Scholarship? Stability? These are not central to our profession. Courage is. Hear it again in the Air Force song: "We live in fame or go down in flame, nothing can stop the U. S. Air Force."

This is the spirit, the legend celebrated at dining-in, parade, O'Club bar; wherever "eagles" have gathered since the misty days of aviation's youth when the Mitchells, Fouloises and Rickenbachers were learning their trade. It is expressed well in verse from the "Ghosts of the Eighth Attack" written to immortalize the achievement of strong men who flew with the Eighth at Saint-Mihiel and Chateau-Thierry in World War I:

> Kingsland turned to spin and burn
> Red and Gallagher died
> In battle flame on the fields of fame
> With Mitchell by their side
> From death unveiled they never quailed
> Nor brake upon the rack
> But rose we ken, to fight again,
> The Ghosts of the Eighth Attack!

'Tis a proud heritage that is ours!

But we cannot live in the glorious past. Each morning you and I awake in Vietnam, 1969. Here, rather than "Damn the torpedoes, full speed ahead," we daily hear "Stay out of the ground fire," "don't press; no target is worth the loss of aircraft and crew;" "minimum altitude is . . ."

Reinforcing this calculating approach to war are command responses to bomb damage achieved versus battle damage incurred. An exceptionally good air strike is recognized and celebrated at crew and squadron level, seldom higher. But *non-battle* damage incurred to aerospace vehicle or crew is investigated with a fervor born of the axiom that if a plane is damaged, somebody goofed! This seeming inconsistency between legend and today's reality is confusing to most and frustrating to many. To the man who has steeled himself stateside for his "moment of truth" in Vietnam it is disconcerting to not be immediately ordered at full speed "into the valley of death."

But the problem is not new: we encountered it in the later stages of the Korean police action when the violence of the first year's fighting had stabilized into a war of attrition. There, our crews were soon categorized under the labels *Pussy-Cat, Tom-Cat* and *Tiger*. The *Pussy-Cat* response to restrictions in ordnance delivery was "O.K., I'll take your minimums and double 'em; I'll be very, very safe while you play your silly numbers game and the mission be damned!"

At the other extreme, the *Tiger* proved utterly incapable of shifting gears. His response was to continue to sniff through the trees at 300 knots, always searching for his elusive "Ploesti" but too often finding more flame than fame. Fortunately, the majority of the crews were *Tom-Cats*. Their attitude was "You make the rules, Chief, and we'll show you the best results achievable within those parameters!"

Today as in those days we see the variety of responses. The timid betray the mission while using delivery limitations as a crutch for their consciences. The Tigers still bull their way through the treetops, ever re-proving to their own satisfaction that they are fearless. But the majority still are the Tom-Cats, the real pros. They hone their skills carefully and take pride in being part of a *disciplined* professional fighting team.

In every war there will be moments and places where men are called upon to *Live in Fame or Go Down in Flame* and we will always glory in the selfless courage of those who answer this call. But the strength of the Air Force for the long haul will always be the steady, disciplined Tom-Cat who can take orders, live by them and still do a professional job. ★

(Courtesy of *Combat Safety*)

Although they were in a clear area, the

The F-4 crews walked from the snack bar into the cool predawn Gulf coast air and over to the briefing room. Even though they had risen early, they had all enjoyed a good night's rest. They were briefed for a tactical formation flight involving air - to - ground simulated nuclear and low angle conventional deliveries.

All four crews had been the same route before, nothing at all unusual except they expected ten minutes actual weather during climbout and recovery. An hour and 20 minutes of VFR flight, ten minutes of IFR operation, a fuel load of two hours and 30 minutes and a fairly close alternate looked like duck soup. However, the weatherman threw in a curve when he warned that the air-to-ground range might be IFR.

The alternate plan was to continue to practice tactical formation until reaching a 6000-pound Bingo and then recover in two flights of two. Preflight, taxi, runup, takeoff at ten second intervals, and formation join-up were performed with no problems.

The flight of four then climbed to 30,000 feet and flew "fluid four" tactical formation for 30 minutes. By this time, the flight leader had determined that the weather at the range was not suitable for performing the air-to-ground weapon delivery portion of the mission. He directed Nrs 3 and 4 to take the lead element position and continue to practice formation at 30,000 feet until time for penetration and recovery at home plate.

After 56 minutes of flight, Nr 1 directed recovery because the Nr 3 bird indicated 800 pounds less fuel than the others. Smooth, precise formation work, good decisions, everything was going great. Ground radar accepted control of the birds to maneuver them to 4000 feet and a 25 mile fix from home base TACAN. Approach control (RAPCON) would then pick them up for formation element GCAs and wing landings.

The penetration was started in VFR conditions from flight level 300. The pilot in the backseat of Nr 4 was doing the flying on the right wing of the element leader. They arrived at the handoff point (25 mile fix) at 16,000 instead of 4000 feet and requested a 360 to lose the excess altitude. Halfway through the turn they ran into thick clouds as they passed 10,000 feet.

Nr 4 lost sight of Nr 3; the pilot became disoriented and asked the aircraft commander to take over. The pilot (backseater) later described his confusion as not really knowing what attitude his aircraft was in while he was flying wing on the lead aircraft. This cleared shortly after going back to instruments as he relinquished control. The AC was not monitoring the gages just before he took over. He was looking over his right shoulder trying to spot the position of Nrs 1 and 2. He quickly turned his head back to the left and took the controls. The flight entered a clear area; the AC became disoriented and asked the pilot if they were right side up. As the pilot assured him that they were in a safe attitude, they entered another area of very dense clouds. This penetration occurred before they returned completely to wing position.

Nr 4 told Nr 3 that he had lost him and turned right to initiate the lost wingman procedures. Vertigo had induced a left descending turn sensation when they were in a 30-degree right bank; therefore, the additional 60 to 70 degrees of bank put them in a 90- to 100-degree right bank. The AC later stated that he knew they were descending in a right turn but he felt they were rolling to the left and was not sure the blue he saw was sea or sky. (They were over the open sea during letdown.)

When the pilot, who had returned his full attention to the gages, called

AC asked the pilot··are we RIGHT SIDE UP?

the steep right bank to the AC's attention, the AC rolled past wings level and into a 90-degree left bank.

The airspeed had bled off from 280 KCAS when they departed the formation to 200 KCAS at the 90 degree left bank point. The pilot watched the roll continue to an inverted position and the nose drop rapidly below the horizon. The airspeed started to build as full military power was added and the stick neutralized. Two attempts were made to pull the aircraft out of the wings level dive, which had progressed by this time to about 80 degrees nose down attitude, but buffet was encountered at each attempt. As they passed 6000 feet the AC ordered bailout, but the pilot didn't hear the command. He finally ejected at 3000 feet after seeing the AC pop out at about 4500 feet.

Both pilots received only minor injuries from the ejection. The AC released his parachute canopy completely when his feet hit the water, but the pilot was able to disconnect only one harness release on impact. He was dragged for a short distance before disconnecting the other riser. They hit the water about 100 yards apart and were quickly in their rafts, communicating by radio with each other and another flight which flew cover and directed a rescue heli-

. . . . he watched the roll continue to an inverted position and the nose drop rapidly below the horizon.

copter to the scene. They were in the water from 25 to 30 minutes.

The Board determined the primary cause to be operator factor because the aircraft commander failed to monitor his flight instruments during initial weather penetration while his pilot had control. Furthermore, when he assumed control he failed to effectively transition from formation flight to instruments while executing lost wingman procedures and allowed the aircraft to get into an attitude and descend to an altitude from which he couldn't recover. Several contributing causes were listed in the final report.

The Board found operator factor on the pilot's part while he was at the controls because he failed to initiate lost wingman procedures upon losing sight of the lead bird. He also took no positive action when he noticed that the AC didn't execute safe recovery techniques and couldn't control the aircraft after breaking out of formation.

Weather conditions were another contributing cause. Frontal cloud density made formation integrity difficult if not impossible to maintain and created a situation requiring transition from formation to instrument flight while executing lost wingman procedures. The accident board made several recommendations which are vital aircrew information.

All crews must be constantly aware of the need for coordination to insure that the member not handling the flight controls constantly checks formation position and monitors flight instruments. The importance of this requirement multiplies many times during instrument weather penetrations. All formation flights must be briefed on lost wingman procedures with emphasis on the pilot's responsibilities for decisions and assistance to the aircraft commander.

Angle of attack indexer lights should be modified to remain on after landing gear retraction. This will provide the backseater limited angle of attack information to assist in out-of-control or unusual attitude recovery. This mod has been completed on the C and D models and the kits should soon be available for the E.

During the course of the investigation, several other factors not directly related to the accident were discovered.

The element leader did not initiate lost wingman procedures when he became aware that his wingman had lost sight of him. He should have rolled out of his turn immediately. The element leader also failed to move his fuselage rotating beacon light switch to the steady position as the element formed for the weather formation penetration and approach. If left in the flashing position in actual weather, the beacon can cause pilots of wing aircraft to get vertigo. Testimony revealed that the four crewmembers of the flight who were not actually at the controls while in the weather were not monitoring flight instruments. They were either looking around, not paying any particular attention to anything, or were watching the lead aircraft. Thus, in each element of two F-4s during the weather penetrations, only one of the four backseaters was actually flying instruments or monitoring the gages.

Luckily, only two of the eight pilots involved got seriously disoriented. One of these couldn't overcome the malady and the other wouldn't take control when the situation demanded. One must trust his instruments over his body balance mechanisms when disoriented—no matter how painful or unnatural. To quote Lt Col J. L. Lillie, USMC, in a recent *TAC Attack* article, "All pilots have talked about it, heard about it, and may have experienced disorientation at one time or another. However, how many pilots have seriously considered how this phenomenon can be countered and what steps should be taken when the time comes? A few minutes reflection on the ground could result in great returns in the air." ★

the I.P.I.S. approach

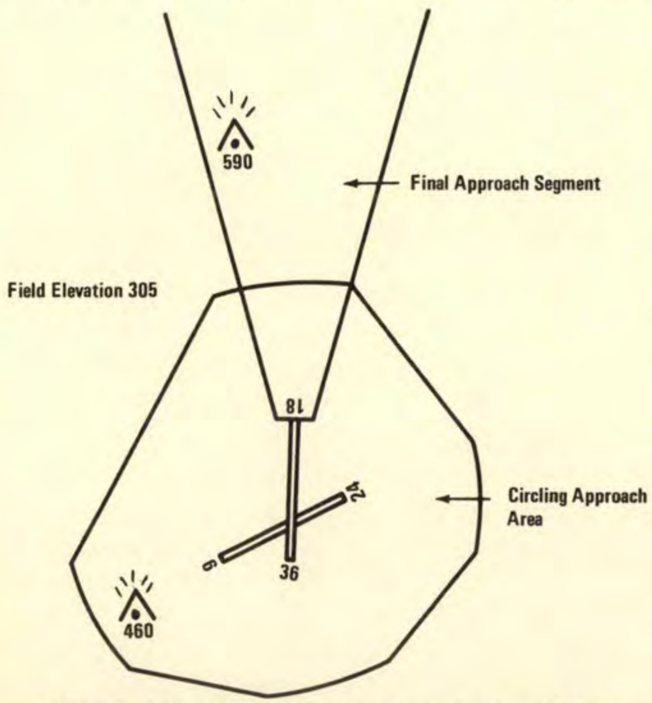
By the USAF Instrument Pilot Instructor School, (ATC)) Randolph AFB, Texas

Q Several bases publish different circling approach minimums (MDAs and weather requirements) for the same aircraft category for various runways within an airport complex. Why should one aircraft category be required to conform to different circling approach minimums at the same airport? Secondly, if different minimums do exist, which minimums must the pilot conform to—the minimums published for the runway to which the instrument approach is made or the minimums established for the runway to which the pilot intends to circle and land?

A The situation described in the preceding question is not unusual and is perfectly correct. A circling approach minimum descent altitude (MDA) must provide the obstacle clearance required by JAFM 55-9 (TERPs) in both the final approach segment and the circling approach area. (A minimum of 250 feet obstacle clearance in the final approach segment and a minimum of 300 feet obstacle clearance in the circling approach area.) The final approach segment is located between the final approach fix and the missed approach point. Consequently, circling MDAs will be different whenever the controlling obstruction for one runway is located within the final approach segment outside of the circling approach area. A higher MDA may, in turn, require higher weather minimums.

