Flying SAFETY

Deadly Winds

One Zero Ways to Bust Altitudes

Decoding Mother Nature

Low Approach or Missed Approach?

AUGUST 1993

WEATHER

THERE I WAS

■ Training students in the little Tweet was hardly something you bragged about. It was slow and it was noisy. It didn't go very fast and it was noisy. In the summer it was hot and it was noisy. It took forever to climb high enough to do spins. But it sure was a good teaching tool. I learned a lesson almost every time I flew.

On one summer sortie at a Southwestern base, I had climbed to the top of the high areas to accomplish some needed spin training. During the brief time we were at altitude, the typical afternoon buildups started. Eventually we were squeezed into one corner of the area in order to avoid spinning above the clouds. When Center announced the SOF's weather recall for potential thunderstorms over the base, I was ready to go home.

Looking from our area back toward the common recovery point out of the areas, I noticed two of the bigger towering cu's on either side of our usual route. Neither had reached much over 20,000 feet, and neither had anything resembling an anvil. I couldn't even see anything falling from the bases.

Since we were the only Tweet in the areas, I was given an immediate descent to the recovery point. The two buildups appeared to be about 10 miles apart, so I planned to fly between the two towering clouds columns and stay in the clear all the way home. It looked like the sky between them was blue and clear. At 200 KIAS, with the speedbrake extended, and using frequent valsalvas, we were "racing" downhill for home.

Suddenly, we flew into a rainshower. The precipitation was so heavy, we lost all forward visibility. The noise was so great, we couldn't hear each other over the intercom. The shower lasted for about 7 or 8 seconds. As suddenly as it started, it was over and we were back in the clear. I had hardly had enough time to get my cross-cockpit instrument scan going.

Before I had a chance to say a word, the student muttered "Jeeez!" from the left seat.

"What is it?" I asked.

"Look at the wing," he answered.

I leaned over to see what was wrong with the left wing. I really couldn't see anything and he finally said, "It's the intake."

Looking over my own canopy rail, I saw the fiberglass intake was thoroughly stripped of paint and a lot of it had been delaminated. I declared a precautionary recovery with the SOF and returned straight home without a stop at the Aux field.

The Safety shop and the fire department met us as we cleared the runway. Before we could unstrap and climb out, all of the people on the ground were pointing at our jet and walking closer for a better view. After stepping over the side, I was as speechless as the people who met us. Every light (taxi light, "passing" light, wing tip, beacon, and strobe light) was gone. The entire speedbrake surface looked like a wild man with a ball peen hammer had pounded every square inch. The fiberglass intakes and the leading edge of the wingtips were stripped of paint and nearly peeled away as if hit with a giant sandblaster. The leading edge of the vertical and horizontal tails were seriously dented. Clearly, we had not flown through a rain shower. We had spent 7 or 8 seconds in some major hail.

Despite the apparent lack of thunderstorm characteristics, the towering cu's were indeed growing thunderstorms. Even without an anvil, they were capable of producing major hail. My somewhat casual treatment of these clouds led me to believe it was "safe" to fly between them. Blue skies above and small-sized building clouds were no insurance against the power of nature.

Since that day, if I even suspect there's a chance clouds might be potential thunderstorms, I've given them a wide berth. Even the slow Tweet can make double-digit distances around building weather with ease. Besides, even the Tweet deserves better treatment than found around thunderstorms. ■

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GEN MERRILL A. McPEAK
Chief of Staff, USAF

BRIG GEN JAMES L. COLE JR.
Chief of Safety, USAF

COL JOHN R. CLAPPER
Commander, Air Force Safety Agency

LT COL ROY A. POOLE
Editor-in-Chief

PEGGY E. HODGE
Assistant Editor

CMSGT ROBERT T. HOLRITZ
Technical Editor

DOROTHY SCHUL
Editorial Assistant

DAVE RIDER
Art Director

ROBERT KING
Staff Photographer

CONTRIBUTIONS

Contributions are welcome as are comments and criticism. No payments can be made for manuscripts submitted for publication. Address all correspondence to Editor, *Flying Safety* magazine, HQ AFSA/SEDP, 9700 Ave "G" S.E., Ste 282 Kirtland Air Force Base, New Mexico 87117-5670. The Editor reserves the right to make any editorial changes in manuscripts which he believes will improve the material without altering the intended meaning.

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SPECIAL FEATURES

REGULAR FEATURES

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LIGHTNI

AND ITS EFFECT ON AIRCRAFT

There was a time when we knew what to expect when big, metal airplanes were hit with lightning. The growing number of composite structures provides a good excuse to review our knowledge of lightning.

MAJOR WILLIAM N. WAGNER
AFSA

■ Remember way back when you were a kid and you first saw a pitchforked light in an ominous sky? On the way to ask Dad about it, you heard the awesome clap of thunder when it finally got to you. At the very least, it was a very memorable occasion.

The incredible light show brings back thoughts of Moses on Mt. Sinai. No doubt, lightning is something to be revered, yet, also something to be understood. Hopefully, in the next few pages, you'll gain a greater understanding of lightning and how to avoid it when flying.

First, what is this phenomenon we call lightning? Lightning is merely a release of electricity somewhat akin to shocking your friend's ear after shuffling your feet across the carpet. Lightning can occur within a cloud, from one cloud to another, or from cloud-to-ground. Only about 20 percent of lightning is cloud-to-ground.

Lightning can create temperatures twice those of the surface of the sun. Because of the almost instantaneous ionization and expansion created by lightning's heat, a shock wave is formed which comes back to us in the form of thunder.

In order for lightning to occur, you must have the right ingredients. Although "bolts from the blue" have occurred, these are extremely rare. Typically, lightning is associated with clouds. Normally, these clouds are cumulonimbus clouds. The rising and falling air inside a thunderstorm, or convective activity, sets up the motion thought to create the charge imbalance within the clouds.

As water droplets are cooled to -40 degrees Celsius, they freeze and collide. They break apart and transfer ions — the bigger piece becoming negative and the smaller piece becoming positive. The heavier piece drops through the atmosphere down to the bottom of the cloud taking its negative charge with it. The small piece is taken aloft by convective activity, thus depositing a plus charge at the top of the cloud. So, a charge imbalance exists within the cloud.

Air is a great insulator. But when the difference in potential reaches a critical value, even air cannot stop the cascade of electrons which flows.

As the resistance of the air is overcome, the discharge starts through the first of its various stages. Initially, a "stepped leader" moves slowly along (relatively speaking) as it ionizes the air in its path. A conducting filament then carries the current from the cloud to its destination. Filaments can branch off in any direction but generally point in the direction the current is traveling.

The lightning, in the form of a return stroke, becomes visible as it shoots up the ionized path into the cloud. In a few microseconds, the lightning stroke is formed.

The subsequent leader is called a

NG

"dart leader" which will take the same path as the original leader. The lightning stroke will typically consist of three or four leaders followed by their respective return strokes. The whole scene can last up to a full second. This, then, is lightning.

When aviation was still young and the Wrights were still worried about whether or not the *Wright Flyer* would actually fly, people were not concerned about lightning strike protection. However, in 1940, a DC-2 crashed near Lovettsville, Virginia, due to a lightning strike. An interagency governmental task force was formed to study the effects of lightning on aircraft. Few incidents happened and interest waned.

Then, in 1959, a TWA *Constellation* was apparently struck by severe lightning on climbout from Milan, Italy, resulting in explosion of the fuel cells and the deaths of all aboard. A new "blood priority" drove standards for aircraft lightning protection still used today.

Recent studies have been motivated by an attempt to understand how lightning affects advanced composites or solid state electronics. And just so we do not think modern aircraft are invincible, let's look at the following mishap.

An F-15 in the clouds at FL 330 was receiving vectors around thunderstorms. Lightning struck the Eagle, exploding the external tank, sending shrapnel into the fuselage fuel tank and severing the right engine throttle cable. The right engine

continued

LIGHTNING AND ITS EFFECT ON AIRCRAFT

continued

Designed to dissipate static buildup on aircraft, these "whiskers" were unable to handle the tremendous surge of a lightning strike.

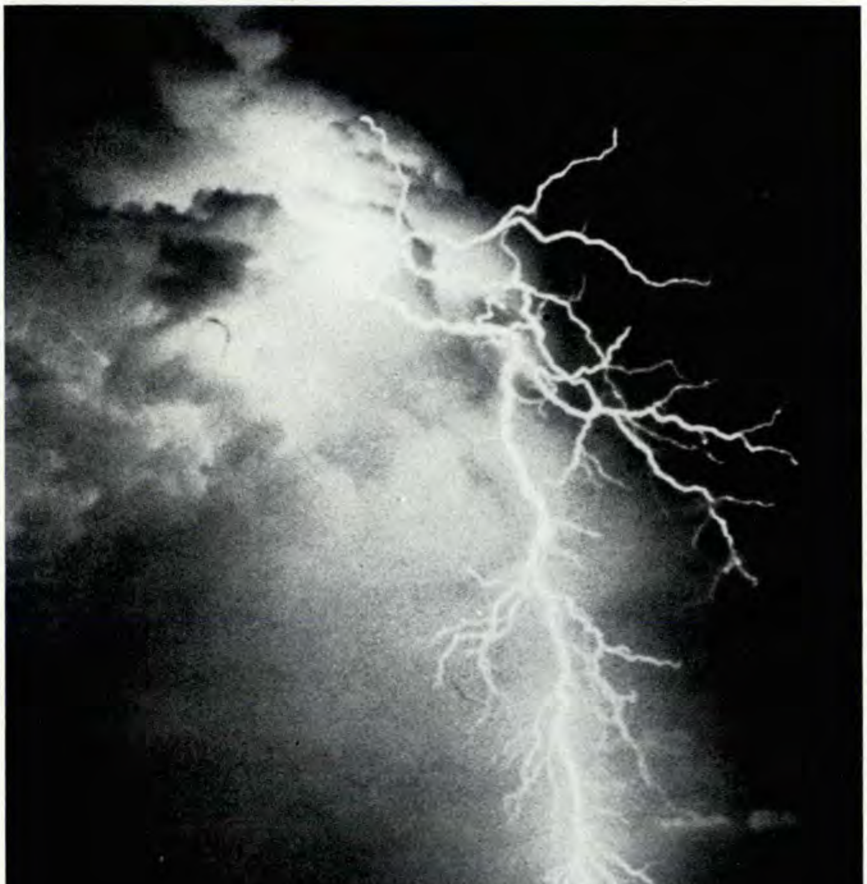
remained stuck at 82 percent. The fuselage fuel leak caught fire. The mishap pilot made a single engine landing at the nearest base.

How, exactly, does the aircraft interact with a lightning-potential environment? According to data from actual aircraft lightning strikes, most lightning strikes occur within 8 degrees Celsius and 5,000 feet of the freezing level.

From 1980 to 1983, NASA completed a study using an F-106B. It was intentionally flown into thunderstorms to determine if previous information was still true. To everyone's great surprise, the level of highest threat was actually from 36,000 to 40,000 feet at a temperature of -40 degrees C to -45 degrees C.

There is some explanation for the differences. Typically, pilots at higher altitudes can deviate around these areas because they can see them, but at lower altitudes during departure and arrival, flight paths are more or less established. Another surprising statistic was the lack of correlation to turbulence or precipitation.

The frequency of strikes above 18,000 feet was considerably higher than that of flying below the level of the thunderstorm. However, the strength of the bolt was greater when flying lower due to its generally being a cloud-to-ground strike rather than the less potent cloud-to-cloud variety. The aircraft itself triggered 90 percent of the lightning strikes.



The pilot is always the last link in the chain. No computer yet designed can assimilate all the variables and arrive at the best course of action as well as the human. Here, then, is a list of techniques to fill up your clue bag where lightning is concerned.

- Avoiding areas of known thunderstorms is undoubtedly the best solution of all.
- Check frequently with Center or Flight Service along your route for any areas of buildups.
- Avoid the anvil of a thunderstorm. Even a dissipating thunderstorm can leave a significant charge there.
- If possible, stay away from flying in the clouds so you can see what's out there. If that won't work, have an operational weather radar. Finally, give METRO or Center a call and ask for thunderstorms in your flightpath.
- Picking your way through the only opening in a line of thunderstorms for hundreds of miles will only get you into trouble.
- Stay at least 20 miles away from a thunderstorm.
- Fly radar trail or separate vectors in areas of lightning.

