flying

SAFETY

JUNE 1988

Thunderstorm Tip Off

Pumping Up Nature's G-Suit

A Superbowl of a Different Sort

Wind-Shear Update

THERE I WAS

■ . . . practicing emergency landings in a Cessna 150. It was the week before I received my private pilot's license. The sky was clear on a beautiful June afternoon with no crosswind. It was a perfect day for flying. I was making my sixth simulated emergency landing when it happened.

On final, approaching the threshold, the prop suddenly stopped. I put the nose down and touched down at about 80 mph. When I had slowed enough, I headed for the grass to get out of the way of the twin engine Cessna that was behind me. As I cleared the runway, I heard him go around.

In the air, there had been no time to attempt a restart. I was glad I didn't bother to try because when I tried it on the ground, it wouldn't start. But after the first try, I saw why. Embarrassment can hit pretty hard. The fuel mixture knob next to the throttle was all the way out. This, in effect, shut off fuel to the engine and caused it to stop.

Proficiency can breed complacency, even in low-time pilots. I had gotten so confident that I didn't bother to look when I pulled the throttle knob back on final. Instead of getting the throttle, I had grabbed the fuel mixture knob and pulled it all the way out. I was concentrating on other things and didn't even notice the different feel of the knob.

I had heard stories about other pilots making dumb mistakes that I would *never* make. Suddenly, THERE I WAS . . . ■

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flying

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SPECIAL FEATURES

REGULAR FEATURES

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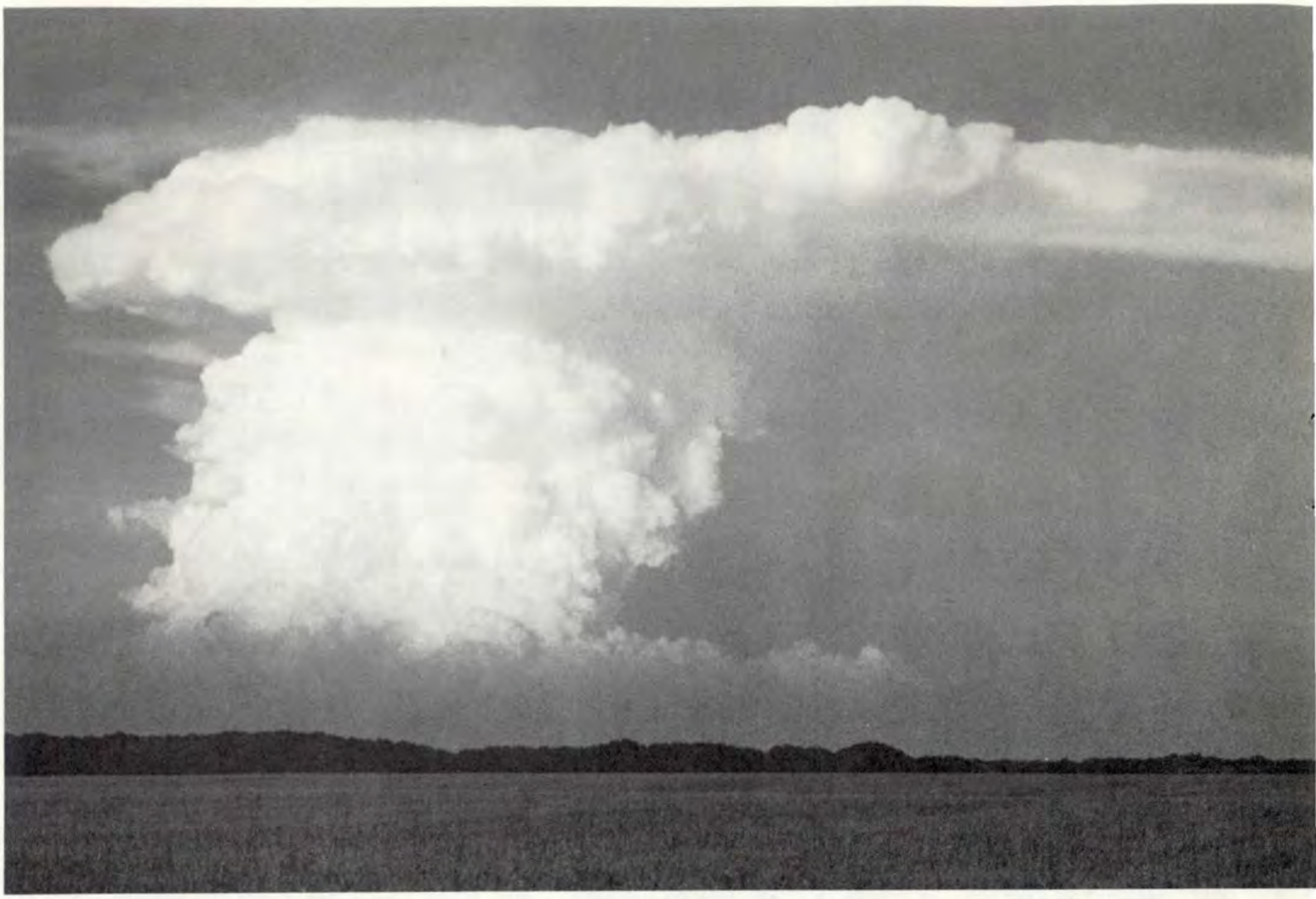