A pilot making an instrument approach to one runway and planning on circling to land on another runway must use the circling MDA published for the runway to which he is making the instrument approach.

Using our example diagram, consider the pilot of a Category C aircraft planning a radar approach to runway 18 and intending to circle and land on runway 36. He would need weather of at least 600 - 1½ to start the approach, and his circling MDA would be 840 feet. The higher MDA and weather requirements for runway 18 are caused by the 590-foot obstacle in the final approach segment.



CIRCLING RWY	CATEGORY	MDA VIS	HAA	CEIL-VIS
06, 24, 36	A, B	760-1	455	(500-1)
06, 24, 36	C	760-1½	455	(500-1½)
18	A, B	840-1	535	(600-1)
18	C	840-1½	535	(600-1½)

Q The definitions of DH and MDA refer to the term "runway environment." Specifically, what is considered to be the runway environment? Is a pilot required to have visual contact with the actual landing area at the missed approach point?

A AFR 60-27 defines the runway environment as: "The runway threshold, approved lighting aids, or other markings identifiable with the runway." A pilot does not have to be able to see the actual landing area before continuing the approach from the missed approach point. In many cases it will be impossible to see the runway at the missed approach point. For example, when flying an ASR approach to one-half mile visibility conditions, a pilot will be unable to see the runway at a missed approach point one mile from the runway. However, the pilot will be able to see approach lights when over ¾ mile from the runway landing area. Identification of the runway environment (approach lights) may enable the pilot to safely continue the approach. ★

The X in WX

Adapted from a paper by
Maj Gale L. Haskins,
written for MAC Flyer

Two brief stories about airplanes and crews that suffered misfortunes will introduce a subject which may be responsible for more aircraft dents and bashes than most of us realize. The subject is wind shear, and here are two examples of its effects on aircraft during the final approach phase.

• The pilot and copilot both testified that the approach was normal. They made a GCA to a 9000 foot runway, but landed about 300 feet short of the threshold, wiping out the landing gear and rupturing the fuel tanks. The pilots said they were on the glide slope, maintaining slightly more than normal power with a vertical descent of about 500 fpm. While descending through 150 feet, the aircraft seemed to fall out of the sky. They both said the airspeed was *right on charted*. The weather was VFR with light winds so the board concluded that weather was not a factor. The primary cause was listed as pilot factor because he misjudged the approach. The copilot was listed as a contributor because he didn't recognize a hazardous situation and call the pilot's attention to it.

• The pilot and copilot both testified that the approach to the 5000 foot runway appeared normal until they crossed the fence at 50 feet in the air. Airspeed was charted but the aircraft seemed to float right past the touchdown point. They finally touched down about 2500 feet from the threshold and then applied reverse thrust. The runway was slightly wet with a Runway Condition Reading (RCR) of 14 as the big transport skidded off the other end of the runway into the mud. The weather was VFR with a light wind of five knots so the investigation board concluded weather was not a factor in the mishap. The primary cause was listed as pilot factor because he misjudged the approach. The copilot was listed as a contributor because he didn't recognize a hazardous situation and call the pilot's attention to it. The real reason for these two mishaps should have been weather—more specifically, wind shear. To help you avoid the same misfortune as these pilots, let's look into the little known phenomenon of wind shear.

Wind shear is a change in wind speed or wind direction in a short distance resulting in a tearing effect. It can exist in a horizontal or vertical direction and occasionally in both. Shear can be present at any level and usually produces churning motions causing turbulence; however, the wind shear area can be so thin that the turbulent area will be hardly noticeable. Fluctuations in airspeed will take place whenever an aircraft suddenly flies through a change in wind direction or velocity, the degree of fluctuation depending on the ability of the aircraft to overcome its own inertia and the relative wind shear.

The two most critical phases of flight affected by this unwelcome wind shear are the takeoff and landing. During the takeoff the pilot's flight references have changed from the ground to the air with the aircraft accelerating rapidly so the effects of wind shear lessen. For our discussion in this study, only vertical wind shear on final approach will be considered. We will discuss the groundspeed and airspeed relationship, kinetic energy of descent, and the basic aerodynamic lift equation. Then the effect of wind shear can easily be seen by examining the variables of each equation.

GROUNDSPEED VS AIRSPEED

Every crewmember agrees that groundspeed varies with the airspeed. But we also should remember it varies with other factors such as temperature, pressure, density and wind. While descending through a sudden wind shift or change in velocity, the groundspeed can't go immediately from say, 130 knots to 150 knots. It all takes time for the speeds to stabilize. The actual airspeed under these conditions is increased or decreased by the change in relative wind until the groundspeed can get into phase with the newly encountered wind.

While flying with a 20- to 30-knot headwind you could very rapidly descend through a wind shear line and find the same amount of wind on your tail. Or what is more common, you could descend from a 20-knot headwind into a calm surface wind. In either case, the aircraft experiences a decrease in airspeed about equal to the change in wind component. Without a change in power, the aircraft will eventually readjust to the new airspeed. But in the meantime, if the decrease in airspeed has dropped the indicated speed of your bird below its stalling speed, you've just bought the farm. You are about to experience the same sensations as the man on the top floor of the Empire State Building who just punched the basement button on the fast elevator. You must land whether ready or not!

LANDING

Everyone associates a landing with the screech-screech of rubber on concrete; but to be more precise, a landing is a transition between environments. It is a transition that usually ends up in only the termination of the mission, but can, if allowed, be a time of complete disaster. The bad landing is still common in both reciprocating and jet aircraft. It can be caused by poor pilot technique, wind shear or a combination of both. Remember, airspeed, sink rate and the approach angle to the runway are the three essentials for a good landing.

$KE = \frac{1}{2}MV^2$

The kinetic energy of descent produced during approach is one half of the mass of the aircraft times the square of its vertical velocity. As sink rate increases the kinetic energy of descent increases, but not on a one for one basis. It increases as the square of the sink rate velocity. Thus, if the sink rate on final approach doubles, the kinetic energy involved will quadruple and possibly reach disastrous values.

For example, a jet is descending on final approach with a sink rate of 600 feet per minute (fpm). If we increase this descent to 900 fpm the vertical component of the aircraft's kinetic energy is more than doubled; ie, $(600)^2 = 360{,}000$ while $(900)^2 = 810{,}000$.

If the aircraft is going to touch down smoothly the sink rate must be very low (the kinetic energy of descent near zero). This can be done by pulling back on the yoke which increases the angle of attack and lift of the wing. Now, if we are coming down final at a high rate of descent, a higher airspeed will be necessary for a safe flare and landing. However, if we are diving down final approach at an angle so steep that an excessive increase in lift is required, and if at the same time we have an excessive sink rate from a diminished headwind, we are in for a bad landing.

To explain how important airspeed is, let's look at the formula for lift of an airfoil, $L = \frac{1}{2} C_L \rho V^2 S$. Here L is lift; C_L is lift coefficient;

ρ is air density; S is wing area; and V is forward velocity. Since wing area and density are constant, the only way lift can be suddenly increased is by increasing the angle of attack (increased C_L) or by increasing the forward velocity. A small increment of velocity affects the amount of lift substantially because of the V^2 term in the lift equation. On final approach, where the airspeed is relatively low (about 125 per cent of stall), the angle of attack is very high. This produces near the maximum C_L, but could be dangerous if the angle of attack should increase slightly to the burble or stall range.

Now that we have discussed the theory of landing, including the kinetic energy and lift equations, let's see how a small wind shear can be squared into real trouble.

NORMAL

Figure 1 is a normal approach situation with the stronger wind at altitude gradually decreasing as you descend. The difference between the wind velocity at approach altitude and on the runway is the actual wind shear. However, it usually presents no problem when the velocity gradient is gradual. As the wind velocity tapers off the indicated airspeed will approach the groundspeed.

Don't forget that both Instrument Landing Systems (ILS) and the Precision Approach Radar (PAR) are more accurate as you near the runway. A glide slope deviation of 25 feet may not even be noticeable at the outer marker or glide slope interception point, but the same 25 feet will gradually show up as you approach the threshold. This gradual deviation is normal, but beware of a rapid change in airspeed or glide slope indication.

Wind shear effect can give you a sudden departure from the glide path and change in airspeed in the same direction at the same time. Going high on the glide slope accompanied by an increase in airspeed, or dropping below the glide slope with an abrupt decrease in airspeed, can mean big trouble.

STRONG TAILWIND INTO CALM

The event pictured in Figure 2 might look like an unrealistic approach, but it occurs often. With light or calm wind at your destination most of you normally shoot the approach and landing to the instrument runway having the precision approach. During the evening hours and in warm frontal zones it is possible to have strong winds at approach altitude, but still be calm on the surface. This diagram shows the effect of a strong tailwind aloft with an abrupt shear line and calm surface wind. Theoretically, an indicated approach airspeed of 130 knots with a 40-knot tailwind will yield 170 knots of groundspeed. Your rate of descent must be much greater than normal to stay on the glide slope. As the aircraft passes through the abrupt shear into calm air, it will maintain this 170-knot groundspeed for a short period of time because of inertia. Therefore, the indicated airspeed will increase suddenly and the aircraft will probably go high and fast on the glide slope.

Actually the airspeed in this case wouldn't instantly jump to an exact 170 knots, because there is some deceleration while passing through the shear zone. But for practical purposes you may assume the airspeed will change whenever there is a sudden change in wind direction or speed. The amount of airspeed change will approximate the rate of wind shear. In other words the larger or faster the wind shift, the greater the change in airspeed.

Fig 1

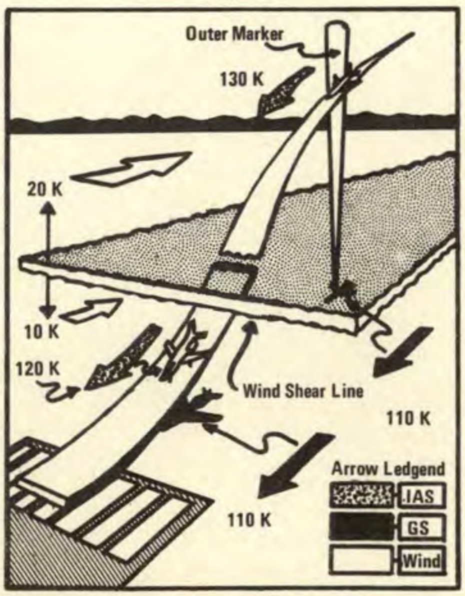
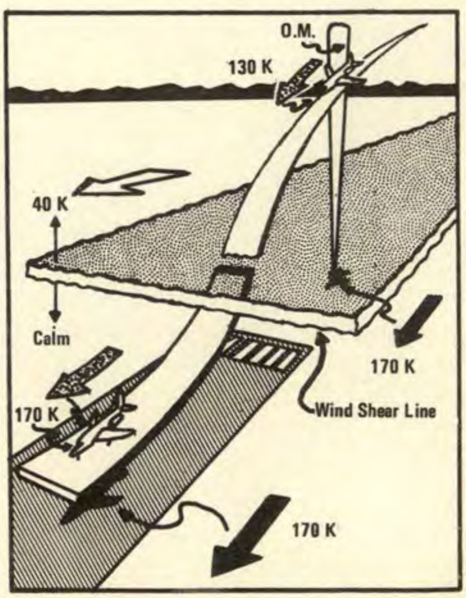


Fig 2



STRONG HEADWIND INTO CALM

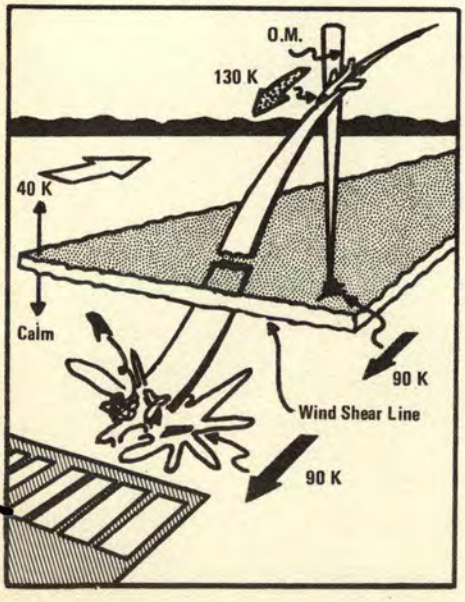
The approach cross section showing the effect of a strong headwind aloft combined with an abrupt shear into calm surface wind is illustrated in Figure 3. This is obviously the most dangerous type of wind shear situation. The vector sum of 130 knots of indicated airspeed and 40 knots of headwind gives a groundspeed of only 90 knots. You can detect this strong headwind while on final because an extremely low descent rate will hold you right on the glide slope. It will also be very easy to get below the glide slope. Now, when the aircraft passes through the shear zone the airspeed will drop to near 90 knots. Again just how much the airspeed drops will depend on the depth of the shear zone. At any rate, there is a possibility that the aircraft will enter the stall zone. Whether the aircraft crashes depends upon the amount of airspeed loss and the altitude available for recovery. If the shear zone is very close to the ground, landing short of the runway might be inevitable.