Although flying at the higher altitudes can be more hazardous, flying at any altitude can still be life threatening when done near a thunderstorm. April and May are the highest threat months.

Two ways to combat the lightning threat are through proper regulation and design and also through pilot awareness.

The aircraft itself is able to protect its own most vital organs due to shielding techniques. First, you must know what subsystems are normally hindered. Older aircraft were typically made with an aluminum exterior. This insulated the vital working parts and gave a path for the electricity to flow through. With the advent of composites, various other techniques must be employed.

Composites can have metal strands woven into the material. Another method is to place a metal screen near the surface between layers of composite. These strands of metal shield the underlying fuel cells and electronics from lightning.

It becomes trickier when trying to divert an arc inside a composite fuel cell. Critical design areas are filler caps and suspension equipment. These have historically created the most problems. Finally, the conversion from the more volatile JP4 to JP8 will take the ambient fuel temperatures out of the range of combustible vapor temperature.

You can enjoy the beauty of an afternoon light show only when the jet is safely put to bed and you're sitting with your feet propped up. The more we know about lightning, the better this idea sounds. ■

Depending on the nature of the structure, the damage of an exiting lightning bolt may be minor or catastrophic. The structural integrity of this nose cone was lost when the bolt exited at a seam.

■ But how do we protect these vehicles we strap on and hurl through the air? In order to more fully delve into the area of aircraft protection, we need to understand how lightning and aircraft interact. The Federal Aviation Administration has defined this for us under the title "Lightning Strike Zone Definitions."

Zone 1a: Initial attachment point with low possibility of lightning hang-on.

1b: Initial attachment point with high possibility of lightning hand-on.

Zone 2a: A swept stroke zone with low possibility of lightning hang-on.

2b: A swept stroke zone with high possibility of lightning hang-on.

Zone 3: All other areas not in 1 or 2. It may carry substantial current but has a low possibility of attachment of lightning. These zones are defined in MIL-STD-1757.

As the lightning strikes the aircraft, it must enter one place and leave at another. These are cleverly called entry and exit points. The exit point is normally in Zone 1b at a trailing edge. Since the lightning bolt remains relatively stationary and the aircraft continues to move through space, the lightning attachment or entry point will continue to move aft on the aircraft. The lightning will "sweep" aft on the aircraft; thus, it is called a swept stroke. These points then will lie in Zone 2b. These are shown on figure 5.

As the lightning strike sweeps back, the entry and exit points can eventually come in close proximity to each other.

Lightning will normally last longer than one-fourth of a second. In this time, a fighter will usually travel its own length. So the normal path for it is to enter at the pitot tube and exit at the stabilator. The attachment point will move aft through Zone 3 until both the entry and exit attachment points are nearly together on the stabilator. Flashes which get near the inlet of the aircraft can cause compression or ionization of the air, thus setting up the opportunity for stalls and loss of thrust.

Note: This condition does not normally occur in the F-16 due to the overhang of the cockpit area which, in a sense, protects the inlet. ■

Large Aircraft Ground Deicing

The following is not directive. Rather, it lets us all see how the FAA approaches icing and deicing. Ed.

■ Federal Aviation Regulations (FAR) prohibit takeoff when snow, ice, or frost is adhering to wings, propellers, control surfaces, engine inlets, and other critical surfaces of the aircraft. This rule is the basis for the **clean aircraft concept**. It is imperative takeoff not be attempted in any aircraft unless the pilot-in-command (PIC) has ascertained all critical components of the aircraft are free of frozen contaminants.

The clean aircraft concept is essential to safe flight operations. The **PIC has the ultimate responsibility** to determine if the aircraft is clean and the aircraft is in a condition for safe flight. This requirement may be met if the PIC obtains verification from properly trained and qualified ground personnel that the aircraft is ready for flight. The general consensus of the aviation community is that a critical ingredient in ensuring a safe takeoff in conditions conducive to aircraft icing is visual and/or physical inspection of critical aircraft surfaces and components shortly before takeoff.

Common practice developed by the North American and European aviation communities is to deice and, if necessary, to anti-ice an aircraft before takeoff. This is accomplished most commonly by the use of heated aqueous solutions of Freezing Point Depressant (FPD) fluids for deicing, followed by anti-icing using cold, rich solutions which are thicker and have a lower freeze point. Several different types of FPD fluids have been developed during the past 40 years, and many are in common use today. Each of these various fluids has unique characteristics and requires handling unique to that particular fluid. More recently developed fluids, such as those identified as International Standards Organization (ISO) Type II and Society of Automotive Engineers (SAE) Type II, will last longer in conditions of precipitation and afford greater margins of safety if they are used in accordance with aircraft manufacturers' recommendations. *If improperly used, these fluids can cause undesirable and potentially dangerous changes in aircraft performance, stability, and control.*

Ground deicing and anti-icing procedures vary depending primarily on aircraft type, type of ice accumulations on the aircraft, and FPD fluid type. **All pilots should become familiar with the procedures recommended by the aircraft manufacturer** in the Aircraft Flight Manual (AFM) or the maintenance manual and, where appropriate, the aircraft service manual.

Aircraft icing and frost accumulations on the ground cause a serious risk for safe operations. Most of the recent mishaps associated with this risk have been in the civilian community. However, global reach places nearly every Air Force crewmember in a position to deal with this problem.

Preflight Icing Checks

The following list provides key points regarding aircraft deicing and anti-icing procedures.

- Most icing-related mishaps have occurred when the aircraft was not deiced before takeoff attempt.
- The deicing process is intended to restore the aircraft to a clean configuration so neither degradation of aerodynamic characteristics nor mechanical interference from contaminants will occur.
- It is essential the PIC have a thorough understanding of the deicing and anti-icing process and the approved procedures necessary to ensure the aircraft is clean for takeoff.
- A post-deicing/anti-icing check should be performed during or immediately following the ground deicing and anti-icing process.
- A pretakeoff check may be required before takeoff roll is initiated. The pilot may need the assistance of qualified ground crews to perform pretakeoff checks.
- Ice, frost, or snow on top of deicing or anti-icing fluids must be considered as adhering to the aircraft. Takeoff should not be attempted.
- Flight tests performed by manufacturers of transport category aircraft have shown most SAE and ISO Type II fluid flows off lifting surfaces by rotation speeds (V_R). Some large aircraft experience performance degradation and may require weight or other takeoff compensation. Degradation is significant on small airplanes.

There are many different methods used to deice USAF aircraft. Each location with extreme weather may have a different way to help crews achieve a clean aircraft prior to takeoff.

Clean Aircraft Concept

Test data indicate ice, snow, or frost formations having a thickness and surface roughness similar to medium or coarse sandpaper on the leading edge and upper surface of a wing *can reduce wing lift by as much as 30 percent and increase drag by 40 percent.*

These changes in lift and drag significantly increase stall speed, reduce controllability, and alter aircraft flight characteristics. Thicker or rougher frozen contaminants can have increasing effects on lift, drag, stall speed, stability and control, with the primary influence being surface roughness located on critical portions of an aerodynamic surface. These adverse effects on the aerodynamic properties of the airfoil may result in sudden departure from the commanded flightpath and may not be preceded by any indications or aerodynamic warning to the pilot. Therefore, it is imperative **takeoff not be attempted** unless the PIC has ascertained, as required by regulation, all critical surfaces of the aircraft are free of adhering ice, snow, or frost formations.

Numerous techniques for complying with the clean aircraft concept have been developed by the aviation industry. The consensus of the aviation community is the primary method of ensuring safe flight operations in conditions conducive to aircraft icing is through visual or physical inspection of critical aircraft surfaces to ascertain they are clean before takeoff. This consensus is valid regardless of the deicing and anti-icing techniques used. ■

IT'S CALLED WIND SHEAR

PEGGY E. HODGE
Assistant Editor

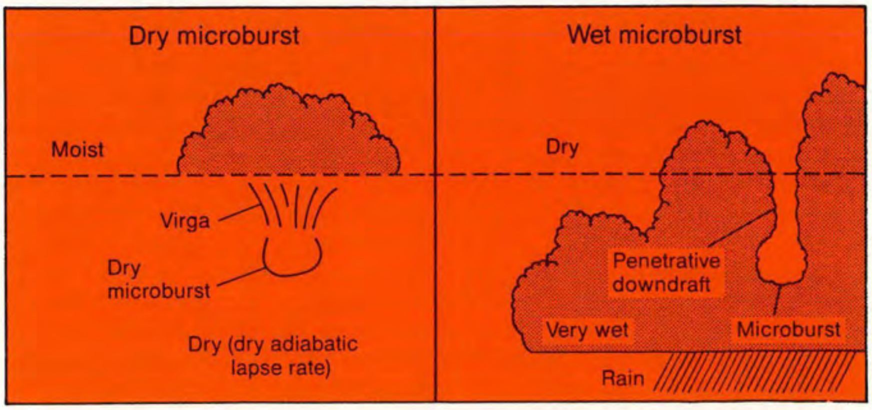
wind shear (wind sher), n. a sudden shift in wind direction and/or speed. The most severe form — microburst — is caused when a mass of cooled air rushes downward out of a thunderstorm, hits the ground, and rushes outward in all directions.

■ The tragic results associated with microburst wind shear, in both the commercial and Air Force flying communities, have led to a great deal of research and study. Air Force mishap experience from 1985 to the present tells us each year, wind shear continues to cause us problems — and mishaps. During this period, we experienced at least one Class A, two Class B, and six Class C mishaps.

Even one mishap, especially one involving a life and destroying an aircraft, is one too many. We are currently flying in the thunderstorm season when microburst wind shear is likely to be present. Let's review this very serious phenomenon and maybe we can keep our mishap slate clean in the future.

Wind Shear Is Serious Business!

Wind shear can cause an aircraft to crash and can mean tragedy. Do you remember the Pan American Boeing 727 tragedy in July 1982 at New Orleans International Airport? During liftoff and initial climbout, the aircraft experienced a 40-knot decrease in headwind and subsequent loss of airspeed and lift which caused it to abruptly pitch down. The pilot added full power and attempted to raise the nose. However, recovery was not possible. A few seconds later, all 145 persons on



board and 8 persons on the ground died. The National Transportation Safety Board (NTSB) determined the probable cause of the mishap was microburst wind shear associated with a thunderstorm.

Wind shear *is* serious business. Most who encounter even moderate wind shear without warning could crash. And, even if warned, a pilot *not* trained to respond could crash if severe wind shear is encountered. Our best line of defense to this phenomenon is our knowledge — knowledge of how to detect and avoid, and if avoidance is not possible, recognize and

Detect and Avoid

Microbursts can't be positively predicted or detected in most operational situations, but there are clues we can watch for which add up to a high probability wind shear and microbursts are imminent. One of the more dangerous situations this time of year which can create microburst is the thunderstorm.

The FAA reports two out of every three wind-shear events are related to convective storms. Approximately 5 percent of all thunderstorms produce a microburst. Dangerous microbursts can be generated by any convective airmass, from single cells to supercell thunderstorms. They can occur anywhere convective weather conditions (thunderstorms, rain showers, or virga) occur.

Remember, precipitation signals the beginning of the mature stage of a thunderstorm and presence of a downdraft. After approximately an hour, the heated updraft creating the thunderstorm is cut off by rainfall. Heat is removed, and the thunderstorm dissipates. Many thunderstorms produce an associated cold air, gust front as a result of the downflow and outrush of rain-cooled air. These gust fronts are usually very turbulent and can create a serious threat to aircraft during takeoff and approach.

Be alert for the more severe thunderstorms associated with weather systems like fronts, converging winds, and troughs. These thunderstorms form in squall lines, last several hours, generate heavy rain and possibly hail, and produce strong gusty winds and possibly tornados. They will probably contain large horizontal wind changes (speed and direction) at different altitudes inside the thunderstorm. Whenever possible, avoid thunderstorms! They're TROUBLE!

Wind shear from thunderstorms may initially be very localized as seen in the lower left corner of the upper photo. Despite the wider area of gusts in the lower photo, the wind shear force has not lessened.

Recognize

If your attempts to detect and avoid wind shear fail, the next steps are recognition and recovery.