Thunderstorm TIP OFF

LT COL JIMMIE D. MARTIN
Editor

■ Thunderstorms have been around a lot longer than aircraft. But as long as pilots have been flying, they have been tangling with thunderstorms and their effects. The thunderstorm usually wins, but fliers can be awfully stubborn. The following short article appeared in the April 1948 issue of *Flying Safety* magazine. It indicates a lack of knowledge about the aviation hazards of thunderstorms.

"Back in 1945 I cleared IFR from a South American field in an A-26 which was scheduled for delivery in Italy. The wheels were barely up after takeoff, when I was on the gauges. Two hours later at 9,000 feet I relaxed and thought that instrument flying wasn't half bad. Then, without warning, the plane began to lurch violently and started to gain altitude at a terrific rate.

"The large hand on the altimeter wound itself around the dial and stopped abruptly at 20,000 feet. Then I started descending as rapidly as I had gone up.

"Using the needle and ball, I leveled the wings and started to pull out of the dive. I broke out of the overcast at 1,500 feet with an airspeed of over 400 mph and in a 45- to 50-degree dive. By cutting mixture controls, increasing RPM to full low pitch, and pulling back on the control column with both hands, I finally got the A-26 out of its downward plunge just above the tree tops. The only damage was a slightly bent left horizontal stabilizer which had hit an overgrown tree in the jungle.

"At the first opportunity I made every effort to learn all I could about the techniques to use when flying in thunderstorms."

Since that article appeared, we have learned much about all aspects of weather, including thunderstorms. Does all this wealth of information and associated training mean we have learned not to joust with thunderstorms? Unfortunate-

Thunderstorms are one of the most awesome displays of power in nature. We've studied them for years, and it's remarkable that we're still learning more about the way they work, where the hazards are, and how we as flight crews must deal with them.

ly, looking at a few current mishap reports will tell us the answer is — No. *Charge*!

- A C-130 was flying an overwater navigation proficiency flight and maintaining 10,000 feet due to an aircraft pressurization problem. Multiple layers of clouds and haze restricted in-flight visibility, forcing the crew to rely on radar for weather avoidance. While flying 10 NM downwind of a thunderstorm in IMC, they flew under the anvil and encountered severe hail resulting in substantial damage to the aircraft.
- During climb to FL 230, the lead of a flight of four F-16s saw a line of towering cumulus and cirrus clouds extending across their flightpath. After level off in cirrus clouds, the lead used airborne radar to pick his way through the weather. He took the flight between two cells approximately 20 miles apart on his radar. The flight encountered heavy rain, hail, and turbulence before breaking out in the clear. All four aircraft were damaged.
- An F-15 was flying in the clouds at FL 330 and receiving air traffic control vectors to avoid thunderstorms when lightning struck the external fuel tank. The tank exploded and shrapnel severed the right engine throttle linkage and punctured the fuselage fuel tank. The right engine was stuck at 82 percent RPM, and the leaking fuel caught fire. The pilot was able to make a single-engine landing at a nearby base, and firemen extinguished the fire before the aircraft was seriously damaged.