WHERE IS SHEAR?

As long as we continue flying airplanes we are probably safe in saying that we will continue to land. In fact, to have a safe operation the landings have to equal the takeoffs. If they don't we are in real trouble, so let's look into the general locations where we can expect to find shear. Most of the time wind shear on final approach is very evasive and difficult to recognize because it isn't necessarily marked by visible clues. It can be associated with clouds, but is just as common in clear air. The greatest wind shear affecting our landing pattern is usually found in these areas:

- When strong temperature inversions or density gradients such as those produced by cooling on a calm, clear night exist.
- In the vicinity of dry, cold fronts.
- Near fast moving warm fronts overrunning a cold, dense air mass.
- During pronounced gustiness on the surface.

Fig 3



FRONTAL VERTICAL WIND SHEAR

Vertical shear can be expected with both frontal and non-frontal weather. Generally wind shear associated with the frontal zones will follow this rule of thumb: "Vertical wind shear after the cold front and before the warm front."

NON-FRONTAL VERTICAL WIND SHEAR

Wind shear not associated with weather systems (fronts) can usually be detected on the USAF Skew T, log p diagram, one of the weatherman's best tools for forecasting. We don't need to go into great detail of all its uses, but the name describes it. We get a graphical picture of the vertical cross section of atmosphere up to 10 millibars (101,886 feet). Usually the winds are plotted on the edge of the chart so here is where you come into the picture. Study the winds around the 850 mb (5000-foot) level down to the surface. When the winds are 50 knots at the 850 mb level you should expect strong winds at the surface. The difference between the two levels is the actual shear. Normally two or three knots of shear per thousand feet presents no problem, but five to six knots would definitely be cause for concern.

In areas of inversions or sudden wind shear lines a 30-knot differential per 1,000 feet is not uncommon. In frightening terms, it's enough to drop the $V_{1.3}$ final approach speed to $V_{1.0}$ (V_s) and that is certainly not good to say the least. When flying at V_s the big question is not whether the aircraft will go up or down; it is how far and how fast it will fall.

Wind shear is a hazard of flight that we have to accept. But that doesn't mean we can't do anything about it. First, understand it and its effects on your flight path. Then, keep abreast of weather conditions: (1) During weather briefing prior to flight, (2) enroute and prior to approach for landing.

With this knowledge the pilot can effectively plan his approach, taking any shear factor into account.

When going from a tailwind on approach to a low or zero surface wind, the problem will be to decelerate the aircraft, which will have a high groundspeed. If the pilot is high on the glide slope, he may not be able to slow down in time, in which case he may have to go around.

When going from a headwind on approach to a zero surface wind, groundspeed will be low and the airspeed will tend to decrease at the shear. Now the possibility of landing short becomes the problem.

The alert pilot will be carefully watching airspeed and rate of descent. He will make power adjustments as necessary. Finally, he will break it off and go around if the situation appears to be getting out of hand. ★

It's spring and time to begin thinking about thunderstorms. This article covers the major factors to be considered and is a good refresher for both old ACs and new jocks. Take five, and read about the . . . . . .

Thunder

bumpers

1/Lt Robert E. Chapman, 3617 Pilot Training Sq, Craig AFB, AL

In a head-to-head encounter with a thunderbumper, you can't win. Last summer, for instance, a T-37 crew was cruising in and out of clouds at FL210, when they suddenly ran into moderate turbulence, heavy icing, and hail. The hail caused extensive damage to the entire aircraft. Their weather flimsy contained mention of isolated, small thunderstorms. The finding of the accident board? Primary cause: Operator Factor, in that the IP allowed the aircraft to enter clouds in an area of forecast thunderstorms without determining if thunderstorms were embedded in those clouds.

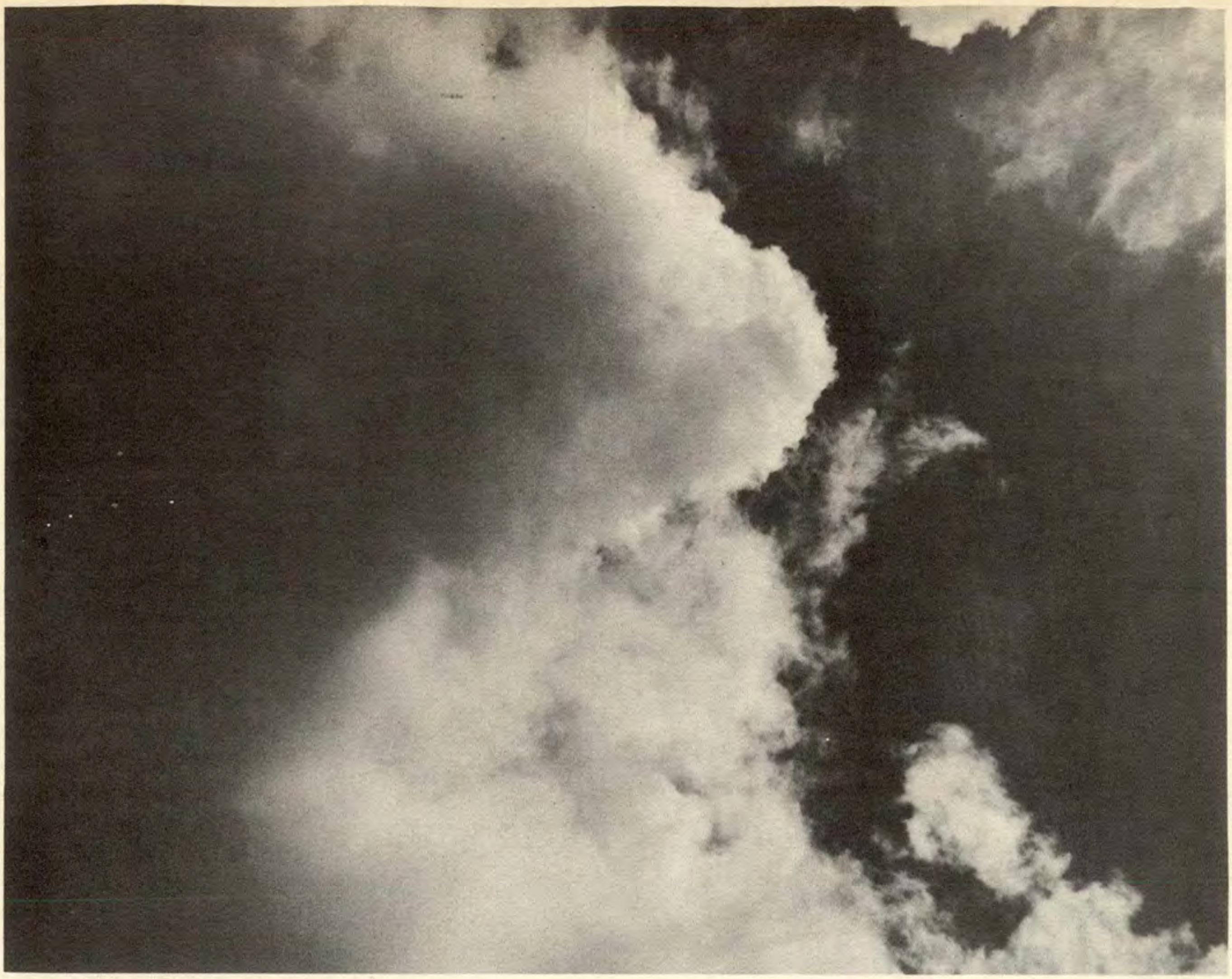
Each year, the Air Force suffers damage to its hardware from encounters with thunderstorms. In most parts of the country, flying in the vicinity of thunderstorms is a way of life. It's good, then, if we take a minute or two to review the kind of a wallop a thunderstorm packs, and see what we can do to put some muscle in our corner of the thunderstorm fight ring.

Broadly speaking, there are two types of thunderstorms. One is the isolated air mass thunderstorm, which is most prevalent in the Gulf States region. It is caused by heating of unstable, moist air, and tends to build in the afternoon, and have a relatively short life. The other type is the frontal thunderstorm, which builds ahead of a moving front, and tends to group together with other thunderstorms to form squall lines. Development and associated weather phenomena of both types follow the same general pattern, with a few added dangers in the frontal type.

Thunderstorms are born when moist, unstable air rises and forms the familiar cumulus cloud. As it builds, at a rate often approaching 3000 feet per minute in the early stages, and up to 6000 feet per minute as it matures, the newborn thunderstorm begins to accumulate its arsenal of deadly weapons. Moisture precipitates into droplets which hang suspended in the updrafts. There they lurk, ready to coat an aircraft with ice if it should venture into the cloud above the freezing level. As the cumulus grows, the water droplets begin to fall as rain, dragging air with them, and forming large downdrafts in the cloud. These downdrafts emerge at the surface causing gusty, variable direction surface winds and rain showers.

Some of the water droplets never reach the ground, but are caught in the turbulent up- and downdrafts. As they rise, they freeze, and form hail. Hail forms in most thunderstorms, but can be especially dangerous if the thunderstorm is very tall, has a high moisture content, and large water droplets. The air of the southeast U.S. is usually always moist, therefore in a large buildup one should expect hail. Hail is found most often between 10,000 and 30,000 feet, in all directions around the storm out to as far as 10 NM from the cloud, but particularly under the anvil-like top of the maturing bumper.

Severe up- and downdrafts give rise to another characteristic of thunderstorms—lightning. It is thought that friction between the up- and downdrafts causes an electrical potential to build up between different sections of the cloud, finally seeking equilibrium in lightning discharges. The frequency of lightning flashes, then, becomes a good indi-



METRO is the best bet for T-storm avoidance information. Include METRO frequencies in your preflight planning and help by giving a PIREP when appropriate.

cator of the potential being generated and, therefore, of the severity of the turbulence within the cloud. Even after the thunderstorm dissipates, a residual electrical charge may remain, and lightning may be encountered for several hours in the lingering stratus.

A lightning strike can cause damage to your bird from burning, pitting, fusing, and breaking of parts, primarily radomes and antennas of radios and navaids—all of which become very valuable in TSM areas. But, there are at least two other effects which are not as well known. One effect is a serious impairment of physiological functions. For example, crewmembers of an airline 707 were blinded for five to 15 seconds, and partially incapacitated for several minutes by a lightning strike on the nose of their airplane. The Captain, who was hand-flying at the time, said that he felt like he was in shock—numb, but conscious of very slow mental action. He had little control over his muscles, and he said that any flying that he did during this time was by instinct alone. It is suspected that a lightning strike similar to this may have contributed to the disastrous crash of another airliner in 1963 by incapacitating the crew. No one knows for sure. There were no survivors.

A second little known danger from lightning is the possibility of ignition of fuel in the wing tanks. Following the 1963 crash, a study was made of fuel combustibility and lightning ignition of fuel. It was found that of Av-Gas, JP-4, and kerosene fuels, only JP-4 forms a naturally combustible vapor mixture at the altitudes and temperatures encountered in flight. It is ideally combustible in the altitude range of 10,000 to 25,000 feet; temperature zero plus or minus 10°C. The potential hazard is greatest during ascent, say the researchers, because the greater relative pressure inside the tanks tends to force vapor through the vents to the lower outside pressure. The gas is on, but there is no match—yet. For a potential match, another series of experiments demonstrated that lightning tends to strike the wings, within one foot of the tip, and on the sharpest point located there. If this happens to be the fuel vent, there is now an electrical spark for a match. It doesn't take much imagination to see that taking off into a thunderstorm, or climbing near one, isn't the wisest course of action to take.

Strong winds aloft, such as around fronts, or those associated with frontal movement, can cause other hazards to develop in thunderstorms. The most obvious is that of the squall line, where a line of thunderstorms precedes a rapidly moving cold front. Thunderstorms present the pilot with a wall, every bit as dangerous as a brick wall.