When an aircraft flies into a microburst, it may initially experience a strong increase in headwind with a resulting increase in indicated airspeed and lift causing the aircraft to pitch up. (Note aircraft A in figure 1.) With no pilot inputs, the aircraft will gradually slow to the airspeed for which it was previously trimmed. Most pilots, however, attempt to correct by reducing power and applying nose down pressure at the onset of the pitch up.

Approximately 30 seconds after flying into the microburst, the aircraft suddenly loses the headwind and picks up a strong tailwind. (Note aircraft B on page 10.) The re-

continued

It's Called Wind Shear continued

sulting loss of indicated airspeed and lift causes the aircraft to pitch down. Pilot reaction would typically be to add power and apply back pressure on the controls. However, this action might be too little or too late if the pilot had just previously corrected for the headwind (reduced power, nose down) and unknowingly compounded the effect of the tailwind.

It's important to review your Dash 1 and its discussion of wind shear and gusts. Since most USAF Dash 1s concentrate on frontal passage shears and gusts, and don't include much about microbursts, we have provided additional information on the microburst. (Please see "Anatomy of a Microburst.")

Recover

Aircraft recovery will depend on pilot reactions, aircraft performance capability, and the altitude at which wind shear was encountered. A sudden loss of headwind at low altitude may exceed pilot and aircraft recovery capability and result in tragedy.

The FAA has published a technique which, while not the best in every case, was found most effective in a wide variety of wind-shear situations. The FAA recovery technique uses pitch attitude and thrust to restore or maintain flightpath control. This recovery procedure is presented here as a starting point for discussion.

NOTE: The process applies to any aircraft, but the specific procedures for flying through wind shear vary according to the flight characteristics of each aircraft. Before you use these procedures, especially the specific pitch attitude references, check your flight manual for possible restrictions!

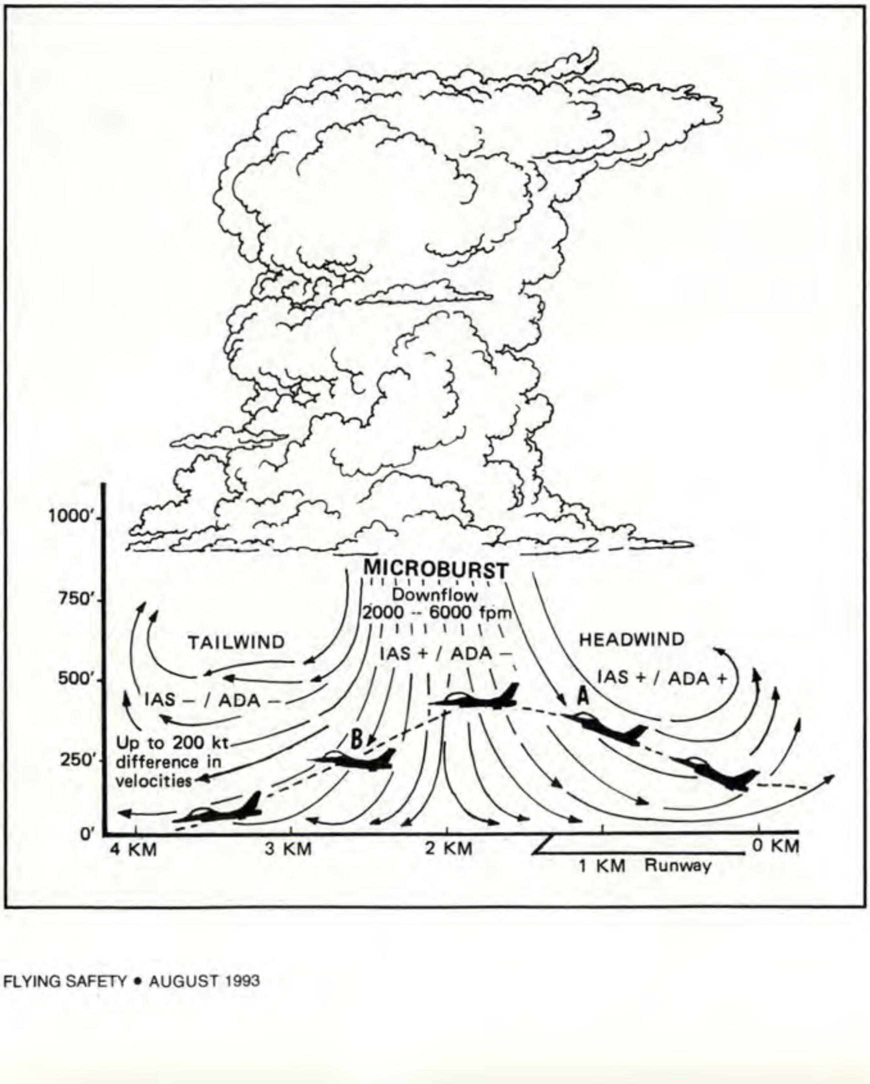
- Again, remember to evaluate the weather for signs of wind shear, keeping in mind that avoidance is the absolute first line of defense against wind shear. Figure 2 is a guide for assessing weather.
- Keep asking, "Is it safe to continue?" Delay the approach or landing until you and your immediate supervisor can definitely answer "YES!"
- Use precautionary procedures when no serious threat of wind shear actually exists, but some of the indicators are present.
- On takeoff, use maximum rated thrust. Maximize available stall margin through runway selection, flap setting, and delayed rotation, all in accordance with the flight manual.
- On landing, select the minimum landing flap position consistent with the field length, add an appropriate airspeed correction for gusts. Avoid large thrust reductions or trim changes in response to sudden airspeed increases. Consider using autopilot/autothrottle to provide more instrument monitoring and recognition time, but manually back up the throttle.
- Compare flight instrument values of pitch attitude, rate of climb or descent, and airspeed to normal values so deviations can be recognized early. The FAA and industry leaders in wind-shear training use the following uncontrolled deviations as indicators of wind shear:

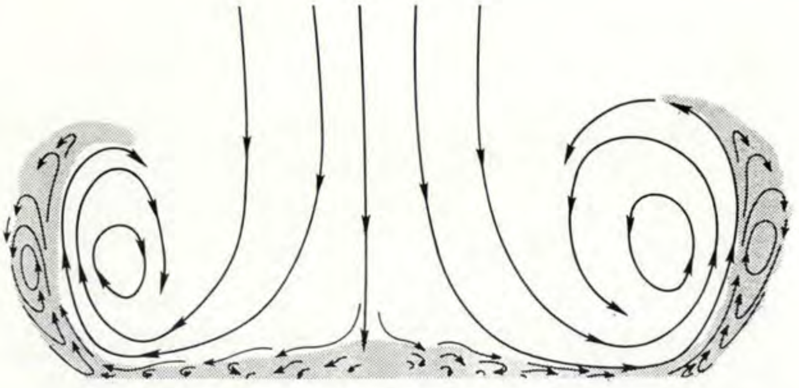
  — 15 KIAS

  — 5 degrees pitch

  — 500 fpm vertical speed

  — More than one dot off localizer glideslope
- Act immediately if an inadvertent wind-shear encounter occurs.
- Use maximum thrust, avoiding engine overboost or overtemp unless necessary to ensure safety.
- Adjust pitch attitude toward approximately 15 degrees. If the resulting flightpath is still not acceptable, consider increasing pitch even further. The pitch attitude may need to be reduced to maintain adequate stall margins. Use the stick shaker/aural stall warning/AOA according to your flight manual.
- Maintain configuration until an acceptable flightpath is restored.
- Remember the pressure changes within the shear area make the pitot-static instruments unreliable. Use pitch attitude, AOA, and radar altitude to measure the recovery.





The internal dynamics of a microburst wind shear involve much more than a headwind or tailwind. Updrafts and downdrafts complicate a safe recovery for aircrews.

- Make a PIREP as soon as conditions permit. If the microburst is still intensifying, you may save the next aircraft!

It's Called Wind Shear!

It's called wind shear, and keeping up with current research, being constantly alert for the signs of wind shear, reacting in a timely manner, and reporting any incident are the best lines of defense against this potential killer. ■

For your information, two publications on wind shear are the FAA Advisory Circular No. 00-54, Pilot Wind Shear Guide, and the U.S. Department of Commerce's handbook, Microbursts — A Handbook for Visual Identification. These materials are available to you from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402.

ANATOMY OF A MICROBURST

PROPERTIES

- A microburst is a violent downward rush of air that flattens out when it hits the ground and spreads in all directions, creating wind-shear conditions.

OCCURRENCE PATTERN

- The Joint Airport Weather Studies revealed microburst events tended to peak in the early afternoon, and again in the early evening, and were generally associated with convective weather peaks.

SIZE

- Because of their small diameter (less than 2-1/2 miles) and short lifespan, microbursts do not affect all departing and arriving aircraft. These small microbursts are usually caused by a heavy rain shaft that generates an intense, violent outflow of air near the ground.

ASYMMETRICAL MAKEUP

- Microbursts may not be symmetrical — the outflow on one side of a microburst might be more severe than the outflow from the other side. In the worst case, this may mean flying into an area is survivable, but flying out of it is not.

WIND VELOCITY

- The average wind speed change from a typical microburst at its peak intensity is nearly 50 knots. This typical microburst will intensify for about 5 minutes after it first touches the ground, and during that time, may increase up to three times its original strength.

DURATION

- Microbursts typically start to dissipate 10 to 20 minutes after ground impact. When you hear a wind-shear report, assume it's in the intensification cycle until you are positive the danger is past. Downdrafts as strong as 3,000 feet per minute have been measured.

CLUSTERS

- A single downburst may generate a series or a cluster of microbursts. The result can be widely varying wind conditions for as long as 20 minutes.

VORTEX RINGS

- A downdraft generates large vortex rings when it hits the ground. These cause extreme rotational moments, along with the wind speed deviations more commonly reported. Another effect is extreme pressure and temperature differentials.

■ The following checklist is offered to help you detect the presence of dangerous wind shear.

- Evaluate departure and arrival weather calling for gusty winds, heavy rain, or thunderstorms, keeping in mind avoidance is the absolute first line of defense against wind shear.
- Look for visual clues of wind shear once seated in the aircraft: Blowing dust or rain, virga, and the old standby, the tornado.
- Include a search for convective SIGMETS during your preflight weather check.
- Check the Low Level Wind Shear Alert System (LLWAS). This is another source of information. The system detects wind speed and direction variances between five outlying sensors and a reference sensor located at, or near, center field.
- Be aware many microbursts are small enough to enter the sensor array undetected!
- Search the weather radar for convective echoes in the terminal area, although in some cases, such as the "dry" microburst (without the usual precipitation), a hazardous wind shear may reflect weak echoes or no echoes at all.
- Listen for PIREPs! The PIREP is one of the best sources of windshear information. Since microbursts are known to move and intensify, though, don't "press on" just because the person in front made it through. ■

WAKE VORTICES:
A PRIMER

In 1972, a DC-9 got too close behind a DC-10 while landing at Dallas/ Ft Worth Airport and crashed, killing all aboard. In 1988, a Yak-40 got too close behind an IL-76 while taking off at Tashkent and killed all aboard. The United States averages about one mishap a month and one fatal mishap a year (mostly to small general aviation aircraft) due to vortices.

ROBERT E. MACHOL, PH.D
Chief Scientist, FAA
Courtesy *Aviation Safety Journal*

■ Airplanes fly because the shape of the airfoil and the laws of aerodynamics reduce the pressure above the wings and increase the pressure below the wings. At the wingtip, the high-pressure air wants to run around from below to reach the low-pressure region above, creating a vortex. However, this is a rather simplistic explanation of a very complex situation.

Generally, "vorticity" is created and shed all along the wing, and a sheet of vorticity then rolls into a well-developed pair of counter-rotating vortices about 10 wingspans behind the aircraft. The pair of vortices tends to stabilize at a distance of about three-quarters of a wingspan apart and sinks a few hundred feet per minute.

The strength of the vortex is proportional to the sink rate. If the vortices are prevented from sinking, they tend to dissipate.

We know a great deal about the initial strength of vortices, between 10 and 40 wingspans behind the aircraft (40 wingspans can exceed a mile). The vortex consists of a "core" in which speeds can be quite high — speeds over 300 feet per second (200 mph) have been measured off a B-757, creating "horizontal tornados." Though the core is very narrow (the radius may be less than a foot for aircraft as big as a B-757), considerable energy remains at much greater distances.