These three mishaps are an extremely small sample of the hundreds that reside in the AFISC computer. The damage ranges from minor to major, but the number of close encounters with thunderstorms indicates our flight crews are still missing some vital knowledge concerning flight in thunderstorm conditions.

This one article obviously won't solve the problem. However, just like chicken soup, "it can't hurt." Most of the information presented here comes from aviation seminars and materials furnished by the Federal Aviation Agency, the Aviation Research & Education Foundation, the University Corporation for Atmospheric Research, and "Weather Avoidance in the Terminal Area" by Henry Lansford. Some of the information is a review and some is the result of recent research.

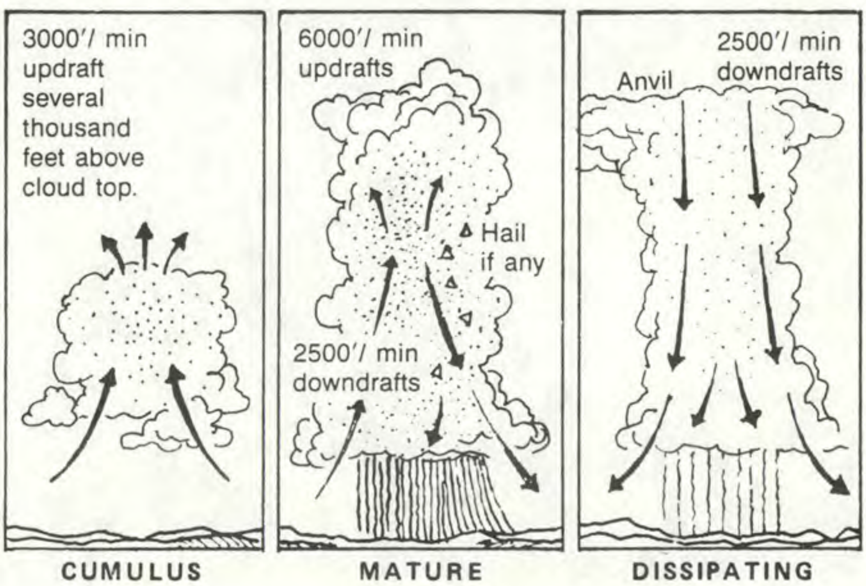
Thunderstorm Primer

First, a basic review. In simple terms, thunderstorms are formed by convection — the upward movement of warm, moist air. As the air rises and cools, it expands and the water vapor condenses into liquid droplets and ice crystals, thereby releasing latent heat that accelerates the upward motion of the air. As shown in the figure, all thunderstorms progress through three stages.

The *cumulus stage* begins if the atmosphere is sufficiently moist and unstable, and the familiar puffy white cloud forms. The cloud continues growing upward, driven by the heat released through condensation in a strengthening updraft.

continued

Figure 1. Stages of a Thunderstorm.



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The *mature stage* is marked by heavy precipitation — rain and sometimes hail — falling from the base of the cloud. This produces a cold downdraft that often drives a horizontal gust front out ahead of the storm. This is the most intense and most dangerous stage of the thunderstorm.

In the *dissipating stage,* the updraft weakens, reducing the supply of heat and moisture that fuel the convective cell. The precipitation grows lighter, and the cell collapses as the downdraft takes control. Some of the worst microbursts may come during this stage.

However, things are never this simple in the real world. Thunderstorm is a term used to describe several different types of storms. It is much like saying you drive an automobile. Just as there are many different automobiles, there are also many different thunderstorms. Let's look at some of these differences.

Thunderstorm Classifications

For convenience, severe-storm meteorologists have classified thunderstorms into four main categories with varying degrees of intensity.

- Single Cell — nonsevere and severe
- Multicell — nonsevere and severe
- Supercell — severe
- Squall Line — nonsevere and severe

A common misconception is that the worst type of weather comes from squall lines. This is absolutely false. Squall lines can be dangerous, but most severe weather usually comes from the super cell which is normally more isolated than the long line of thunderstorms in a squall line. As you can see from this list, single cell, multicell, and squall line types can be severe, although most of these storms are nonsevere. However, supercell storms are *always severe* and very often produce the most extreme severe weather.