Other hazards are hidden vortices near violent *bumpers*. They are spawned when wind is sucked into the buildup by the updrafts, and its horizontal vector causes it to swirl as it is pulled upward. A severe thunderstorm tends to spawn smaller thunderstorms on its upwind side, and these, too, contain the swirling updrafts. If the wind aloft is strong enough, it can bend these smaller bumpers toward the parent storm. If the top of the small buildup is absorbed into the larger storm, its updraft merges with the updraft of the stronger storm, and is accelerated by it. The parent storm acts as a giant vacuum pump literally sucking the smaller swirling vortex into a compact, violently spinning vortex. These vortices are invisible except when they touch down to earth as tornadoes, and suck up dirt, houses, water, and the Wizard of Oz movie set. No aircraft can withstand the forces generated by the hidden vortices. Your chances of hitting one are pretty good if you penetrate through clouds within five miles of the main storm, at around 20,000 feet, on the upwind side of the thunderstorm.

The wind-caused tilting of the thunderstorm causes another danger: Most of the rain and hail now fall outside the cloud into innocent looking, clear air—a hidden punch that could catch you off guard.

So, how should we fight thunderstorms? To twist the cliche, the best offense, is a good defense. You have to circle and stay out of reach until your opponent tires. Avoid thunderstorms. Thorough preflight planning is the first big help you have. Check for areas under Severe Weather Warnings. Check sequences of stations along your route. Check the weather radar for buildups in the departure area. Then, plan a route to avoid the big bumpers. It may pay off to fly earlier in the day if you expect air mass thunderstorm activity. Remember, too, that it doesn't take long for the isolated buildups in the forecast to turn into larger areas of thunderstorms.

But, there will be times when it is impractical to avoid thunderstorm areas. If you fly in a thunderstorm area, it may be wise to take some advice from the people at United Airlines (*Aerospace Safety,* July 1968, page 18). United uses the following procedures for non-radar equipped aircraft operating around thunderstorms, and they have not had any hail damage to their equipment for several years. Here's what they say:

"By visual inspection of clouds, only the height, size, and exterior appearance give clues to the hazards within. These characteristics do not provide unique indicators of severity and are not available if masking clouds interfere.

"Avoid by at least 10 miles any storms which have any or all of the following characteristics: taller than 30,000 feet, large in diameter, anvil top, and growing rapidly.

"To gain more information on storms in the flight path, call military forecasters . . . or ask ARTCC for assistance. However, remember that ARTCC does not have weather radar and is limited in the weather information it can provide."

The limitations of ARTCC that United speaks of are basically two. First, their primary function is to control traffic efficiently and safely, not to look out for thunderstorms. Second, ARTCC radar is modified specifically to do the job as effectively as possible. ARTCC employs three main features to eliminate extraneous echoes from weather and other non-traffic sources: (1) Circular Polarization, and (2) Moving Target Indicator, both designed to cancel non-traffic returns from ground clutter or precipitation; and (3) Secondary Beacon Radar, a secondary radar mode which displays only beacon target echoes on the controller's screen.

METRO is a better bet for thunderstorm avoidance if there is a station along your route, because they are equipped with radar specifically designed to paint weather echoes. It can't see turbulence, though, only precipitation patterns. But turbulence is usually encountered in areas of heavy precipitation echoes. Include METRO frequencies in your preflight planning, and use their services. Don't forget to notify the FAA facility before changing frequencies. Don't begrudge METRO a PIREP—it could help your buddy. In case you've forgotten, here's the format:

PILOT REPORT (PIREP) FORMAT transmit to METRO, if possible, otherwise to ARTC:

1. LOCATION

2. TIME(GMT)

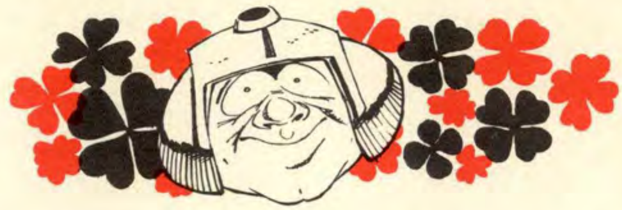
3. PHENOMENA REPORTED TO INCLUDE:
- **a. Any hazardous weather**
- **b. Marked wind changes**
- **c. All turbulence with intensity, duration, & proximity to clouds**
- **d. Altitude of phenomena**
- **e. Type aircraft**

If echoes do show up on ARTCC or METRO radar, avoid them by asking for vectors around them. You'll have to ask for this service. Don't expect deviations to be handed to you on a silver platter. If necessary, declare an emergency, but don't penetrate a heavy echo.

During thunderstorm season, let's keep the good fight going. The muscle to use is mental muscle. Plan well, keep abreast of things while airborne, and employ good avoidance techniques to keep you and your aircraft healthy! ★

CROSS COUNTRY NOTES

LUCKY PIERRE. Weather briefing for his destination gave the pilot of a T-33 a 700 foot overcast, viz one and one-half miles in fog. His alternate was forecast for 1500 scattered, 10,000 overcast, seven miles. Enroute, the weather deteriorated at his destination to one-eighth mile with ground fog. The pilot declared minimum fuel with the Center and proceeded to the base where he called wheels down, field in sight, turning base. The tower gave him the word on the weather—one-eighth mile viz in ground fog—which the pilot acknowledged. He repeated he had the field in sight. He was cleared to land and advised that below 50 feet to expect zero visibility. Pierre landed 1300 feet down and on the extreme left edge of the runway with his left wheel between the white line marking the edge and the actual concrete edge. If it hadn't been for a small mound of snow that caused minor damage to the left



main gear door and the left flap, Pierre would have got off scot free. Weather at the alternate was clear with nine miles viz. After the aircraft was shut down, the fuselage fuel gage showed 72 gallons and the counter showed 130 gallons.

WAKE TURBULENCE. Takeoff and climb were normal until about 100 feet when the O-2 ran into wake turbulence left by a departing C-130. The O-2's right wing dropped, the pilot lost control and the bird stalled and crashed. The turbulence left by the C-130 was so severe that the right wing of the O-2 failed.

Apparently the turbulence came as a surprise to the O-2 pilot. He was busy running up his engines and occupied in the cockpit when the '130 took off. Also he was wearing an almost soundproof ballistic helmet and didn't hear the Herky go by.

Enough has been written on this subject in the past three or four years to fill a shelf of books and indoctrinate any pilot who would take the time to read any of the many articles. Most of us have had some experience with wake turbulence; for those who haven't, believe me, it can give you some real thrills, especially when one runs into it in a light aircraft while it is fresh and at a couple of hundred feet or less.

The only sure way to avoid damage is to avoid the turbulence, but sometimes you don't know it's there. Here are some other recommendations: (1) Give the big aircraft ahead of you from two to four minutes before following him on takeoff; (2) Avoid intersection takeoffs in a light plane, so that you will be climbing above the flight path of the preceding heavy aircraft; (3) Read up on the subject — like in last month's *Aerospace Safety*.

STINGY PILOT. Sometimes smart people do the dumbest things. When an aero clubber with approximately 140 hours flying time encountered lousy weather, including icing conditions and was low on fuel, he used some real smarts and landed in an open field. Good Show! THEN he negated his sharp action by putting two—that's really two—gallons of gas in the bird and taking off for an airport three miles away. Yep, he ran out of gas on downwind, made a forced landing and folded the nose gear.

Also, this young man was on a cross country to home base from an airport 265 miles away. Enroute weather, according to the accident report, was 400 broken, 600 broken, two miles viz, freezing rain.

Aero club safety officers, here's a good item for your next safety briefing.

CLASSIC FOR THE DAY. The A/C of a four-engine bird recently decided to *overfly* an excellent alternate airfield even though he had one engine caged. He reasoned that since he was maintaining altitude and airspeed he had a "no sweat" situation. He didn't declare an emergency either, just tooled along through the skies watching the pretty cloud formations. When suddenly—yep, you guessed it—he had to shut down another engine. Even his sterling flying ability could no longer force his bird to maintain altitude and airspeed. He started to consider return to the overflown base (less than an hour away) when his aircraft settled the problem for him, low oil pressure light on a third engine. Somewhere in this rapidly degrading situation, our aviator friend (with friends like this who needs enemies?) declared an emergency and headed for the alternate. He also restarted one of his two stopcocked engines and made an uneventful three engine landing. Fortunately, this fellow, his crew and his aircraft all made it to the air patch in one piece.

Rex hadn't heard one like this for years, but apparently such things still occur. I got this from safety briefs from one of the commands.

WHEN THE WIND BLOWS. This is supposed to be the windy—or windiest—part of the year in many parts of the country. Perhaps, but for pilots the windy season lasts 12 months a year, some periods just being a little more so than others. And jocks continue to get into trouble with wind, even though this phenomenon has been well understood since 1903. And they get into trouble in all kinds of airplanes, for example:

- *F-100* During flare for landing right wing dropped and struck runway. There was a gusty quartering headwind at the time. Pilot factor: improper use of the controls.
- *T-33* Report reads almost identically to the one above.
- *A-1E* Just after the aircraft touched down a gust veered it to the right. The pilot was able to stop the veer but could not realign the bird with the runway and finally retracted the gear. Pilot factor: pilot failed to maintain control during gusty wind condition.
- *C-7* Aircraft veered off runway into soft sand during takeoff on a short, narrow SEA strip. Pilot factor: poor technique, failed to maintain directional control. Contributing were gusty winds and the lack of a windsock to provide wind indications.
- *C-47* On takeoff the aircraft went off the left side of the runway, groundlooped and was destroyed. Pilot factor: poor technique, also crosswind in excess of recommended maximum.
- *T-41* The aircraft was being taxied down the runway when a gust of wind overturned it.

Now what can be said about wind and its effect on landings and takeoffs that pilots don't already know? Nothing really, except that these mishaps continue to occur and we strongly suspect that our old enemy complacency is more often than not the culprit. There's no pilot as sharp as one who has just had the h____ scared out of him. So when there's any wind present, especially in gusts, how about running a little scared? ★

SHOULD I QUIT?

A lot of publicity and education have been directed in recent years toward the effects of smoking upon health. Since the Surgeon General's report on the correlation between lung cancer and smoking, considerable energy has been expended in trying to change the smoking habits of the United States population. But the net effect has been rather dismal; cigarette sales in the United States are greater than ever before. Unfortunately, individuals don't believe that "it can happen to them." This article is an attempt to state simply what facts are known so that your decision to continue or stop smoking can be made without the emotion of a TV commercial.

The evidence is overwhelming that there are certain harmful physical effects of smoking. Studies have shown that the incidence of lung cancer is six-fold greater in individuals who smoke one or more packages of cigarettes per day. Heart attacks occur four times as often, and pulmonary disease is three times greater, among heavy smokers.

Lung cancer and heart attacks have received a lot of publicity, but pulmonary disease, which is not generally understood by the average individual, has not been as well publicized. The irritation caused by

Lt Col Robert H. Bonner, USAF, MC, Directorate of Aerospace Safety

inhaling the hot smoke of a cigarette, cigar, or pipe produces changes in the lungs, making it more difficult to exhale which causes trapping of air inside the lungs. This condition is called emphysema. It is a common disease of smokers and can be equally as crippling and fatal as lung cancer or a heart attack.

The statistics involving the harmful effects of smoking are not encouraging if you elect to smoke. But the evidence also indicates that the harmful effects of smoking can be reversed merely by stopping. An immediate effect is the reduction in heart attacks and pulmonary disease. A longer term effect is a reduction in lung cancer.

More pertinent, perhaps, to the aircrew member is the relation of smoking to flying. The smoke from tobacco contains high quantities of carbon monoxide which has a 200-fold greater affinity for blood than does oxygen. Consequently, it is more difficult to induce the blood to give up any absorbed carbon monoxide. A one-pack-a-day or more smoker has enough carbon monoxide trapped in his blood to produce at ground level the same relative amount of hypoxia as a non-smoker has at an altitude of 8-13,000 feet. Therefore, the smoker's tolerance to hypoxia is reduced by the same amount. Any individual's ability to react quickly or make rapid decisions would be degraded if he were subject to oxygen pressure regulator malfunctions or mask leaks. For the smoker the effect would be aggravated.

Another effect on the aircrew member is the reduction in night vision. The blood supply to the retina (vision part of the eyeball) is not very good and must have maximum oxygen to yield good night vision. If 10 or 15 per cent of the blood is tied up by carbon monoxide, the maximum amount of oxygen cannot reach the retina and reduced night vision is the result. This degradation of night vision could pose a problem in night reconnaissance and target acquisition in poorly illuminated areas.