Strength of Vortices

"Vorticity" is related to the speed of the air's rotation. "Circulation" is related to angular momentum — speed plus the lever arm or distance from the center of the vortex — and is the best measure of the strength of a vortex.

Vortices dissipate in three ways. The most obvious, simple frictional erosion, is usually least important. The most common mechanism, which can easily be observed on a clear day by watching contrails, is the "sinusoidal" or "Crow" instability in which the pair of vortices move closer together and farther apart (with a wave length of about six wingspans) in a sinusoidal pattern until eventually they meet. This does not destroy the vortex — it remains as a ring of vorticity.

An aircraft passing through such a ring will be buffeted but is not subject to the violent rolling moments which may cause mishaps. The third method, even less understood, is called vortex bursting because the vortex suddenly bursts and moves axially along the vortex tube.

Aircraft Encounters With Vortices

We know a bit more, but not enough, about encounters between aircraft and vortices. Most dangerous axial encounters where the rolling moment created by the vortex may exceed the roll-control authority of the aircraft. Normally, pilots come into a vortex pair from the side. The immediate effect is to lift the wing closest to the vortex, which tends to throw the aircraft out of the vortex. Pilots may intuitively fight this lifting of the wing, inadvertently throwing the aircraft back into the vortex.

As stated, the vortices tend to remain at a separation of approximately three-quarters of a wingspan, until they sink to an altitude equal to about half their normal separation. Then they stop sinking and begin to spread out at a rate equal to their sink rate. That is, if the pair of vortices is normally 100 feet apart, they will sink to an altitude of about 50 feet and then start spreading.

If the wind is absolutely still, the vortices cannot remain on the runway. But a crosswind of 3 knots blows one vortex rapidly away from the runway while the other is blown back onto the runway and may remain stationary there. Furthermore, such winds usually have a shear, because the wind speed is higher at higher altitudes. This shear represents a kind of vorticity which tends to weaken one vortex but strengthen the one which gets blown back over the runway. A stationary vortex at an altitude of less than 100 feet could be catastrophic if an aircraft encountered it on takeoff or landing.

A vortex could also be blown toward an adjacent runway, either parallel or convergent. This is a real danger where runways are less than 1,000 feet apart. Different airports handle this threat differently.

At Los Angeles and Hartsfield Atlanta, which have two pairs of parallel runways, one runway of each pair tends to be used for takeoff and the other for landing. Vortices from one runway generally cannot endanger aircraft on the other.

At San Francisco, which has two parallel pairs at right angles, controllers often bring planes in on one parallel pair side by side during visual meteorological conditions to provide gaps for takeoff on the other pair. This also is completely safe.

Spacings for Landing and Takeoff

The other (and more important) kinds of spacings are those for aircraft following each other on landing or takeoff. Required spacing depends on the sizes of the leading and following aircraft. For this purpose, the FAA classifies all aircraft as "Small," "Large," or "Heavy," based on maximum certificated gross takeoff weight (not actual weight). If this weight is 12,500 pounds or less, the plane is Small; more than 12,500 and up to 300,000 pounds, Large. For air traffic control purposes, aircraft 300,000 pounds and above are referred to as Heavy. However, an empty (Large) Citation with most of its fuel spent can be well under 12,500 pounds, but is still classified as Large. Since a B-757 also is classified as Large, the rule for Large-behind-Large permits the empty Citation to follow just 3 miles behind the B-757.

Summary

The FAA believes research and operational experience show current standards are safe, but with traffic volume nearing capacity, wake vortex issues are in the forefront when it comes to considering closer separation standards. ■

Deadly Winds

EDITORIAL STAFF REPORT
Flight Safety Foundation Accident Prevention, May 93

Seconds after turning onto the final approach course for runway 35 at Colorado Springs Municipal Airport, Colorado, the Boeing 737 rolled abruptly to the right, pitched nose down and struck the ground in a near-vertical attitude.

■ Many years ago, a B-52 flying along Colorado's front range encountered turbulence so severe as to remove most of the vertical tail. Pilots flying there all speak of the continuing chance of turbulence caused by mountain waves and rotors. This article shares the extreme danger of this all-too-common weather feature.

Following an exhaustive investigation, the U.S. National Transportation Safety Board (NTSB) said it "could not identify conclusive evidence to explain the loss of United Airlines flight 585." The crash killed all 25 people on board, including two flight crewmembers and three flight attendants.

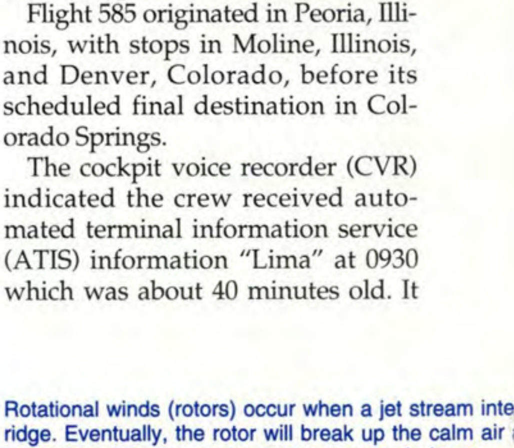
The NTSB report concluded: "Although anomalies were identified in the airplane's rudder control system, none would have produced a rudder movement that could not have been countered by the airplane's controls. *The most likely atmospheric disturbance to produce an uncontrollable rolling moment was a rotor (a horizontal-axis vortex) produced by a combination of winds aloft and the mountainous terrain.*

"Conditions were conducive to the formation of, and some witness observations support the existence of a rotor at or near the time and place of the mishap. However, too little is known about the characteristics of such rotors to conclude decisively whether they were a factor in this mishap."

Flight 585 originated in Peoria, Illinois, with stops in Moline, Illinois, and Denver, Colorado, before its scheduled final destination in Colorado Springs.

The cockpit voice recorder (CVR) indicated the crew received automated terminal information service (ATIS) information "Lima" at 0930 which was about 40 minutes old. It

Rotational winds (rotors) occur when a jet stream inte
ridge. Eventually, the rotor will break up the calm air
tors may encounter moderate to severe turbulence.



reported the wind at 310 degrees at 13 knots with gusts to 35 knots. It also said low-level wind shear advisories were in effect with a "local aviation wind warning in effect calling for winds out of the northwest, gusts to 40 knots and above."

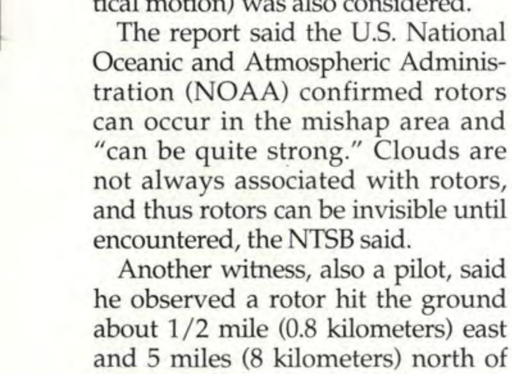
The Colorado Springs controller cleared the aircraft to land and reported winds at 320 degrees at 16 knots with gusts to 29 knots. A few moments later, the first officer asked the controller if other aircraft had reported significant airspeed losses or gains on final. "The controller replied that a Boeing 737 [had] reported a 15-knot loss at 500 feet [151 meters], at 400 feet [121 meters] 'plus 15 knots,' and at 150 feet [45 meters], 'plus 20 knots.' The first officer replied, 'Sounds adventurous, uh, United 585, thank you.'"

Most of the weather investigation focused on the possibility a rotor caused the mishap, the NTSB said. But the report also said another phenomenon known as a "jump" (a concentrated region of upward vertical motion) was also considered.

The report said the U.S. National Oceanic and Atmospheric Administration (NOAA) confirmed rotors can occur in the mishap area and "can be quite strong." Clouds are not always associated with rotors, and thus rotors can be invisible until encountered, the NTSB said.

Another witness, also a pilot, said he observed a rotor hit the ground about 1/2 mile (0.8 kilometers) east and 5 miles (8 kilometers) north of the extended centerline of runway 35 with estimated wind speeds of up to 80 mph (129 kph) at about noon on the day of the mishap.

racts with the still air on the lee side of a mountain or
and descend to the surface. Aircraft flying through ro-



In the center of this valley, smooth lenticular clouds float above the ragged clouds marking turbulence from a mountain wave rotor.

The report said, "Tree limbs were blown off and car hoods were damaged. He (the pilot witness) believed the rotor was part of a line of rotors extending north to south which would most likely have extended to the area where the mishap had occurred. He added the force of rotors impacting the ground has severely damaged houses, railroad cars, and trucks. Calm returned after 30 seconds."

The NTSB said one witness reported a brief 90 mph (145 kph) or stronger gust from the west about 2 miles (3 kilometers) east (downwind of the mishap site), and another witness reported a 50- to 70-knot gust about 1.25 miles (2 kilometers) east of the mishap site. But it added "most witnesses near the mishap site reported light winds."

In addition, pilot reports on the day after the crash indicated flights encountered measured turbulence and vertical velocities of 800 feet (242 meters) to 1,000 feet (303 meters) per minute in the area of the mishap. Atmospheric conditions were similar to those on the day of the mishap.

"Regardless of the availability of rudder motion, a severe rotor 10 times worse than those previously documented would have had to be present to cause the upset," the NTSB said. " A less severe rotor motion, combined with pilot delay in reaction, could have led to this upset. However, the CVR data revealed a rapid verbal, and presumably physical, response to the upset by the pilots."

"Either meteorological phenomena or an undetected mechanical malfunction or a combination of both could have led to the loss of control," the NTSB said.

The NTSB recommended the U.S. Federal Aviation Administration (FAA) develop a meteorological program to study potential meteorological aircraft hazards in the Colorado Springs area, with a focus on approach and departure paths. It also urged a broader program be implemented to include other airports in or near mountainous terrain. ■

ONE ZERO WAYS TO BUST AN ALTITUDE

DONALD L. GEORGE
Researcher, NASA's Aviation Safety Reporting System (ASRS)

Reprinted with permission from *ASRS Directline*

■ Here I am, the PIC (passenger in coach) on a coast-to-coast widebody cruising along at Flight Level 350. I'm in Seat 25B (one of the cheap seats), feeling fairly comfortable after recovering from an earlier incident in which the guy in Seat 24B suddenly tilted his seat to the full recline position and speared me with my very own tray table. In any decent football league, that would have been a 15-yard penalty, but I didn't even get an "excuse me."

No cracked ribs, so I try to relax; but I can't because now I'm already worrying about the fact we will have to descend in a couple of hours. I know from reading a lot of ASRS reports our chances of getting down through 11,000 and 10,000 feet *without* an incident are pretty remote. I conjure up in my mind a scenario which runs like this …

If pilots and controllers use clear, concise radio technique, paying particular attention to the hearback phase, the potential for error will be reduced.

Controller will say, *"Descend and cross three-zero miles west of Gulch VOR at one-one-thousand, reduce to two-five-zero knots, report leaving flight level two-zero-zero, Podunk altimeter three-zero-zero-five."* With all those zeros now implanted into the flightcrew's heads, one of them will read back, *"Descend to one-zero-thousand,"* along with the other values, and the controller will fail to note the wrong altitude in the readback.

Shortly thereafter, we will change over to approach control and report, *"Out of one-eight-thousand for one-zero-thousand."* Again a busy controller will most likely miss the incorrect altitude.

As we start to level off, the controller sees our altitude readout, questions us, and tells us to climb back to one-one-thousand, where we belong. At the same time, a couple of departure aircraft are heading in our direction, also at 10,000 feet. We evade them by making some steep turns and climbing rapidly. Not much harm done except a few spilled drinks and the possible creation of some future paperwork.

Pretty soon, I hear the pilot announce flight attendants should prepare for landing.

This is my favorite part of the trip because it means the guy in Seat 24B must put his seatback into the upright position, and it also indicates we have gotten down through 11,000 and 10,000 feet without hitting another aircraft. Both of these occurrences allow me to breathe a lot easier!

Okay, so I made up all this stuff about the guy in Seat 24B and the dogfights with other aircraft. But it all could have really happened, because seriously, there is a real-life 10,000/11,000 problem, and I wanted to get your attention so we could talk about it.

Contributing Factors

Why do a lot of altitude deviations occur at 10,000 and 11,000 feet?