Before looking closer at these storm classifications, we need to ask what difference does it make? Are there visible clues the flier can use to judge the severity of the weather? Can the flier pick out the most hazardous areas?

Allan Moller, National Weather Service meteorologist, says, "I think one problem is that we sometimes rely so completely on radar that we neglect visual clues and other valuable sources of data for evaluating weather hazards. Radar is a vitally important tool for detecting hazardous weather, but it shows us only what's happening in part of a thunderstorm — the rainy downdraft region. Even though the updraft is the lifeblood of the storm, providing the heat and moisture that feed its growth, we don't see much of it on the radar screen, because it's precipitation-free, for the most part."

Radar expert, Archie Trammell, affirms that radar tells only part of the hazardous weather story. Although many airborne radar screens display reflectivity intensities in red, yellow, and green, Trammell points out that these familiar colors aren't a traffic light to tell the pilot when to stop and when to go. "You can get your teeth kicked out while flying in the green," he says. Radar is not a go/no go signal, it's a weather analysis device."

Trammell and Moller both emphasize that it's necessary to analyze the structure and strength of a storm to judge how hazardous it is to aircraft. With knowledge of the storm type, and how it is likely to interact with its environment, Moller says fliers can estimate its hazard potential, at least qualitatively. "One of the best instruments we have available to us is our mind combined with our senses — and the basic sense is eyesight. What you see and what you can figure out about what you're looking at are the keys."

Moller is convinced fliers can do a much better job of avoiding hazardous weather if they understand the four main types of convective

Photo 1

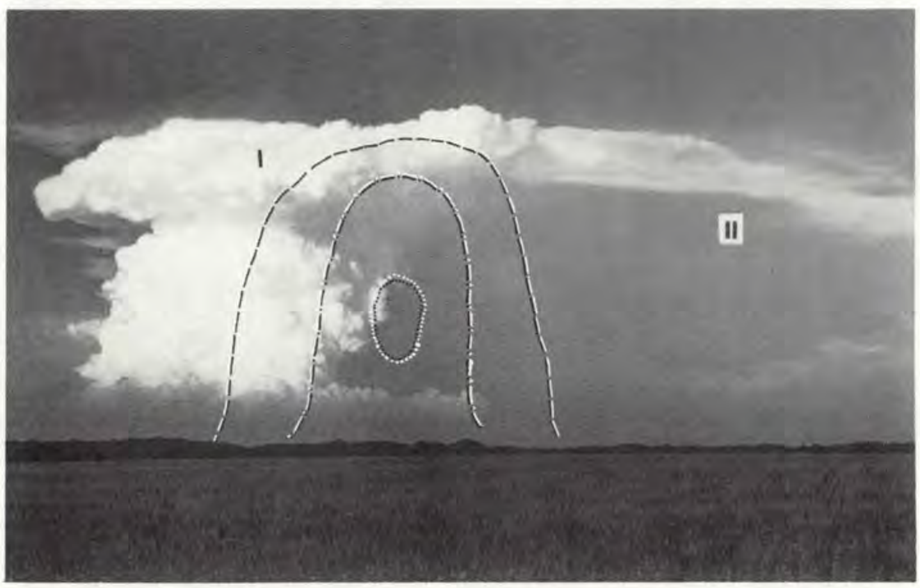


Photo 2

storms mentioned earlier. He cautions, however, that "these main storm types are not discretely different members of a discontinuous array. Rather, they are part of a continuous spectrum, and cannot always be separated from one another. Therein lies the primary difficulty in severe-storm meteorology — trying to determine whether a hybrid storm is more 'this' or 'that' type."

■ **Single Cell Storms** (photo 1)

These storms are relatively rare. They frequently evolve through their three-stage life cycle without producing severe weather, especially when there is little vertical windshear and only moderate instability. Without strong winds aloft, the cloud will grow almost vertically, and the downdraft will cancel the updraft as the storm matures.

The single-cell storm, however, can bring a short episode of severe weather, producing microbursts with or without heavy rain. Because the severe single-cell storm is so small and develops so rapidly, it often appears without any severe-weather warning from forecasters or controllers. Thus it calls for special vigilance from pilots — it was this kind of storm that brought down Delta 191 at Dallas/Fort Worth and Pan Am 759 at New Orleans.