A significant product found in cigarette smoke is nicotine. There is some evidence to suggest that nicotine reduces an individual's G tolerance and his overall ability to cope with unusual stresses such as might be encountered during an inflight emergency. A common effect of nicotine is the increase in stomach acidity (heartburn) and the increase in the irritability of the intestine which can sometimes lead to explosive diarrhea.

Nicotine also causes a marked narrowing of the small blood vessels such as those found in the fingers and toes. This could pose a problem to aircrew members operating in cold environments since narrow blood vessels in the fingers and toes increase the speed of onset of cold discomfort and frostbite.

If, after having read this far, you are considering "kicking" the cigarette habit, here are some suggestions which may assist you:

• If you need some of the nicotine-like drugs which are designed to assist individuals quit smoking, do not take these easily obtained items without first consulting your flight surgeon. All of these items have side effects which can be hazardous in flying, and he can advise you accordingly.

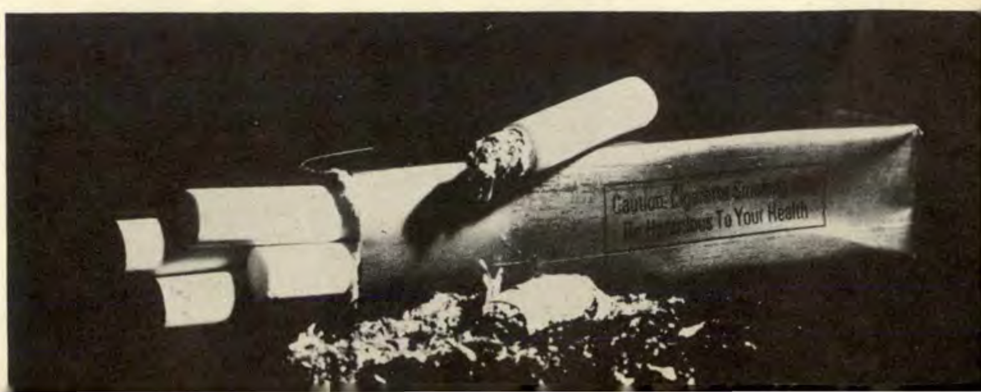
• Statistics show the greatest success rate in those individuals who stop their smoking "cold." Attempts to merely reduce the number of cigarettes smoked per day have usually resulted in failure.

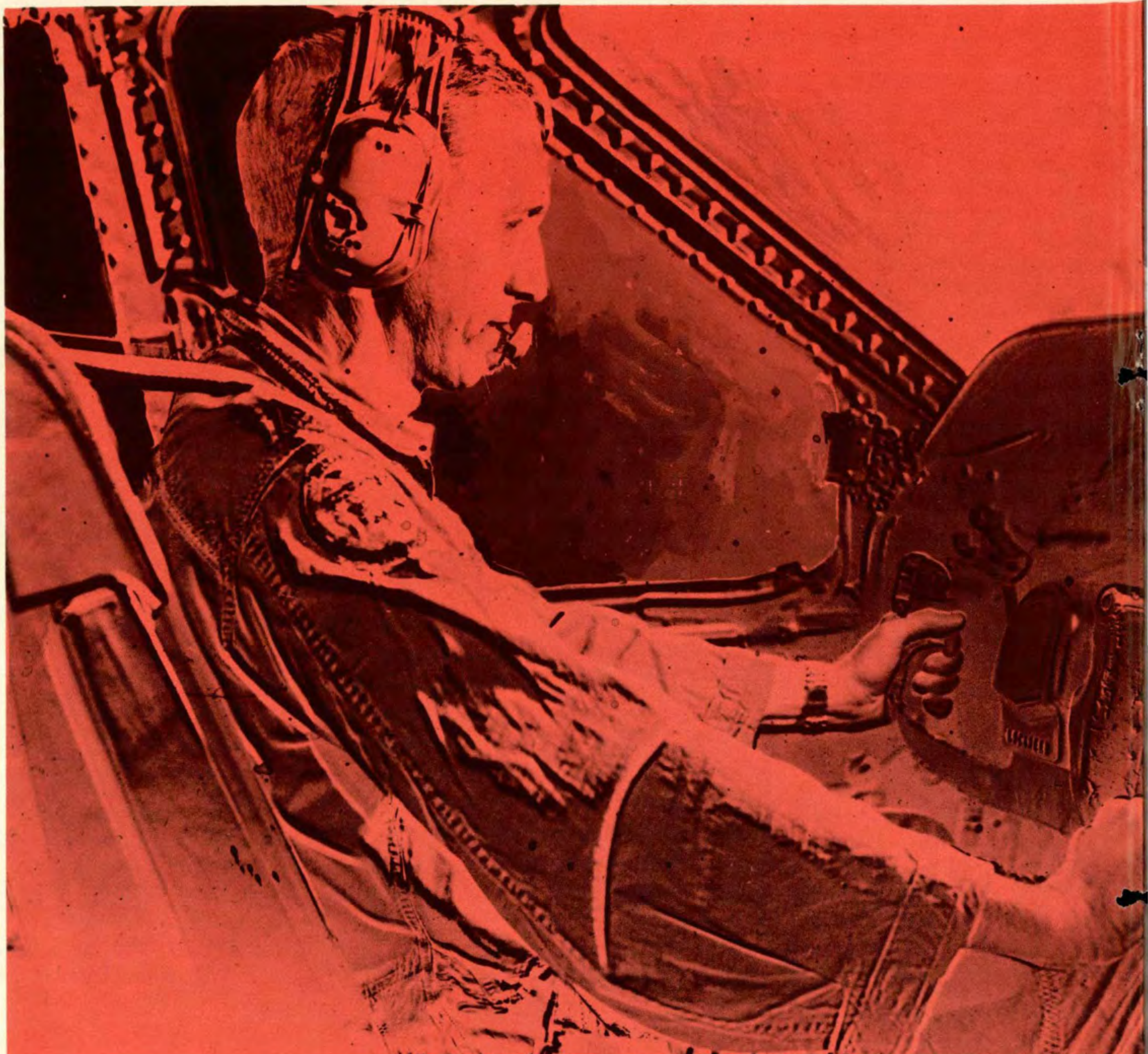
• Statistics also show that switching to cigars or pipes is not very effective because the confirmed cigarette smoker has a tendency to inhale. Inhaling cigars or pipes is far worse from a nicotine-coal tar standpoint than inhaling cigarettes.

• Pay particular attention to your diet, since many individuals tend to gain weight after they have stopped smoking. There are many low-calorie beverages and candies available which can decrease appetite without adding weight.

• Once you have successfully stopped smoking, *do not* under any circumstances ever smoke even a single cigarette again. (I made that mistake and am now faced with having to suffer withdrawal from the cigarette habit again.)

Should you quit? No one but you can really answer that. You now have unemotional facts to consider. The end result will be *your* decision. ★





FLASHBULB IN THE COCKPIT!!

A night penetration through low ceilings, crosswinds and rains is rough enough even without added fireworks displays.

Capt Charles E. Bopp, McChord, AFB, Washington

The mission was set up to rotate aircrews from the States to England. I had flown C-141s from McChord for two years but this would be my first opportunity to fly to Europe since I left SAC three years ago.

The challenge of flying into different areas and unfamiliar bases is always very real for the MAC pilot. I thought back to my previous duty in Europe. I remembered the low ceilings and poor visibility common to England, but also about the good radar coverage that was available. Yes, I could remember quite a number of things about flying in Europe that I would add to the information in the enroute supplements and letdown charts. I certainly could not foresee any unusual problems, and it would be a desired change from the Pacific missions our unit normally flies.

Our itinerary called for pickups at Travis, Kelly and Dover. We would crew rest at Dover prior to proceeding to our destination — Mildenhall.

Saturday morning was a beautiful day at McChord. As we took off, the sun was coming over the crest of Mt. Rainier. Everyone on the crew was in good spirits and looking forward to seeing Europe.

The first day out was really enjoyable, and it was obvious that I was flying with a crew of professionals. All problems encountered were quickly resolved and we arrived at Dover ahead of schedule. After coordinating with Mildenhall ACP we decided to take two extra hours of crew rest. This would give us a better takeoff time in the morning and a better arrival time at Mildenhall.

We were alerted on time, and after a thorough study of the European procedures and letdown plates, we received our weather briefing. The forecast was for good weather enroute with an 800-foot ceiling and one mile visibility upon our arrival at Mildenhall. Greenham Common, our alternate, had a 2000-foot ceiling with three miles visibility. This was even better than I had expected.

This happy state began to sour slightly when we were about one hour past ETP (equal time point). Mildenhall A C P called and requested we change our alternate to Prestwick because Greenham Common weather had just gone below minimums.

For the next few minutes we were busy. I had the navigator compute the fuel with Prestwick as an alternate. He said we would have a thousand pounds to spare. Good! Then I had the copilot call Mildenhall to O.K. the change of alternates and get another forecast for Mildenhall. I called Oceanic Control for a clearance to flight level three seven zero and received same.

About five minutes later we received a new Mildenhall forecast, which called for rapidly deteriorating weather due to a fast moving low pressure area. The winds were forecast from the west at 20 knots with gusts to 25. The ceiling was 1000 feet overcast and visibility three miles in heavy rainshowers. The engineer checked the crosswinds—21 knots, the limit for a wet runway.

The stars were visible above us, but clouds obscured the lights below as we crossed the English coastline. I decided to continue to Mildenhall. The weather was not good and the winds were at crosswind limits, but we had enough fuel for one approach before proceeding to our alternate.

After accomplishing the approach briefing, with special emphasis on keeping track of the crosswind conditions, we completed the descent checklist and called radar control for an enroute descent beginning 125 miles out of destination. How-

FLASHBULB IN THE COCKPIT!! *continued*

ever, we received clearance to descend from 60 miles out. I knew we were on a dogleg to the runway and expected to get down in time with a maximum rate of descent.

During descent we rechecked the winds and found that they were as forecast and the runway was wet. Then I noticed a light out in front of the aircraft — static electricity was building up on the radar dome. I had encountered buildups on the dome before. It beacons out in front of the aircraft like a searchlight and peels off over the canopy with a loud snap.

This buildup was much brighter than any I had ever seen, and I thought about turning up the cockpit light intensity but didn't want to ruin my night vision. We were now passing through 10,000 feet and I anticipated seeing the runway or lights below when we broke out of the clouds.

Then, crack! Like the snap of a bullwhip, the static electricity peeled off the radar dome. The cockpit lit up as if a flashbulb had just gone off in front of my eyes. I couldn't see the instruments. I asked the copilot if he could see, but he was worse off than I. He had been looking out of the windshield when the static electricity peeled off.

I remembered descending through 9000 feet at about 3000 feet per minute. I knew I had to break that rate of descent, so I started pulling back on the control column. I could make out the instrument panel but couldn't focus my eyes sufficiently to read the instruments. I heard approach control calling for a turn, but I couldn't see what heading I was on. I blinked hard, trying to get rid of the spots in front of my eyes.

As the instruments started coming back into focus, I leveled off at 2000 feet and turned as directed by the controller. As the aircraft slowed to 180 knots, we started preparing for landing.

As we passed through 1000 feet the copilot called "Runway in sight at two o'clock." The rain was now striking the windshield like shotgun pellets; I called for rain removal. Now I could see the runway. We were on glide slope at a 45-degree angle to the runway. The surface wind was still at limits and seemed much stronger. As we passed over the approach light I was just about to add power for a go-around when the wind seemed to die off. I straightened the aircraft to the runway and touched down, called for spoilers and applied pressure to the brakes. As we turned off the runway I could feel my knees shaking.

A mission that seemed to be going so well had progressively turned into a near disaster. Should I have left the autopilot on? Or turned up the cockpit light intensity? Was my weather information lacking? Perhaps you can think of some other questions. I know that since that day I always keep an extremely close watch on rapidly changing weather conditions.

There are a lot of tales
Pilots can tell,
Of heavenly delights
And a bit of hell.
Too bad they're usually
Spent at the bar;
Sharing with all is more
Valuable by far. ★

THE TECHNICAL ORDER SYSTEM

Lt Col Joe J. Williams, Jr., Directorate of Aerospace Safety

On the same day that General Washington issued the general order directing his troops on a midnight cruise across the Delaware, another order was issued by Washington's Chief of Logistics, Colonel Zeroba Lance. This order directed the Brevet Major in charge of transportation to make a thorough one-time inspection of the Army's river boats for leaks. The order contained explicit instructions for leak detection and the latest methods for plugging them. Military historians agree that this was, most probably, the beginning of our Technical Order system. They also agree that while Colonel Lance is considered the father of the system, General Washington should also receive some credit because he directed Colonel Lance to accompany him on the crossing. So much for the historical beginning.