In preparing this article, I reviewed hundreds of ASRS reports which involved a mixup with the two altitudes. The reports reveal several causal factors which show up in nearly all of the incidents. I'll review those factors here. Bear in mind, however, the incidents do not usually happen as a result of a single causal factor. They almost always reflect a combination of two or more of the following factors:

Similar-sounding phrases — Pilots misunderstand the clearance, and controllers misunderstand the readback because of the similar-sounding phrases of one-zero-thousand and one-one-thousand.

"I believe it is very easy to confuse one-one-thousand with one-zero-thousand, and vice versa."

"I don't know if the controller said 10,000 but intended to say 11,000, or if he said 11,000 and I thought he said 10,000."

Readback/hearback — Controllers fail to note incorrect altitude in pilot readbacks — the old hearback bugaboo.

"Voice tape reading showed the clearance was to 11,000 feet, but readback by the captain of 10,000 feet went uncorrected."

"Controller said, 'Oh, I should have checked your readback.'"

Too many numbers — Controllers include several (and sometimes, too many) numbers in the same radio transmission.

"The controlling agency, in rapid manner, told us to turn to 310 degrees, slow to 210 knots, and I understood him to say 'maintain 10.'"

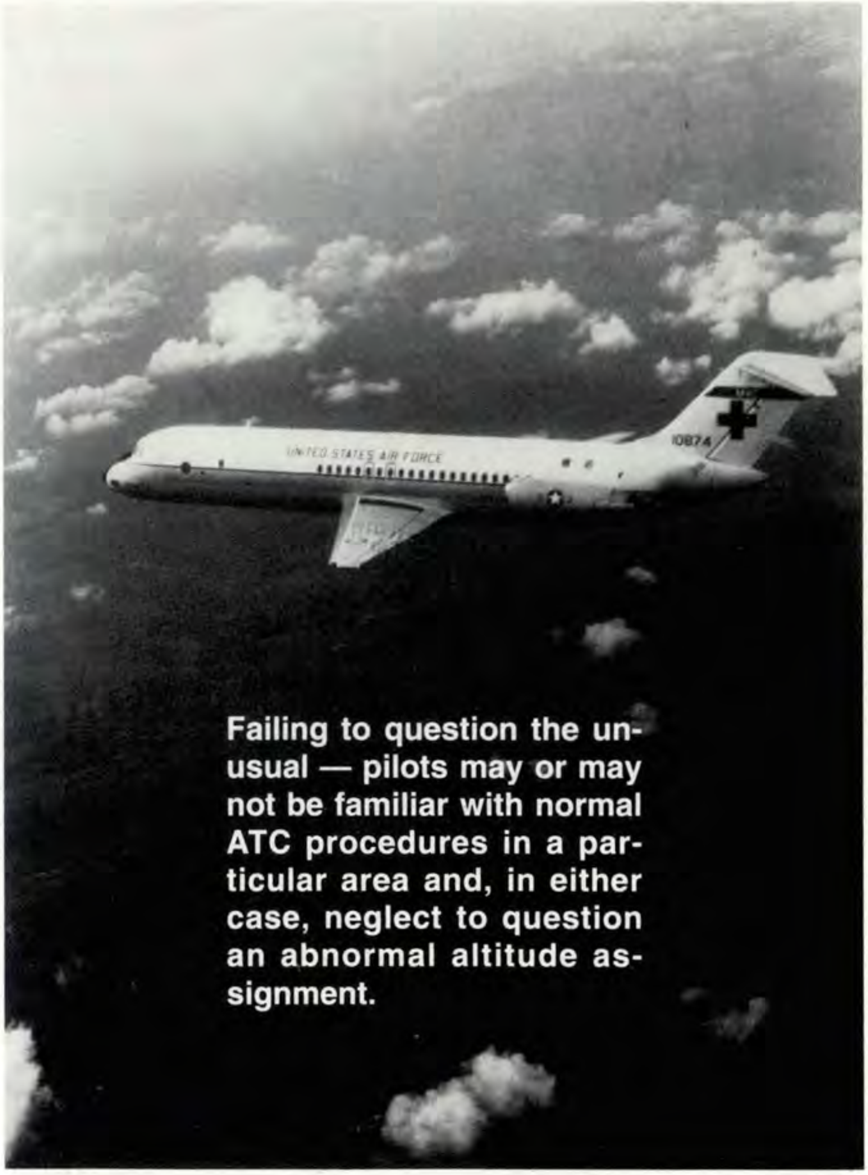
"Very often, controllers issue four to five instructions in the same breath, such as, 'Turn left 330 degrees, maintain 2,000 feet till established, cleared for ILS 30 approach, contact tower 119.4 at the outer marker, and maintain 160 knots until 5-mile final.'"

Similar numbers — Altitude crossing points stated in miles may be similar to the altitude to which the flight is cleared.

"Were we cleared to 10,000 feet 11 miles west of ARMEL, or 11,000 feet 10 miles, or 10,000 feet 10 miles, or 11,000 feet 11 miles?"

"Center cleared us to cross 10 DME NE PVD 11,000, 250 knots. I read back 11 miles NE PVD 10,000, 250 knots. At 10,100 feet, I questioned center, and they said 10 northeast at 11,000, 250 knots. We climbed back up to 11,000 feet."

250 knots at 10,000 — Pilots tend to associate a 250-knot speed restriction with a 10,000-foot altitude assignment, because civil aircraft are normally restricted to a speed of 250 knots or less below 10,000 feet.



Failing to question the unusual — pilots may or may not be familiar with normal ATC procedures in a particular area and, in either case, neglect to question an abnormal altitude assignment.

"A clearance for 250 knots generally makes a pilot think about 10,000 feet due to the association of 250 knots below 10,000."

"We think the 250-knot restriction could have led us to assume 10,000 feet because the majority of locations use 10,000-foot/250-knot crossings in their STARs (standard terminal arrival routes)."

Spring-loaded — Pilots may anticipate receiving a certain clearance but get something just a little different. Perhaps the last SID or STAR they executed had speed and altitude crossing restrictions which were similar but not exactly the same as the one they are currently flying.

Noted an air carrier pilot who initiated a premature descent to 10,000 feet from 11,000 feet: "I may have anticipated being given 10,000 feet after seeing an aircarrier aircraft pass below me."

Failing to question the unusual — Pilots may or may not be familiar with normal ATC procedures in a particular area and, in either case, neglect to question an abnormal altitude assignment.

"Next time into and out of DEN, we will be aware the inbound aircraft are normally at 11,000 feet and departure aircraft normally restricted to 10,000 feet."

continued

ONE ZERO WAYS TO B

"The usual clearance for this arrival is 11,000, but we both followed my error blindly to 10,000 feet."

The 10 mindset — Pilots and controllers often get what is referred to as a "No. 10 mindset" after hearing a lot of zeros. It seems like one-zero-thousand then comes the altitude assignment.

*"I **do** think the number of 10s in the clearance definitely was a contributing factor."*

"Flight crew read back 'one-one-thousand,' but somehow had mindset of one-zero-thousand."

Reduced monitoring — Cockpit duties and distractions result in only one flight crewmember monitoring the ATC frequency. Similarly, controller workload and frequency congestion are factors which affect the ability of controllers to closely monitor pilot readbacks.

"This type of situation has occurred with this crewmember three or four times since flying two-man crew aircraft, when one crewmember is busy reviewing approach plate and procedures and is distracted from hearing conversation between the other crewmember and controller."

Cockpit management — Cockpit management and flightcrew coordination may be less than optimum, and crewmembers fail to adequately monitor each other in such tasks as setting the altitude alert or reading back clearances.

"Center cleared our flight from 17,000 feet to 11,000 feet MSL. This was acknowledged by me; however, the first officer understood 10,000 feet and placed that altitude in the selector."

"I will have to watch the music closer while the other guy is playing the piano."

Radio technique — Very often controllers and/or pilots fail to use proper techniques. I consider this to be the "big one" when it comes to causative factors. Yes, sir, old number one-one (that's 11) is a really critical factor.

"The controller was busy, a lot of traffic. Contributing factors: fast talking, bad radios, long clearances, a lot of numbers — given too fast to comprehend or write down."

Cockpit management and crew coordination may be less than optimum, and crewmembers fail to adequately monitor each other.

"I don't know who is correct, but I know I was incorrect in not requesting a confirmation of the clearance since some doubt existed."

Confusing phraseology — Controllers and pilots frequently misunderstand each other because of using improper phraseology.

"We had understood and read back 'descending to 10,000.' Phraseology contributed to this incident."

"To correct future problems like this, the altitude should be given in the form of 'ten thousand' or 'eleven thousand,' instead of saying 'one-zero-,' or 'one-one-thousand.' There is too much of a chance of error. We are used to hearing ten, eleven, or twelve in everyday life."

Corrective Measures

So, what are we going to do about it? Here are a few starter suggestions.

Saying it twice — differently. Controllers and pilots are encouraged to use both single-digit and group-form phraseology to reinforce altitude assignments whenever a misunderstanding is possible. Consider the following examples:

Controller transmission: *"(Ident) descend and maintain one-zero-thousand, that is **ten** (said with emphasis) thousand."*

Pilot transmission: *"Roger (call sign), leaving one-seven-thousand for one-one-thousand, that's **eleven** (with emphasis) thousand."*

Note: A recent change to *Air Traffic Handbook* Procedure 7110.65 allows controllers to use this phraseology to reinforce an altitude assignment. Many "old" pilots have used the technique for a long time and find it helps.

UST AN ALTITUDE continued

If pilots and controllers use clear, concise radio techniques, paying particular attention to the *hearback* phase, the potential for error will be greatly reduced.

Radio technique — Take a good, hard look at your radio communication techniques. Do you check to make sure the frequency is clear before transmitting? Do you activate transmitter *before* starting to speak? Do you use full and correct call sign? Do you use an acceptable speech rate? Do you enunciate and emphasize when necessary, for clarity? Do you ask the other party to repeat if transmission was not clear or may have been stepped on? Do you listen for similar call signs?

These are just a few of the questions you should ask yourself. I'm sure you can think of many other technique questions.

Area familiarity — Pilots should work to improve their "situational awareness" skills. For instance, you often fly in the Dallas/Ft Worth area and have observed normally departures are restricted to 10,000 feet and arrivals are held up to 11,000 or higher until arrival and departure routes have crossed.

You probably should question any altitude assignment which appears to conflict with these normal ATC procedures. Most terminal ATC facilities use standard routes and altitudes, and your situational awareness can help prevent an incident.

Reduce the number of numbers — Controllers can help make a conscientious effort to defeat the hearback problem by being aware of the nasty effects of including too many numbers in the same transmission and by using named intersections rather than number of miles when issuing crossing restrictions. (If necessary, consider changes to local procedures or to letters of agreement.)