— **Visual Clues:**

When the storm develops with a tilt, it means there is a strong wind shear at altitude (at least 50 to 60 knots).

When the updraft becomes vertically erect after being tilted in the early stages, it is intensifying. Its vertical velocity is increasing, and it is more likely to produce severe weather.

The longer the anvil, the more likely the storm is a severe one. The anvil is blown downwind by the strong updraft and the strong winds aloft.

■ **Multicell Storms** (photo 2) Many single-cell storms evolve into the most common variety of thunderstorm — the multicell storm, usually made up of two to four updraft cells in various stages of development at any given time. Each cell will have a life cycle of about 15 to 30 minutes. Severe multicell storms produce bursts of wind up to 50 knots and hail up to ¾-inch in diameter as each successive cell reaches its strongest updraft stage. Competition between the cells will usually keep the multicell storm from reaching extremely severe proportions.

— **Visual Clues:**

A nonsevere multicell storm will have a relatively weak updraft which tilts downwind.

As the storm becomes severe, the updraft becomes more vertical and develops a midlevel (20,000 to 30,000 feet) overhang.

The strongest downbursts tend to shift from the leading edge of the storm to the trailing flank.

■ **Supercell Storms** (photo 3) Sometimes a multicell storm will move up the spectrum of severity and evolve into a supercell. These powerful storms, which are *always severe* with a high frequency of microbursts, a high frequency of large hail, and often, tornadoes, have nearly vertical, very intense updrafts. They usually develop when there are strong winds aloft

continued

Photo 1. **Single Cell.** The updraft is marked with Roman numeral I, and the downwind anvil is marked II. The dashed pattern represents light precipitation; the dash-dot-dash pattern, moderate precipitation; and the dot pattern, heavy precipitation.

Photo 2. **Multicell.** Roman numerals I and II indicate developing towering cumulus in the flanking line. Roman numeral III is the mature updraft storm top. Roman numerals IV and V are dissipating updraft elements that have "rained out" and become chunks of the downwind anvil. Light, moderate, and heavy precipitation areas are patterned in dashes, dash-dot-dash, and dots, respectively.

Photo 3. **Supercell.** Roman numerals I and II are flanking-line towering cumulus that will merge into the main storm updraft, III before maturing, adding support to the already intense updraft area. The downwind anvil is IV. Light, moderate, and heavy precipitation areas are patterned in dashes, dash-dot-dash, and dots, respectively. The areas from I and II to III will likely contain extremely hazardous wind shears, even though offset from the precipitation area by 5 to 10 minutes.

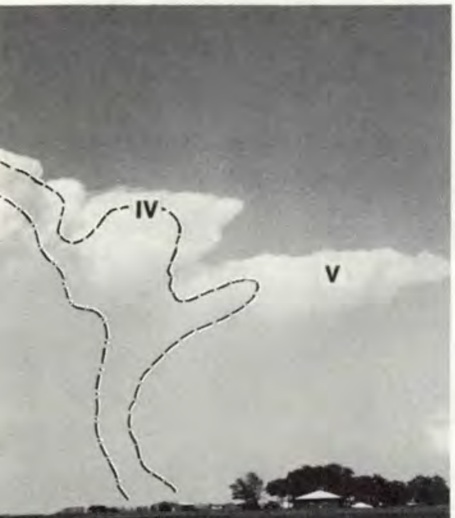


Photo 3

and the wind field below the cloud is veering, producing a rotation of the updraft.

The updraft becomes strong enough to block midlevel winds, forcing them to flow around the storm and resulting in a strong secondary downdraft in the clear air behind the cloud. The low-level spin of the supercell storm produces low pressure at the bottom of the storm, which combines with high pressure aloft to drive the powerful downdraft.

Augmented even more by evaporative cooling from precipitation thrown out of the cloud, this intense rear-flank downdraft accelerates and can produce a violent microburst, or a larger downburst, when it reaches the ground. Thus, a pilot who tries to avoid a supercell storm by flying through the clear air behind the region of cloud and precipitation can encounter violent windshear in the rear-flank downdraft area.