From the first Technical Order, the system has grown until we now have over 75,000 TOs, ranging in size from one page to several volumes. Although it would be impossible for one to become familiar with 75,000 TOs, it is important that aviators be knowledgeable of TO categories, Air Force policy on TO compliance, and be reasonably proficient in the use of TO indexes.

The Air Force policy on the use of TOs is clear; the following is quoted from TO 00-5-1: "Air Force weapon systems, subsystems, and Aerospace Ground Equipment (AGE) will be operated and maintained by use of TOs except as specifically authorized by Headquarters USAF." Further, "The TO system is established as the only official medium for disseminating technical information, instructions and safety procedures pertaining to the operation, installation, maintenance, inspection and modification of Air Force equipment and materials." Technical Orders play a critical role in achieving system and equipment readiness; therefore, the importance of full compliance with the system cannot be overemphasized.

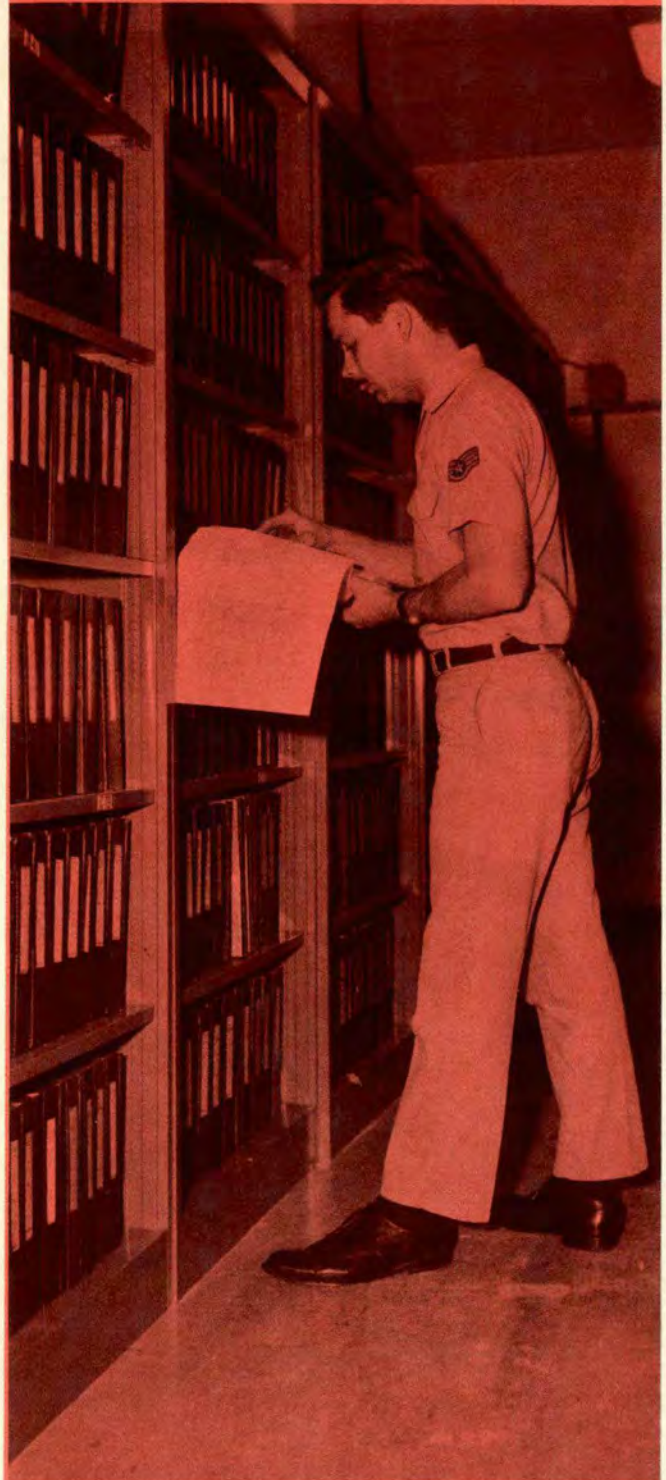
There are six broad types of Technical Orders:

Technical Manuals. These manuals are similar to the service instructions that come with new cars. They contain instructions for maintenance, inspection, and repair of all Air Force equipment.

Time Compliance Technical Orders (TCTOs). These TOs are issued on an as-required basis to modify equipment. They are time-sensitive and always include a suspense date when the modification must be completed.

Methods and Procedures Technical Orders. As their name implies, these TOs contain the rules governing the Technical Order System and the Maintenance Inspection System. They are commonly known as the "Double O Series" because of the first two digits of their numerical designator.

Index Type Technical Orders. These include the numerical and alphabetical indexes, the cross reference tables, and the List of Applicable Publications (LOAP)



The tech order system is the bible for operation and maintenance of all Air Force systems, subsystems and AGE. Therefore, aircrews should have an understanding of the TO system.

for each weapon system. One of the most valuable TOs in the whole system is the alphabetical index, TO 0-2-1, which enables one to find almost any reference.

Abbreviated Technical Orders. These are the inspection work cards, lubrication charts, and checklists used by maintenance personnel. This category also includes the Dash-One checklists used by operations personnel for all of our weapons systems.

Automation Technical Orders. These are the checkout cards and tapes used in many of our missile and later aircraft systems. These are most often electronic query and response checks of Guidance and Bomb-Nav systems.

Each TO number is divided into three or more parts; these parts are separated by dashes. The first part of the number will usually be a TO category as listed below. The first number will usually be the same as the category with the exception of the first two listed. Category 01 TOs (indexes) usually begin with a zero, and the 02 General TOs normally begin with two zeros, "double 0 series." Otherwise, the first number in the TO should conform to the following list. For instance, TO 21M-LGM30-4 is a guided missile TO, more specifically, the Minuteman Dash Four Illustrated Parts Breakdown (IPB). Incidentally, the IPB is an excellent source of visualizing any component within the whole system.

CATEGORIES OF TECHNICAL ORDERS

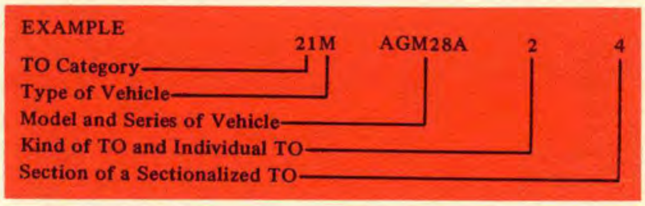
T.O. CATEGORY	TITLE
01	Numerical Index and Requirements Tables, Numerical Index, Alphabetical Indexes, and Cross Reference Table Technical Orders
02	General Technical Orders
1	Aircraft Technical Orders
2	Airborne Engine Technical Orders
3	Aircraft Propellers and Associated Equipment Technical Orders
4	Aircraft Landing Gear Components and Associated Equipment Technical Orders
5	Airborne Instrument Technical Orders
6	Aircraft and Missile Fuel Systems and Equipment Technical Orders
7	Airborne Engine Lubricating Systems and Associated Equipment Technical Orders
8	Airborne Electrical Systems Technical Orders
9	Airborne Hydraulic, Pneumatics and Vacuum Systems Technical Orders
10	Photographic Equipment, Supplies, and Sensitized Materials Technical Orders

11	Armament Technical Orders
12	Airborne Electronic Equipment Technical Orders
13	Aircraft Furnishing, Cargo Loading and Aerial Delivery, and Firefighting Equipment Technical Orders
14	Deceleration Devices, Personal and Survival Equipment Technical Orders
15	Aircraft and Missile Temperature Control, Pressurizing, Air Conditioning, Heating, Ice Eliminating, and Oxygen Equipment Technical Orders
16	Airborne Mechanical Equipment Technical Orders
21	Guided Missile Technical Orders
22	Aerospace Technical Orders
31	Electronic Technical Orders
32	Standard and Special Tools Technical Orders
33	General Purpose Test and Associated Equipment Technical Orders
34	Shop Machinery and Associated Equipment Technical Orders
35	Ground Handling, Support and Base Operating Equipment Technical Orders
36	Vehicles, Construction and Materials Handling Equipment and Equipment and Components Technical Orders
37	Fuel, Oil, Propellant Handling and Associated Equipment Technical Orders
38	Nonaeronautical Engines and Components Technical Orders
39	Watercraft and Associated Equipment Technical Orders
40	Commercial Air Conditioning, Heating, Plumbing, Refrigerating, Ventilating, and Water Treating Equipment Technical Orders
41	Subsistence and Food Service Equipment Technical Orders
42	Chemical, Oxygen, Metal, Textile, Fuels, Cordage, Lumber, and Rubber Materials (Dopes, Cleaning Compounds, Glues, Gases, Lubricants, Paints, Plastics, etc.) Technical Orders
43	Training Devices and Associated Equipment Technical Orders
44	Common Hardware Equipment Technical Orders
45	Railroad and Associated Equipment Technical Orders
46	Office, Duplicating, Printing and Binding Equipment Technical Orders
47	Agricultural Equipment Technical Orders
48	Laundry and Dry Cleaning Equipment Technical Orders
49	Optical, Instruments, Timekeeping, and Navigation Equipment Technical Orders
50	Special Service Equipment Technical Orders

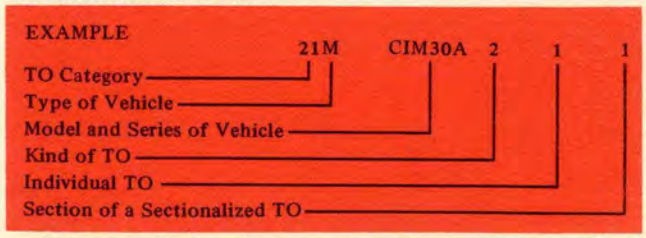
When a TO number has only three parts, the third part identifies the kind of TO, as shown below, except that for general TOs, the third part identifies an individual TO. Numbers -1 to -100 are used for operational and procedural TOs as follows:

-01	List of Applicable Publications (LOAPS)
-06	Work Unit Code Manual
-1	Operational Manual
-2	Organizational (Org) Maintenance (Maint) Manual
-3	Structural Repair Manual
-4	Illustrated Parts Breakdown (IPB)
-5	Weight and Balance Manual
-6	Inspection Requirements Manual
-7	Test and/or Checkout Procedures
-8	Checkout Deck Manuals
-9	Reserved
-10	Engine Build Up Instructions
-11 thru -15	Reserved
-16	Warhead Loading
-17	Storage of Missiles
-18	Field Maintenance-Materiel
-19	Reserved
-20	Reserved
-21	Missile Inventory Record Master Guide
-22	Control Manual
-23 thru -25	Reserved
-26	Non-Destructive Inspection Manual
-27	Calibration and Measurement Manual
-28 thru -100	Reserved
-101 thru -500	General TOs covering several series
-501 and higher	Time Compliance TOs (TCTOs)

When a TO number has four parts, the third part identifies both the kind of TO and an individual TO while the fourth part identifies a section of the sectionalized TO.



When a TO number has five parts, the third part identifies the kind of TO, the fourth part identifies an individual TO, and the fifth part identifies a section of the sectionalized TO.



Briefly, this has been an introduction to our Technical Order System. Additional information may be obtained by reviewing AFR 66-7, TO 00-5-1, and TO 00-5-2. As Rome took slightly more than one day to build, so will your full knowledge of the TO system. The more you work with them, the more you will appreciate the truth of that age-old Air Force proverb, "When all else fails, go by the book." ★

A SHOCKER!

Lt Col William Robinson, Jr., Directorate of Aerospace Safety

Surely you have had the thrill of an electric shock. Most of us have. Unfortunately, there are those who have had this thrill and are no longer among us. Why is it that sometimes this phenomenon produces only a minor jolt, at other times fatal injuries?

The amount of electrical current flowing through a human body determines the difference between a minor jolt and a severe shock. When you accidentally come in contact with a live electrical circuit, you have absolutely no control over how much current will pass through your body. You receive either a minor or severe shock.

Now, having stated the obvious, let's review a few of the electrical accidents that occurred in the USAF in the past year.