Summary

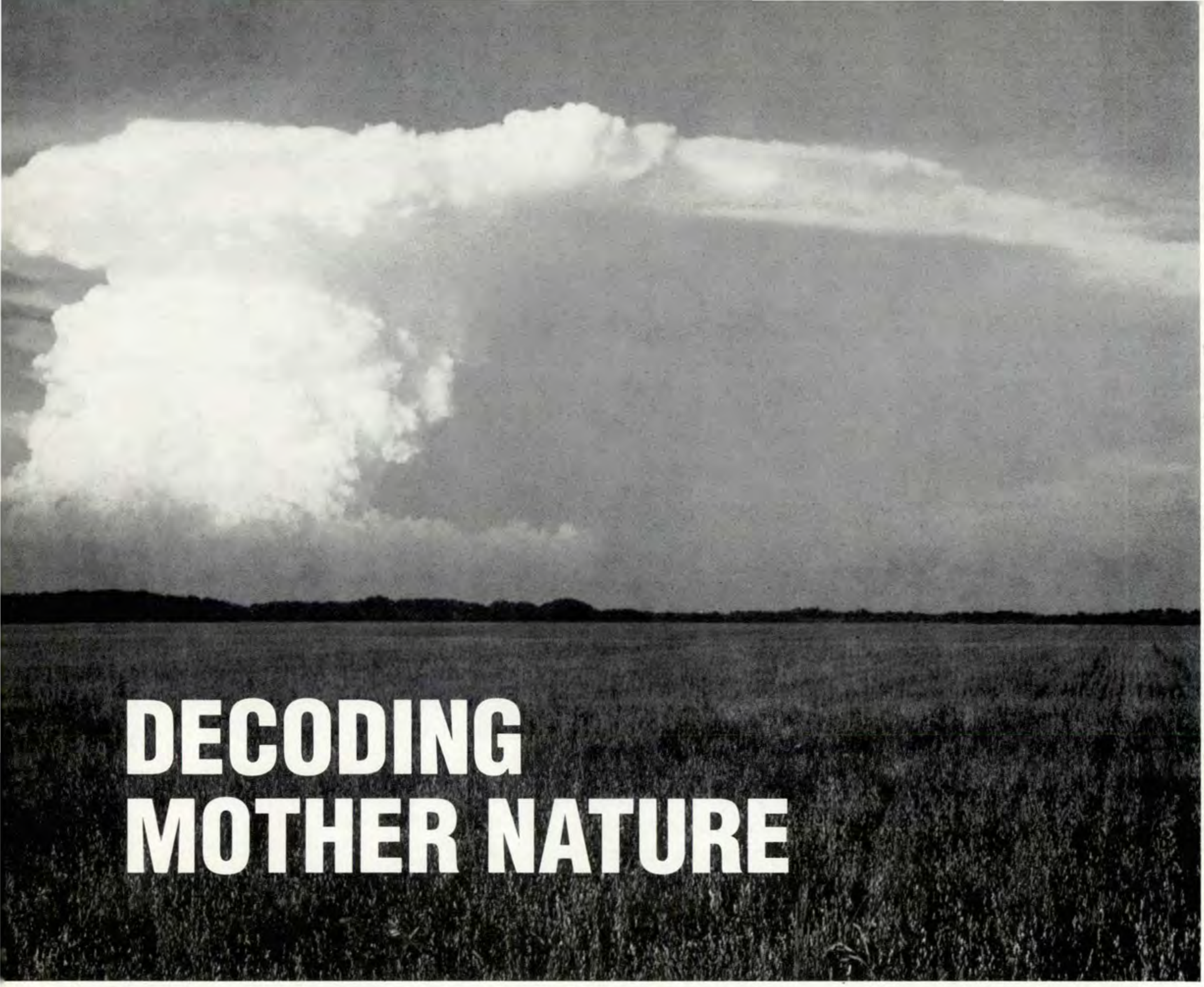
Let's take a final look at some of the reasons for the 10,000/11,000 altitude problem. Factors include

- One-zero-thousand sounds like one-one-thousand, particularly when other numerical information is being transmitted at the same time.
- Pilots may be spring-loaded to expect a 250-knot airspeed in conjunction with a 10,000-foot altitude, thus a clearance for an airspeed of 250 knots may lead the flightcrew to mistakenly assume an altitude assignment of 10,000.
- Pilots may fail to question an unexpected or unusual clearance; anticipate 10 when hearing a lot of zeros; become distracted, as do controllers; and suffer breakdown in cockpit management.
- The 10,000/11,000 quandary seems to be rooted in confusing phraseology and improper radio technique — compounded by the readback/hearback problem.

The solution to the 10,000/11,000 problem lies in realizing the potential for error when descending or climbing through or near the 10,000and 11,000-foot boundaries and in using *both* single digit and group forms to express these altitudes. Be prepared to question a clearance that seems unusual. If pilots and controllers use clear, concise radio technique, paying particular attention to the hearback phase, the potential for error will be reduced.

An Invitation

No doubt, a good many readers of this article are actively engaged in training activities, and you may want to consider this problem as the subject of a lesson or two. If you are interested in obtaining a small package of NASA's Aviation Safety Reporting System reports (about 20) on which to base training sessions, please call (415-969-3969) or write ASRS (P.O. Box 189, Moffett Field, CA 94035) and request the 10,000/11,000 report package. It will be sent at no charge. ■



DECODING MOTHER NATURE

INSTRUMENT FLIGHT CENTER
Randolph AFB, Texas

■ Short and sweet. For those of us who occasionally get lucky enough to decode our own METAR or TAF weather reports, 1 July 1993 was an important day. On this day, the decode format was changed. The following charts replaced the General Planning Chapter 8 charts.

These are the basic organizational changes to the METAR decode.

Under WIND DATA

— Maximum wind when variation is 10 knots or more. It used to be 5 knots.

— Wind variability added.

Under PREVAILING VISIBILITY

— All methods of transmission use kilometers.

Under RUNWAY VISUAL RANGE

— VR no longer is used to specify RVR.

Under SKY CONDITION

— Cloud cover is no longer referenced by eighths. Now clouds are expressed as SCT, BKN, OVC, or SKC (sky clear).

— Most cloud types are removed from cloud height section.

Only CB (cumulonimbus) or TCU (towering cumulus) are used.

CEILING HEIGHT AND REMARKS sections are reversed.

TERMINAL AERODROME FORECAST (TAF) changes are as follows:

— Block 8 is now current weather rather than forecast.

— Block 9. As with METAR, cloud amount is no longer referenced in eighths. SCT, BKN, OVC, and SKC are used instead.

— Block 10. Cloud height specifies bases of the clouds.

— Block 11. Type of cloud indicated only if CB.

— Remarks section is reduced.

There you have it. Simple and to the point. General planning should catch up with these changes in the revision scheduled for September 1993. ■

KEY TO METAR AND TAF CODES

METAR WEATHER REPORT

FORMAT	LOCATION IDENTIFIER	TYPE REPORT	TIME	WIND DATA	PREVAILING VISIBILITY	RUNWAY VISUAL RANGE (RVR) - LOCAL	PRESENT WEATHER	SKY CONDITION	CAVOK	TEMP DATA (HOURLY REPORTS ONLY)	ALTIMETER SETTING	REMARKS	CEILING HEIGHT

METAR DISSEMINATION EXAMPLES

INTERNATIONAL LOCATION IDENTIFIER

TYPE OF REPORT - METAR (HOURLY) OR SPECI (SPECIAL)

TIME OF OBSERVATION (UTC)

WIND DIRECTION TO NEAREST TEN DEGREES. A VARIABLE DIRECTION IS REPORTED AS "VRB". DISSEMINATED DIRECTION WITH RESPECT TO MAGNETIC NORTH LOCALLY AND TRUE NORTH LONGLINE.

WIND SPEED (KNOTS)

MAXIMUM WIND (KNOTS) WHEN VARIATION IS 10 KNOTS OR MORE.

WIND VARIABILITY

9999 INDICATES 10 KM OR GREATER.

INDICATOR (R)

RUNWAY NUMBER (DrDr)

RUNWAY DESIGNATOR (USED TO DISTINGUISH PARALLEL RUNWAYS).

VISUAL RANGE VALUE. (HUNDREDS OF FEET OR METERS)

PRESENT WEATHER - SEE TABLE 1

CLOUD AMOUNT: SCT, BKN, OVC, SKC.

CLOUD HEIGHT. SEE TABLE 2 (ALL HEIGHTS ARE IN HUNDREDS OF FEET)

TYPE OF CLOUD ONLY IF "CB OR "TCU".

TRANSMITTED IN PLACE OF VIS, RVR, AND CLOUD DATA: WHEN VIS IS 10 KM OR GREATER, NO CLOUD BELOW 5000 FEET, AND NO CB, PRECIP, TS, SHLW FOG OR LOW DRFTG SNOW.

AIR TEMPERATURE (DEGREES CELSIUS).

DEW POINT (DEGREES CELSIUS).

ALTIMETER SETTING (INCHES). THIS ELEMENT IS NOT INCLUDED IN SPECI REPORTS TRANSMITTED LONGLINE.

REMARKS: EITHER ABBREVIATED OR IN PLAIN LANGUAGE, AND SUPPLEMENTARY DATA. RMK IDENTIFIES REMARKS FOLLOW.

CEILING HEIGHT (HUNDREDS OF FEET) - ALWAYS FIRST REMARK. **LOCALLY CIG RMK FOLLOWS BKN/OVC LAYER.

LONGLINE	EDAB	METAR	1457	25015G30KT 210V290	0600	NOT TRANSMITTED LONGLINE	FG	BKN005	NOT USAF	01/M01	A2984	RMK	CIGM005
LOCAL	EDAB	METAR	1457	25015G30KT 210V290	* 0.3	R22L/0300	FG	BKN005 **		01/M01	ALSTG 2984	RMK	** CIGM005

TERMINAL AERODROME FORECAST (TAF)

FORMAT	CCCC	G_1G_1	G_2G_2	ddd	ff	/fmfm	VVVV	w'w'	$N_sN_sN_sh_sh_sh_s$	CC	---	CAVOK	6	I_c	$h_ih_ih_i$	t_L	5	B	$h_Bh_Bh_B$	t_L	QNH	$P_2P_2P_2P_2$	INS	REMARKS

TAF DISSEMINATION EXAMPLES

INTERNATIONAL LOCATION INDICATOR

START OF FORECAST PERIOD (UTC)

END OF FORECAST PERIOD (UTC)

TRUE WIND DIRECTION. VARIABLE DIRECTION REPORTED AS "VRB"

WIND SPEED IN KNOTS

MAXIMUM WIND SPEED WHEN IT EXCEEDS THE MEAN SPEED BY 5 KNOTS OR MORE.

PREVAILING VISIBILITY IN METERS. 9999 INDICATES 10 KM OR MORE.

PRESENT WEATHER - SEE TABLE 1

CLOUD AMOUNT: SCT, BKN, OVC, SKC.

CLOUD HEIGHT. SEE TABLE 2, ALL HEIGHTS ARE IN HUNDREDS OF FEET.

TYPE OF CLOUD ONLY IF "CB".

$N_sN_sN_sh_sh_sh_s$ CC REPEATED AS NECESSARY.

NOT USED BY USAF. SEE METAR EXPLANATION.

ICING GROUP INDICATOR

TYPE AND INTENSITY OF ICING - SEE TABLE 4

HEIGHT ABOVE STATION ELEVATION OF THE BASE OF THE ICING LAYER.

THICKNESS OF ICING LAYER IN THOUSANDS OF FEET - SEE TABLE 2

TURBULENCE GROUP INDICATOR

TYPE AND INTENSITY OF TURBULENCE - SEE TABLE 3

HEIGHT ABOVE STATION ELEVATION OF THE BASE OF THE TURBULENCE LAYER

THICKNESS OF TURBULENCE LAYER IN THOUSANDS OF FEET - SEE TABLE 2

Q CODE SIGNAL FOR ALTIMETER

FORECAST LOWEST ALTIMETER

UNITS INDICATOR - INCHES

ABBREVIATED PLAIN LANGUAGE. USE CIG RMK WHEN A BKN OR OVC LAYER IS FORECAST. **LOCALLY CIG RMK FOLLOWS BKN/OVC LAYER.

LONGLINE	FDAB	1212	23015G30KT	9999		SCT030	BKN250				QNH2996INS	CIG250
	BECMG	1617	23015G30KT	8000	-SHRA	BKN020CB	OVC040		650504	550208	QNH2993INS	CIG020
LOCAL	FORECAST VALID EDAB	12Z TO 12Z	23015G30KT	* 7		SCT030	BKN250	**			QNH or ALSTG 29.96	** CIG250
	BECMG	16Z - 17Z	23015G30KT	* 4.3	-SHRA	BKN020CB **	OVC040		MDT ICG 050-090	MDT TURBC 020-100	QNH or ALSTG 29.93	** CIG020

* TRANSMITTED IN METERS, STATUTE MILES, OR NAUTICAL MILES AS DETERMINED LOCALLY.

IFC APPROACH

LOW LEVEL vs LOW APPROACH

LT COL JOHN VOSS
Air Force Flight Standards
Agency Instrument Flight Center

■ "Okay, we're over the IP. Now turn to the target run-in heading. Heading looks good — speed is nailed — altitude, 300 feet — look for No. 2, yeah, I'm visual — tally the target —"

BOOM ... BRIGHT FLASH OF LIGHT!

"What the ...?" Master caution light. No time to study the problem here. Start a climb to get some thinking room. "Bacon 21, knock it off!"

Not an unrealistic scenario. Situations like this happen to a lot of flights. Somewhere in the low altitude structure something attracts your attention away from the business of flying the jet. The actions to solve the problem may be different in each case, but step number one is always the same: Maintain aircraft control while getting some altitude under the aircraft.