— **Visual Clues:**

The updraft becomes virtually erect.

A wall cloud develops at the rear edge of the storm.

The heaviest rain and largest hail will fall near the trailing edge of the storm.

■ **Squall Line Storms** (photo 4) A squall line is simply a solid or broken system of cells organized along a narrow line. Both multicell and supercell storms can occur in squall lines, although supercell storms usually form in isolation or in small clusters. If a supercell storm forms in a squall line, it often will be the southernmost cell or at an eastward bend in the line.

"A long, solid squall line marching eastward is a good example of a case in which the radar doesn't show you all the danger zones," Moller says. "This type of storm will have an updraft on the front, or downwind, side instead of the upwind side. In many cases, the strong outflow will undercut that and move 3 to 5 miles ahead of the radar echo during the mature stage of the squall line — in the dissipating stage, it can reach out 10 or even 20 miles. This gives you a very strong shear zone that is echo-free, well ahead of the rain area in the squall line.

— **Visual Clues:**

As the squall line intensifies, the downdrafts will move to the leading edge of the line.

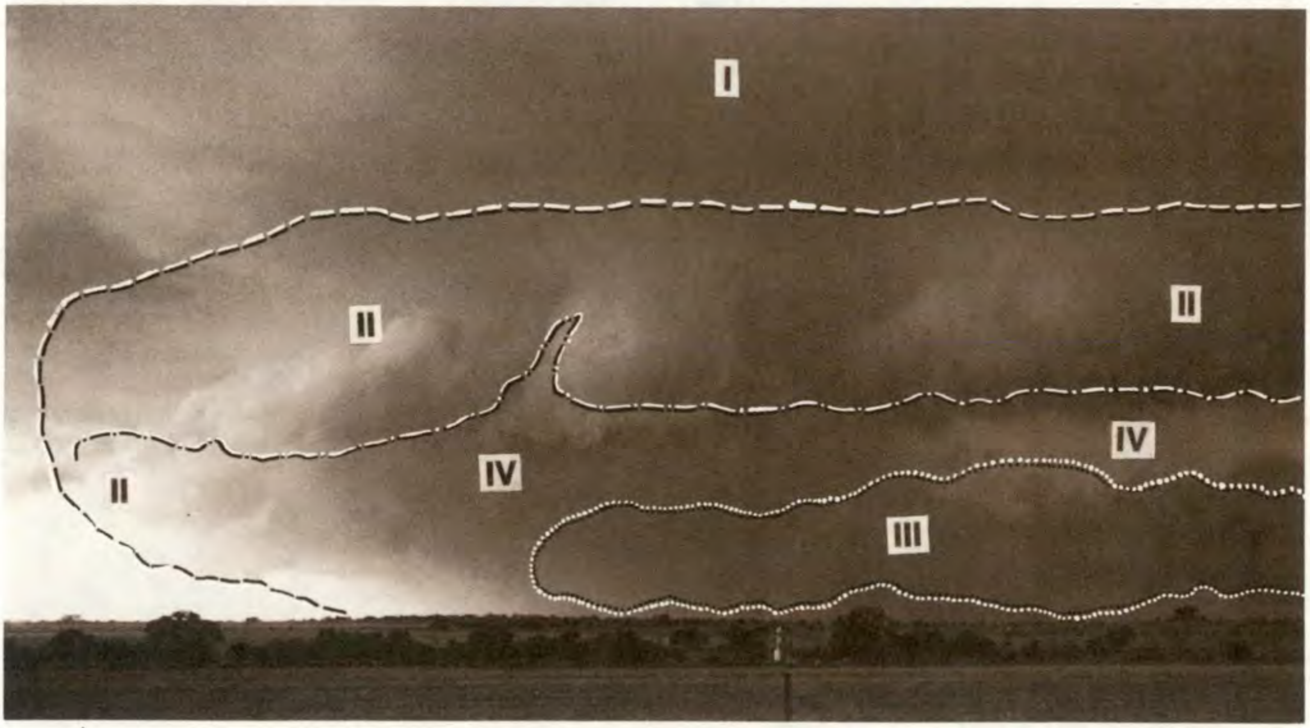
The heaviest precipitation then shifts to the leading edge.