"An A2C had just reported for duty at 2400 hours and was performing maintenance on an MW-2 transmitter when he received a severe electrical shock. All efforts at resuscitation were futile and airman was pronounced DOA at the USAF hospital."

"An A1C was performing maintenance duties on an electrical switching station and was in process of replacing a slack span that had been removed for maintenance purpose when he touched a high voltage line. He died the day following the accident."

"A Sgt and another person were putting up a neon sign when a ladder slipped onto a high tension wire, causing both men to be electrocuted."

"A SSgt was working on his radio antenna when wind blew it against a high tension wire. He was removed to base hospital but did not respond to treatment."

Those five men died needlessly, victims of either carelessness or ignorance of the risks involved in what they were doing. Knowledge can save your life, so here are a few simple facts about electricity and electric shock. An individual receives an electrical shock whenever any part of his body becomes part of an electrical circuit. He is exposed to injury in two ways: First, nerve shock, if great enough, will cause stoppage of heart or lungs, or both; second, the heating effect of the current may cause severe burns where the current enters or leaves the body. The nature of electricity is such that it will always follow the path of least resistance to complete its circuit.

The flow of current is governed by Ohm's law, which says that one volt will cause a current of one ampere to flow through a circuit having a resistance of one ohm. This relationship between electrical pressure (voltage), amount of current (amperage), and resistance to current flow (ohmage) is written:

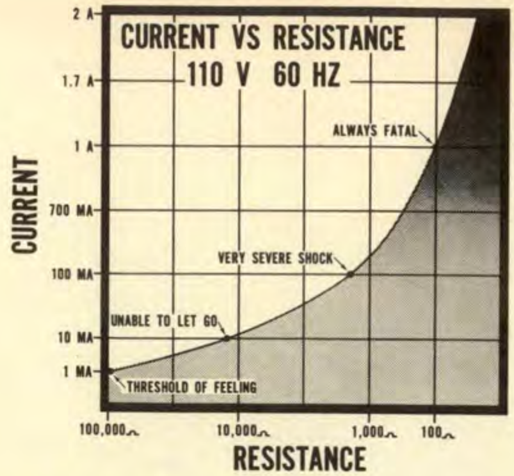
$$\text{Volts} = \text{Amps} \times \text{Ohms}$$
or
$$\text{Amps} = \text{Volts} \div \text{Ohms}$$

An ordinary dry wooden floor has high resistance. Good soles on your shoes have considerable resistance if they are dry and free of nails. Also, skin has considerable resistance if it is dry and clean. Under everyday conditions, the resistance of floor, shoe sole, and skin is high enough that contact with a 110 or even a 220-volt circuit will give only a slight shock. (Figure 1.)

The person who says, "I can eat that stuff," hasn't made contact with a live conductor under conditions that furnish a low-resistance path through him. Under low-resistance conditions he would become either a dear departed or a convert. You should think of electricity as a live force trying to get to ground or to the other side of a circuit. It is kept from completing this circuit by insulation of some type (dry air has a high insulating value). If insulation is reduced to a low enough value the circuit will be complete and current will flow.

Suppose you plug in an extension cord and grasp it where the wire is bare. Say your hand is dirty or sweaty, your feet are wet, and you are standing on a steel floor or on wet ground. Under these specific conditions the resistance of the path of electricity from the extension cord through the skin of your hand, through your body and feet, and on to the ground may be only a few hundred ohms. Estimate it as 1000 ohms. The current you would receive from an ordinary light circuit (100 volts) would be

$$\text{Amperes} = 100 \div 1000$$



or just over 1/10 ampere. This amount of current has been proven to be more than enough to kill.

For any given voltage, the injury incurred depends upon the amount of current, the course it takes through the body, and the length of time the individual is part of the circuit. The amount of current flow will depend upon the voltage of the circuit contacted and the resistance of the circuit of which the individual's body is a part. One-tenth of an ampere of current or less can kill and all ordinary light circuits have this potential. The hazard is no greater for a 10,000 ampere circuit than for an ordinary lighting circuit if the voltage and resistance are identical.

For safety's sake, and your health's sake, you should always make sure, when working with or around electrical circuits or electrical apparatus, that your body doesn't furnish a low resistance path for significant current flow.

If the floor is wet, your clothing is wet, you are sweaty, or you are in a tank or on a metal floor, the path of resistance through your body is likely to be so low that a fatal shock might be received from a circuit of 50 volts or less. Well-documented instances of deaths from 50-volt circuits are on record.

Electrical shock of any intensity instantly produces involuntary muscular contraction. This is of vital importance in close quarters, such as in a tank, or while you are doing overhead work. Muscular contractions may break the circuit, freeing the individual, or may cause him to grasp the conductor more tightly. Unless his grip is released, he can lose consciousness and die slowly. Involuntary muscular contractions of the hand and fingers have been produced by a current of only 1/1000 ampere. Any voltage above 25 volts must be considered hazardous under conditions that are favorable to low-resistance contact.

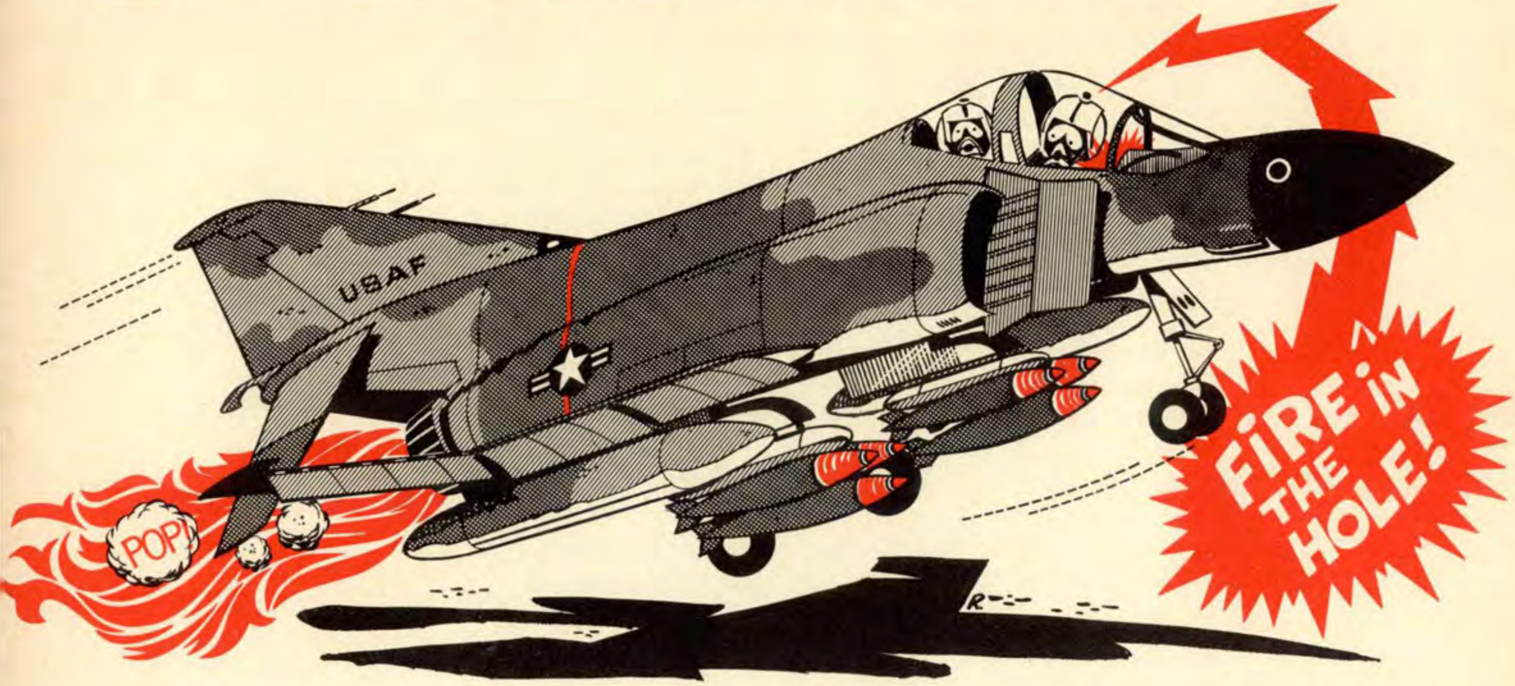
Every individual is susceptible to electric shock and this should be taken into consideration in applying electrical safeguards.

The observance of a relatively few simple rules will eliminate most electrical hazards. For example:

- Always use safety equipment, rubber gloves, fuse tongs, etc.
- Lock and tag switches open before working on circuits.
- Rope off and place danger signs in hazardous areas.
- Do not use metal ladders around electrical equipment, and consider all circuits live until personally proven otherwise.
- Never bridge a fuse.
- Never work alone on live circuits.

Electricity can kill — remember that. Remembering might save your life. ★

AEROBITS



AIR TRAFFIC UP. 1968 was another record year for the Federal Aviation Administration's 27 air route traffic control centers. Preliminary figures show that the centers handled 19.5 million aircraft in 1968—a 17 per cent increase over 1967. Three FAA centers—Chicago, New York and Cleveland—each logged 1.5 million aircraft operations. It was the first year any center had reached the one and a half million mark. (FAA)

LIGHTNING STRIKE. During low level flight the gunner of a B-52 reported lightning struck the ground behind the aircraft. The flight path was along the bottom edge of the clouds with the ground visible. At the time, the crew did not suspect damage to the aircraft, but the postflight revealed numerous broken rivets on the top and bottom of the left wingtip and some scorching. Weather at the time of the strike consisted of stratus clouds, light to moderate rain and light turbulence.

F-4 INCIDENT. Many of the TWX's coming across this desk involve F-4 bashes or incidents, frequently spiced by some form of human frailty. So it's a welcome relief to see one incident where the jock was faced with a critical problem, did the right thing, and brought back a slightly bent bird.

Here's what happened. The young Pursuiter was rolling down a SEA runway in his combat loaded F-4D when, at 170 knots, the right fire warning light came on bright. (Do they come on any other way?) He continued the takeoff and at 220 knots, pulled the offending engine back to idle. Then, since he was able to stay airborne, he shut it off. He jettisoned the external ordnance and made an uneventful landing.

Was there a fire? You bet there was. The afterburner signal hose had ruptured and was spraying fuel in the engine bay.

The story sounds kind of dull, until you consider what could have—and has—happened to pilots who are less prepared for the unusual. According to the book, the pilot had two choices—abort or press on. The pros and cons of these actions will always be argued long and hard. Consider the abort. At 170 knots, aborting *any* heavily loaded fighter is dicey and quite a few end up in the statistics. When this course of action is pursued, the pilot is betting that *all* stopping devices are operating at 100 per cent efficiency in addition to *his* perfect performance. This is a lot to hope for—too much in many cases.

What's on the other side of the coin? Press on—

take off—you are only about 15 knots short of flying speed and here you begin to get some options. Following the dash one, even with the bad engine pulled back to idle, the airplane will get airborne. Once airborne, your ejection capability is increased tremendously—one more block in your favor. Also, you now are buying time: to investigate the reason for the light (is it for real or just a short?), to carry out your emergency drill, to have your wingman check you over, to see how effective your emergency procedure was. In this case, the light went out, the gross weight was reduced by jettisoning ordnance followed by an uneventful landing—a piece of cake—*when you are prepared.*

Lt Col Raymond L. Krasovich
Directorate of Aerospace Safety

NEW BRAKES. Pilots flying the T-39 will be happy to know that this aircraft has something new—not a detergent, not a deodorant, but STOPPING POWER! New brakes.

The new system has 10 pistons, three rotating discs and a pair of stationary discs compared to three, two and two for the original system. Tests on a commercial Sabreliner at 18,650 pounds provided a stop distance of 4300 feet over a 50 foot obstacle versus 6300 feet for the old binders. And, says SMAMA, a service test provided 517 landings before removal for the new brakes compared to 35-40 for the old system.

Caution: New brakes are being provided on an attrition basis and should be installed in pairs. Pilots, check them early and slow. You can see what would happen if you slammed your Nr 12's down on the pedals after landing and only one brake had been changed. And around and around she goes!

MISREADING ALTIMETERS. On page one of the January issue there was an article titled "New Year's Resolutions" in which the author, Lt Col Marshall Norris, referred to several aircraft accidents and incidents. One of these concerned an F-100 pilot who flew a GCA 10,000 feet too high, couldn't complete it, and had to eject.