This is a basic rule we stress to new pilots and to ourselves in the mission briefing. It also happens to work no matter what type of aircraft you're flying. Low and fast, or low and slow, it doesn't make a difference. Get away from the ground if you need to do anything but fly.

No one argues flying gets demanding at low altitude. But when was the last time you flew at less

than 250 feet? "Never," you say! "The MAJCOM minimums won't let us go that low." Well, you might be surprised to know about a small "loophole" in regulation which puts you much closer to the ground than you realize.

Let's turn our thinking from a demanding low level mission to a presumably much less demanding nonprecision approach. When you're flying your final approach, how close to the ground are you? The first place to look for an answer might be the minima block on the approach plate to find the Height above Touchdown (HAT). The HAT for a nonprecision approach is usually between 250 and 500 feet. However, that is only over the touchdown point. What about farther out on final?

How high above the ground are you out there? Without making TERPS experts out of you, you should know the person who designs the approach must provide at least 250 feet of obstruction clearance on the final approach segment of a nonprecision approach. Now, make allowances for a 75-foot altimeter error (worst case) and you could "legally" be 175 feet above the ground or obstacle.

Troubleshooting an aircraft problem at 250 feet AGL is not normally considered a good idea. Put yourself in the situation where you get distracted by something like a radio call from your wingman needing information, or a master caution light while you're flying an instrument final approach with a step down fix. Recent mishap statistics indicate adding power to initiate a missed approach is apparently not high on some pilot's list of considerations. But why not?

Although the answer may be complicated by many factors such as the perceived negative stigma of taking an approach around prior to the missed approach point; or with concerns about the immediate impact to air traffic control, the key is pilot lack of situation awareness.

The fact is, an aircraft is closer to the ground on an instrument approach than it is on a preplanned low level. The only significant difference is time. On a 420-knot low level, a 3° descent started at 250 feet is only 7 seconds from ground impact. The same descent rate on a 180-knot final approach results in ground impact in 16 seconds. Is the 9-second difference really enough time to troubleshoot the problem and recover the aircraft while in the landing configuration? If you are distracted for 9 seconds while you continue to descend, you will only be 100 feet above the ground or obstacle with a downward vertical velocity of 900 fpm.

If your final approach is being flown VMC and there are plenty of visual cues, it might not be a problem since the ground rush might cue you to recover the aircraft. If, however, the weather is at or near minimums for the approach, you will be flying IMC at a low altitude without a chance of seeing the obstacles on final. This is not the place to allow yourself to be distracted from "maintaining aircraft control."

A rule cannot be written to dictate when to go missed approach if something doesn't look right, but aircrews must maintain good situational awareness. Don't forget, the purpose of an instrument approach is to bring you from a higher altitude down to the dirt with little or no visual contact with the ground. It is intentionally designed to put you in the low level structure. Don't be lulled into a false sense of security just because you're slow and relatively close to a runway. It won't do much good to correctly handle an emergency while the aircraft is settling into the trees. You should seriously consider using the same procedures you use in the tactical low level environment.

The bottom line remains, when operating at low altitude, time is a very limited commodity, and the ground has a P_K of 1. ■

"THAR SHE BLOWS"

LT COL ROB LUNDIN
Chief, Aircraft Maint Div, AFSA

■ We all know what a hurricane-force wind can do. We've all worked in areas of the country where it gets really windy, either because it is a windy place or a thunderstorm brings in the gusts.

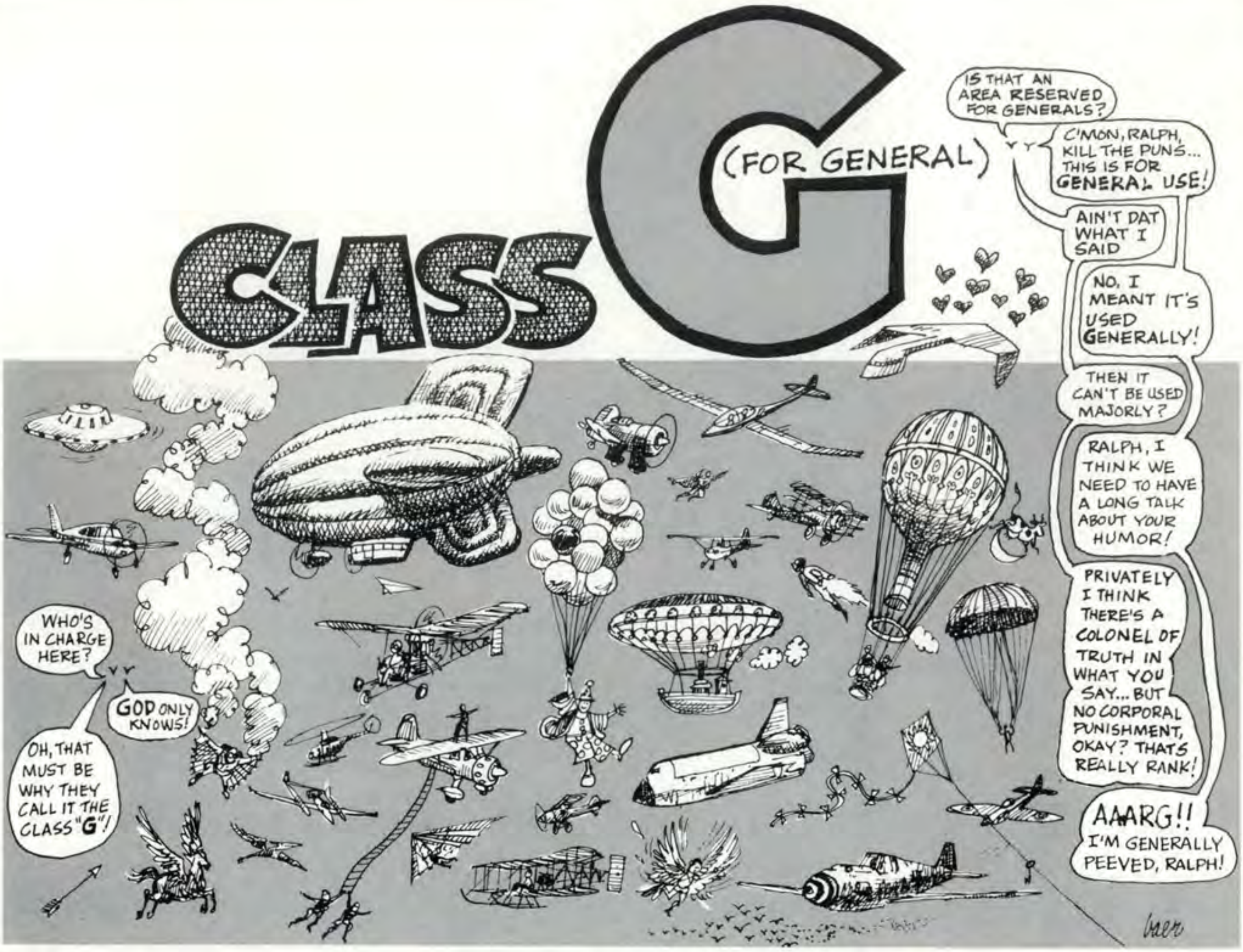
But I bet a lot of us would be surprised at how much force "mere 40-some-odd knots" of wind can generate. Here are some lessons learned recently by the Navy at Rota, Spain.

A bunch of phase dock maintenance stands were parked, supposedly with the brakes on, outside a hangar. Two P-3 sub hunters (about the size of a C-130) were parked 300 to 700 feet away. Thunderstorm conditions were forecast with gusts to 35 knots. As is normal Navy procedure (they're used to doing this on aircraft carriers, so it carries forward to land-based units, even with calm conditions), the big P-3s were physically tied down with chains to the ramp. Just before the strongest winds occurred, one witness noticed the nose tie-down on one P-3 was missing but did nothing to fix it.

Then, the wind came. It was clocked at 42 knots, with blowing rain. Two H-46 helicopters broke free of their moorings and pieces of the hangar blew off. Then the real surprise. The P-3, subjected to a 37-knot headwind component and a 25-knot crosswind component, rotated back on its tail, touching the fuselage to the ramp, and then banged back down.

To the observer's chagrin, the next thing he saw was an entire "squadron" of phase stands marching across the ramp. Several of them smacked into the P-3s with enough force to cause $620,000 worth of radome, antennae, prop, and structural sheet metal damage! Some of the stands still had brakes set! One stand traveled 1,500 feet; one left a 76-foot-long skid mark!

In retrospect, it appears some of the brakes may not have been up to T.O. specifications, or may have even been inoperative (a point to ponder by our non-powered AGE troops). An incident like this causes us Air Force types to rethink our weather advisory, loose equipment securing, and aircraft tie-down procedures. Did you know a 40-knot wind had the power to do that? Is your unit prepared? ■



G, What Happened To F?

LT COL ROY A. POOLE
Editor

■ Isn't it nice to depend on the simple things in life? You know, the sun comes up in the morning, taxes are due on April 15th, and the alphabet is always the same. A is followed by B, C is followed by D, and E is followed by F.

WRONG! For reasons known only to a secret office in Oklahoma, F does not follow E in the great airspace reclassification which takes place on September 16th.

G follows Class E airspace in the new scheme. Fortunately, Class G airspace is the least complicated. It is also the one least likely to be used by military pilots.

Class G airspace is the new name for airspace which is not a control area, not a control zone, not on a Victor route, not a TCA or ARSA, and not a transition area. In other words, Class G airspace is all that light brown area on your low altitude IFR en route charts.

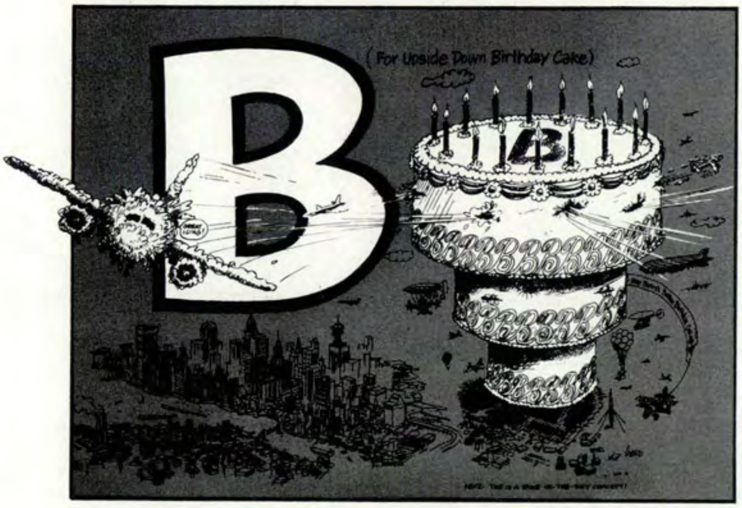
Cloud clearances in Class G airspace remain the same as for "uncontrolled" airspace. Below 1,200 feet agl, you will need one mile visibility and you must remain clear of clouds. At or above 1,200 feet agl, you must have the "standard" 3 sm visibility and remain 500 feet below, 1,000 feet above, and 2,000 feet horizontally from any clouds which you encounter.

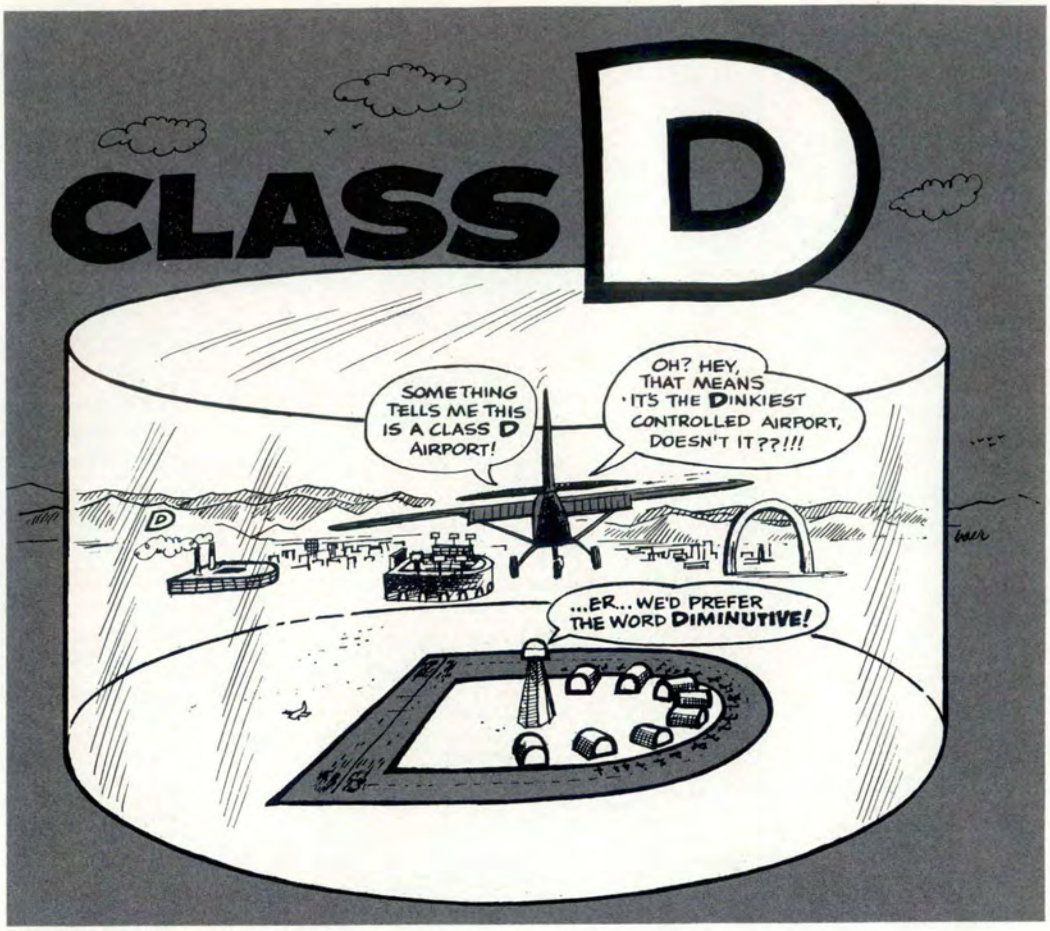
As odd as it might seem, it is entirely possible for somebody to be conducting IFR flight in Class G airspace. Naturally, since this is not controlled airspace, aircraft flying on an IFR flight plan will probably not be talking to anyone. You also shouldn't expect any kind of traffic separation from air traffic control facilities along your route until you enter at least some Class E airspace.

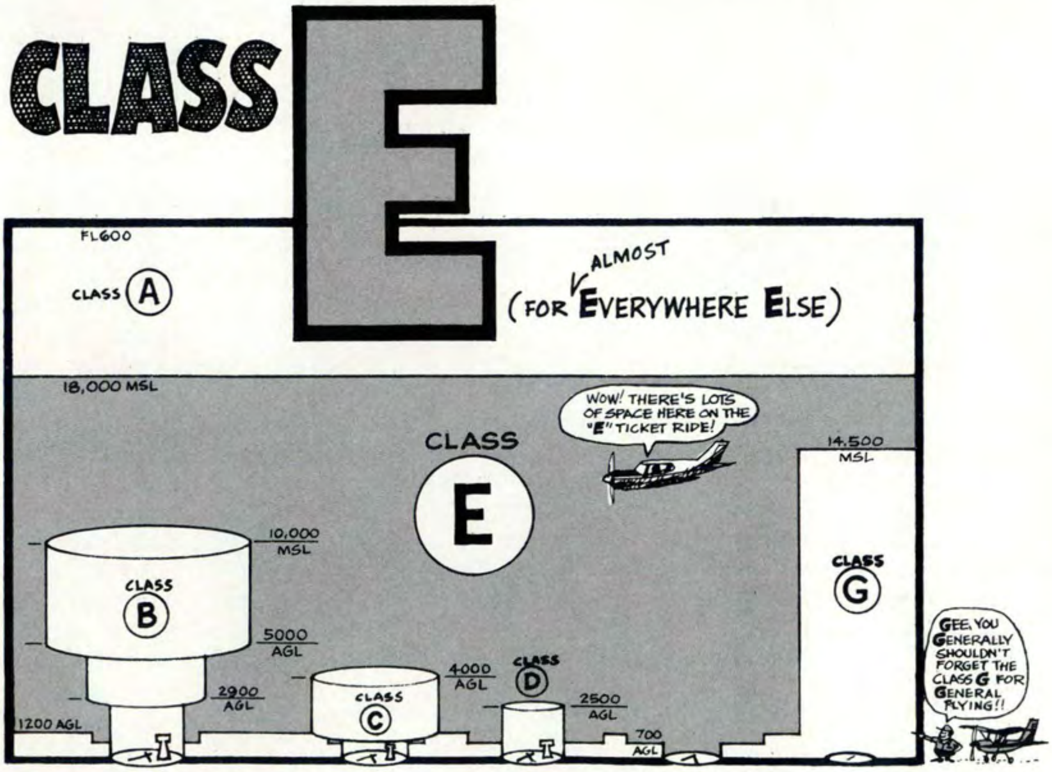
The biggest exposure most pilots will have to Class G airspace is during point-to-point flights or along certain low level routes. All of the potentials for close encounters with civilian pilots attempting to take the shortest flight path home are still in Class G airspace. Watch out for conflicts near mountain passes and along easy-to-identify landmarks.

Gee, since it's uncontrolled, Class G airspace has only one problem — the big sky isn't big enough to keep you safe. ■

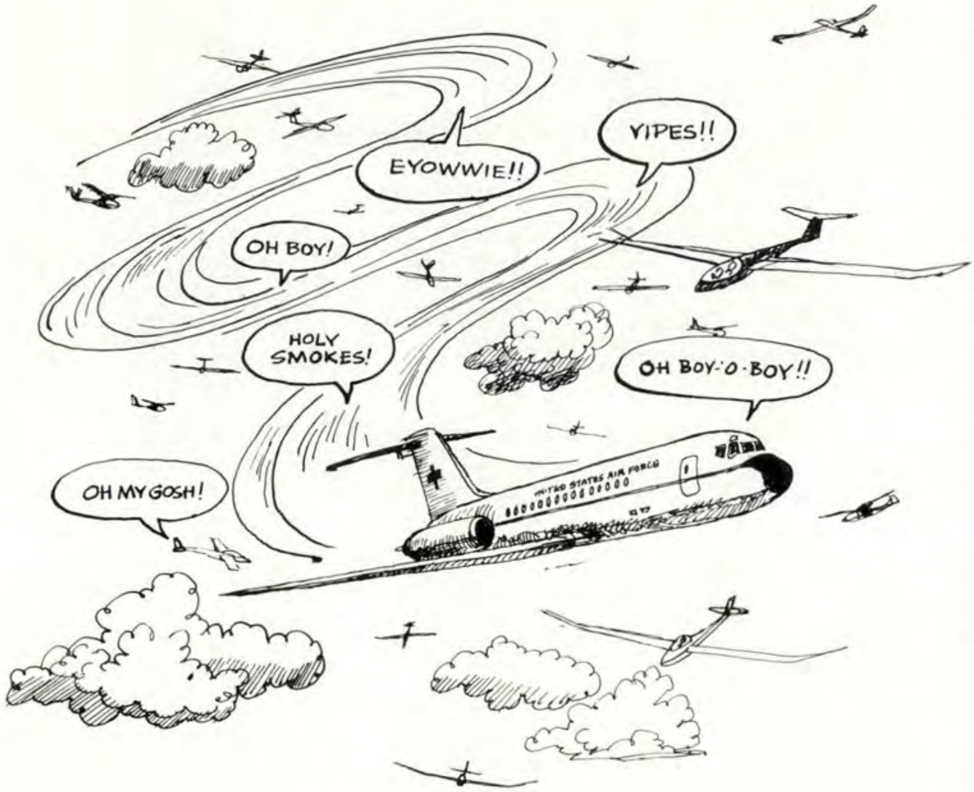
These are the previous chapters of our story …




CLASS D
SOMETHING TELLS ME THIS IS A CLASS D AIRPORT!
OH? HEY, THAT MEANS IT'S THE DINKIEST CONTROLLED AIRPORT, DOESN'T IT??!!!
...ER... WE'D PREFER THE WORD DIMINUTIVE!
D
baer


CLASS E
(FOR ALMOST EVERYWHERE ELSE)
FL600
CLASS A
18,000 MSL
WOW! THERE'S LOTS OF SPACE HERE ON THE "E" TICKET RIDE!
CLASS E
14,500 MSL
10,000 MSL
CLASS B
5000 AGL
2900 AGL
1200 AGL
4000 AGL
CLASS C
CLASS D
2500 AGL
700 AGL
CLASS G
GEE, YOU GENERALLY SHOULDN'T FORGET THE CLASS G FOR GENERAL FLYING!!

OPS TOPICS



Sorry, They've Got the Right-of-Way

■ The traffic call for the C-9 was routine enough. While on departure from a familiar military field, the crew was advised by departure control of "traffic, twelve o'clock, and one mile."

Sure enough, the pilot saw a glider dead ahead and maneuvered to the right to avoid it. But this glider was not alone. The right turn had put the C-9 on a collision course with a number of others circling ahead at altitudes from 4,000 to 7,000 feet. The second evasive turn gave clearance of only a couple hundred feet from one of the gliders.

Even after missing a number of gliders, departure control was still calling traffic at twelve o'clock. The single engine, light airplane passed to the right with 2 miles separation. Obviously, the traffic warning was not for the gliders but for the light airplane. In this case, all of the gliders were operating legally in a VFR environment.

As most radar controllers could tell any pilot, gliders (also called sailplanes) generally don't provide a radar return. They are often constructed of fiberglass which is a poor reflector of radar. Additionally, since their only electrical source is battery power, they usually do not carry transponders. A number of them don't even have a radio on board.

Gliders are most active during the summer months, but they aren't dependent upon thermal activity for lift. Other sources of lift come from winds deflected upward along ridges or mountain wave activity. It's safe to say gliders don't need puffy cu's to go flying.

Depending upon their location, thermals may carry a glider to more than 17,000 feet MSL. Ridge lift has allowed some glider pilots to fly nonstop from Pennsylvania to South Carolina — and return! Gliders flying in mountain waves have achieved heights in excess of 45,000 feet MSL (inside authorized wave "windows").

What all this means to military fliers is that gliders are likely to be found under cumulus clouds, along the windward side of ridges, and on the lee side of taller mountain ranges. There is no "season" for gliders, and remember, they don't show up on radars.

Sorry, but most importantly, gliders have the right of way. It's up to all Air Force aircraft to give way. Since you can't give way if you don't see them, keep your scan up for gliders any time of the year. ■

*U.S. GOVERNMENT PRINTING OFFICE 1993-679-016/60012

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 Mishap Prevention Program.

CAPTAIN
Bruce McClintock

81st Tactical Fighter Wing

■ Captain Bruce McClintock was leading a four ship of A-10s for a live fire demonstration at a local range. After raising his gear on initial takeoff, with the wingmen in 20-second trail, he noticed a red light in the gear handle and the gear unsafe warning horn. A check by the wingman revealed the nose gear was still partially extended and the nose wheel cocked in the wheel well. Attempts to re-extend the gear had no effect on the jammed gear.

After consulting a gear specialist, Captain McClintock recycled the gear with no change to the configuration. The nose gear remained jammed.

After multiple attempts to free the nose gear by inducing positive Gs in a right hand-turn, Capt McClintock accelerated to over 300 kts and accomplished a left-hand, 6.5-G turn which freed his nose gear. With the nose gear now indicating safe, another visual check revealed the nose wheel was cocked 20 to 30 degrees to the right, and the nose gear door had been torn from the aircraft.

Acting on the recommendation of the landing gear specialist, Captain McClintock flew two flawless touch-and-go approaches in an effort to center the nose wheel. By touching down only the main landing gear, he was able to activate the nose gear steering and, on the second attempt, center the nose gear. The final approach and full stop landing were uneventful.

Captain McClintock distinguished himself by calmly and professionally handling an extremely difficult situation. His critical analysis, quick thinking, and superior airmanship saved a valuable combat resource.

WELL DONE! ■

WE'VE MOVED ...

TO OUR NEW QUARTERS AT KIRTLAND AFB, NEW MEXICO OUR NEW ADDRESS IS:

Air Force Safety Agency
9700 Ave "G," S.E.
Bldg 24499
Kirtland AFB NM 87117-5670