To new jocks this may seem a bit wild, but there is a long history of similar occurrences. In fact, we received a call a couple of weeks after the magazine went out from a gentleman who had just read the article and recalled a similar event back in 1951. "How come," he wanted to know, "we haven't learned to prevent such odd-ball accidents?" Good question.

We were a bit bothered by the statement that a GCA *could* be flown 10,000 feet off. Height finding capability is implicit for GCA radar. Now, if you are talking ASR that's another thing. But GCA (PAR) means that the pilot has the assurance of altitude information.

So much for the semantics of the problem. We are reminded of an accident that occurred back in 1965 when two pilots punched out of a T-33 after seven attempts to land. They were apparently misreading the altimeter by 10,000 feet. In retrospect it does seem a bit incredulous that they could goof seven times and not catch on. The crew took the rap for the accident, but did that solve the problem? Apparently not, if it still occurs.

We can't help but wonder what the radar types were thinking when they couldn't get the T-bird on the scope. But apparently the 10,000-foot error didn't occur to anybody, controllers or pilots, even though no one on the ground heard or saw the bird and the crew never saw the ground. The weather during this series of landing attempts was bad but not impossible.

The crew offered a rebuttal in this case and there was a dissenting opinion by one of the accident investigation board members. But the cause remained pilot factor.

New altimetry—tape and the counter drum pointer types—plus attrition will eventually solve this problem of altimeter misreading with the old round, three needle instrument.

Meanwhile, if you're flying a bird with this gage, check carefully, especially when you're having trouble getting radar contact. Of course, controllers should double check with the pilot under these circumstances. If both are on the ball, this easy-to-make error should be quickly corrected.

However, when descending IMC, without precision radar, without altimeter-transponder coupling, please read the dial carefully. These birds don't make good submarines. ★

GEAR-UP ACCIDENTS/ INCIDENTS

The last two issues of *Aerospace Safety* magazine have featured gear-up accidents or incidents, including a KC-135, C-123B, A-1Es, etc. There is an answer for most of these—a sure fire way to make sure that the gear warning horn is ON, unsilenced, on a wheels up approach.

Part of the problem is a lack of aerodynamic change due to gear extension. The KC-135 flies the pattern about the same, gear up or gear down. So do most other aircraft, particularly multi-engine types.

Have you heard of many people making inadvertent flaps up landings? The nose high attitude, sloppy feel, and lack of drag are immediate warnings. Furthermore, how many instances are there to select landflaps without intending to land?

Most, if not all of the inadvertent gear-up landings could have been prevented if the landing gear warning horn was wired through the landing flaps setting. The gear warning horn should come on whenever a landing flap setting is selected while gear is retracted. *This warning should not be cancellable.* On the C-135s, the horn would sound with a flap setting of 40 or 50 degrees; with an F-104, "land" flaps; T-33, full flaps; F-5, full flaps; etc.

If there is an aircraft which routinely uses a landing flap setting while maneuvering (I've logged 38 types and haven't come across one yet), perhaps the horn could be silenced only while holding in an unused button on the stick, having copilot hold in warning silence button, etc.

Since I'm currently on exchange with the Canadian Armed Forces, I don't have access to the USAF Suggestion Program forms. If you would like to submit the paperwork for me, I'll be happy to share the money earned by saving one C-135, two A-1Es, two C-7As, etc.

Maj James M. Reed, Jr
Aerospace Engineering Test Establishment
Ottawa, Ontario, Canada.

A check around this Directorate revealed no consensus. Suggestions forms are on their way.

"THE HOOK AND THE BAKS," AEROSPACE SAFETY, NOV. 1968

The subject article, a reprint from the December 1966 edition, is incorrect, and not in accordance with the technical orders used in the operation and maintenance of the F-105 aircraft... The referenced article conflicts with data published in T.O. 1F-105B-1 and T.O. 1F-105D-1. These flight manuals contain charts with barrier engagement speeds as developed by competent engineering. These charts are based on a yield strength of 45,000 pounds. This figure was developed through a stress analysis of the entire arresting hook system and other components of the F-105 and not only the hook, which is not the limiting factor. The data in *Aerospace Safety* was developed using a hook yield strength of 57,500 pounds. This information was not obtained from nor coordinated with the F-105 SM, the office responsible for such data. This greater figure will allow higher engagement speeds, than are presently authorized by the official manuals. Not only is this misleading to air and maintenance crews it can lead to confusion and possible catastrophic failure...

Hernley L. Madeira
Deputy Director
Materiel Management, SMAMA

F-105 users take note.

AEROSPACE SAFETY

In keeping with the policy, as set out in Aerospace Safety Magazine, I am writing to you to advise that as Associate Editor of the California Chapter, Flying Physicians Association bulletin, I will be reviewing this magazine, along with a host of others, and request your approval for an occasional direct quote from the magazine. I was fortunate in seeing a copy of your magazine at a recent meeting, and it does contain a wealth of material which is of interest to my group.

Any advice or recommendation which you may have will be duly appreciated.

Marvin B. Hays, M.D.
California Chapter
Flying Physicians Association, Inc.

Feel free to quote us anytime you wish. If you desire to use an entire article, we would appreciate a written request. ★

UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Accident Prevention Program.

☆U.S. GOVERNMENT PRINTING OFFICE 1969 341-216/8

MAJOR

Robert D. Russ

FIRST LIEUTENANT

Douglas M. Melson

391 Tactical Fighter Squadron, APO San Francisco 96519

On 20 April 1968, Major Russ and Lieutenant Melson were scheduled to fly the second aircraft in a flight of two F-4Cs departing Cam Ranh Bay Air Base, RVN. The aircraft was loaded with BLU-27 napalm canisters—two on each inboard wing station triple ejector rack (TER) and two on a centerline station multiple ejector rack (MER). There were also two 370-gallon external fuel tanks loaded on the outboard wing stations.

Just as the aircraft broke ground, the crew heard a muffled thump and a slight wing drop occurred. All instruments were in the green, and the gear and flaps retracted normally, so they believed it might have been caused by jetwash. But shortly departure control relayed from the tower that a wheel had separated on liftoff.

Major Russ immediately slowed the aircraft to below 250 knots. Then with Nr 1 on his wing, he lowered the gear and had the other aircrew examine it. The left main wheel assembly and part of the lower strut (10 inches by later measurement) were missing, and several hydraulic and electrical lines appeared to be severed.

After discussion with the command post, Major Russ and Lieutenant Melson elected to make a gear-up landing on the wing tanks with an approach end barrier engagement. They jettisoned the ordance in the ocean jettison area and attempted to jettison the suspension equipment also. The two TERs jettisoned normally, but the centerline MER would not separate. All known methods of jettisoning were tried but the MER remained attached to the aircraft.

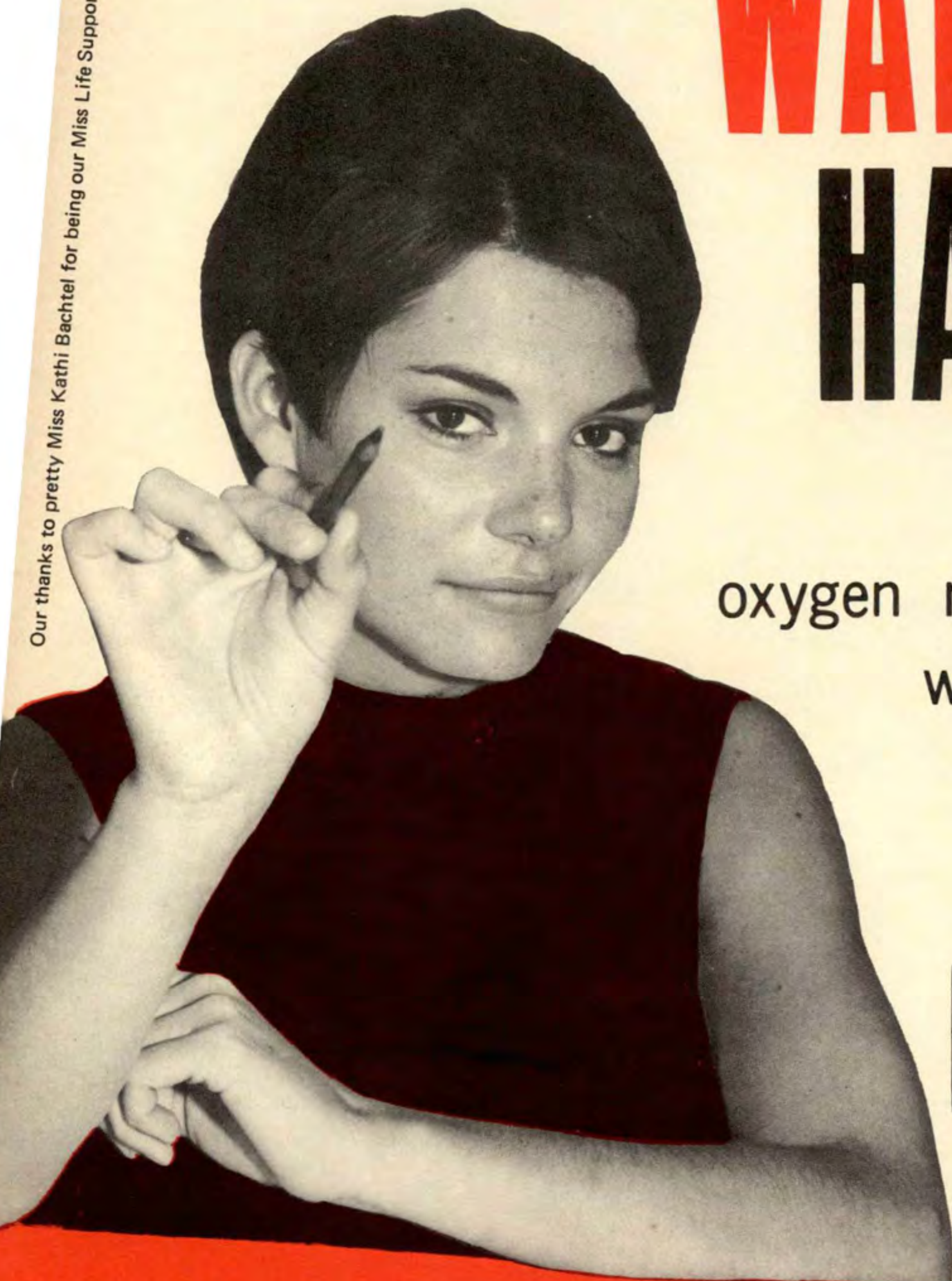
The runway was foamed from 600 feet short of the approach end barrier to 1000 feet beyond it. After exhausting the fuel in the external tanks, dumping the internal wing fuel, and burning the fuselage fuel down to 4000 pounds, Major Russ and Lieutenant Melson made one practice approach to the runway. The approach was made with one-half flaps, gear up, with the airspeed "on-speed" plus seven knots. They flew a wide closed pattern, lowering the hook on the down-wind leg, then made a smooth shallow descent, allowing the tailhook to touch the runway just short of the foam. They eased the aircraft onto the runway in a very smooth landing, touching down 600 feet prior to the barrier at the start of the foam. A momentary flash of flame from the right wing tank was extinguished by the foam. The aircraft came to rest 760 feet past the barrier. The left wing tank had burst into flame but the firefighters extinguished the fire.

Aircraft damage was limited to the external wing tanks, the IR dome, and minor damage to the ailerons. Although the MER and the MAU-12 armament pylons were damaged, the aircraft suspension points for these racks were undamaged. The gentle touchdown was cited as a major factor in keeping the damage as low as it was.

Because of Major Russ' and Lieutenant Melson's crew coordination, skill and professionalism, they were not injured and a valuable aircraft was saved. WELL DONE! ★

Miss Life Support Says..."

WARNING: HAZARD!



The CRU-60/P oxygen mask disconnect warning device...

CAN BE BYPASSED!

Our thanks to pretty Miss Kathi Bachtel for being our Miss Life Support this month.

The CRU-60/P, oxygen mask to regulator connector, contains an oxygen disconnect warning valve which makes inhalation difficult when the regulator hose becomes disconnected from the CRU-60/P. However, a break in the oxygen delivery system upstream ("A") or downstream ("B") from this connector will produce no warning! A serious hypoxic incident occurred without warning when the regulator hose became disconnected from the regulator.

CHECK ALL CONNECTIONS AND HOSES! CHECK THE BLINKER!