The leading edge gust front intensifies, and the strongest downbursts will come from the leading edge.

Severe or Nonsevere?

We have emphasized the hazards of the severe thunderstorm throughout this article. Does this mean you don't have to worry about the nonsevere? Absolutely not! That's much like saying you don't have to worry about a small dog that's snarling at you, just worry about the big ones. The small dog may not be able to severely maim you, but those little teeth can sure scar up your ankles. Little thunderstorms have teeth, too. Respect all thunderstorms and give them a wide berth. ■

Photo 4. **Squall Line.** Roman numeral I marks the smooth-textured thunderstorm base located ahead of the shelf cloud and the gust front. The ragged, wind-torn shelf cloud is II, and III marks the ragged, wind-torn scud clouds. The ragged cloud structures indicate clouds that are in contact with cold outflow (downburst). The gray-colored rain and hail shafts of severe thunderstorms are marked IV. Light, moderate, and heavy precipitation areas are patterned in dashes, dash-dot-dash, and dots, respectively.



CAPT SEAN P. SCULLY
Aerospace Physiologist
1229th Physiological Training Flight
Andrews AFB, Maryland

Pumping Up Nature's G-Suit

Capt Scully is a former Armed Forces powerlifting champion and Air Force and Armed Forces record holder. His best lifts in competition include a 683-pound squat, 501 benchpress, and 738 deadlift. He has been Head Coach of the Air Force team since 1984, and they have won three of the last four Armed Forces championships. He has coached Armed Forces teams to several National meet victories and was the Head Coach of the U.S. National Team at the 1986 and 1987 World Championships in Holland and Norway. Both teams were victorious over more than 25 other countries. He has been a member of the National Strength and Conditioning Association since 1983.

■ Survival is the name of the game. Just because you haven't had a G-induced loss of consciousness (GLC) episode, or even a little "gray-out," don't kid yourself. The potential is there every time you take the jet up. Maybe your baseline tolerance is a little better than most — so what? When the balloon goes up, you'll be playing for keeps, and there may be no time to improve the baseline. What's your tolerance going to be in the fifth engagement of the fourth sortie of the third day? The time to give yourself the edge is right now.

For a few years now, we've been told how beneficial strength training is for improving our G tolerance. This has been demonstrated by several different research teams in various locations. The message is clear — training the muscles used in anti-G straining significantly enhances a flier's ability to pull Gs. So what should you be doing as a minimum? How does a flier with limited time, and very little experience with any form of strength exercises, approach this challenge? What exercises, equipment, and program should he or she use to "pump up?"

I'm not foolish enough to think all of you will know exactly how to properly perform the exercises I will discuss in this article or you'll understand all of the vernacular (which I will try to minimize). But since I don't have the space to diagram and explain all of these things in detail, I must rely on the squadron gym rats and other experts to give you a hand. With that disclaimer, let's proceed.

Which Equipment?

Many of you probably wonder

continued

Pumping Up Nature's G-Suit

continued

which equipment is the best to use in your training program. I'm very partial to free weights — for good reasons — primarily, for results. Because free weights are "free," they allow your body to move through natural ranges of motion, rather than forcing you to conform to the movement of the machine. With free weights, especially dumbbells, you must balance and control the weights through the full range of motion, which brings more muscles into play and exercises them more completely.

Machines do much of the balancing and controlling for us and don't always accommodate different body shapes and sizes. Dumbbells are especially good for overcoming asymmetric strength problems; for example, having a much stronger right arm because you're right-handed. Very few machines provide this advantage. When it comes to money, there really is no comparison. For a tenth of the cost, you can fully equip your gym with free weights and have the tools available to do 10 times the number of exercises that you would be limited to with a row of machines.

There are some advantages to machines. They can be more convenient in some respects and are considered safer to use. However, improper use of machines or free weights can result in injuries. Regardless of the pros and cons of different equipment and programs, the most important questions to ask are "What will I or my crews be willing to use?" and "Where should the equipment be located so that it provides the 'path of least resistance' to the reluctant pilot or WSO?"

If they're more apt to use machines, then get machines. If they're more likely to catch regular workouts if the equipment is in the squadron, then put it in the squadron. The point here is that strength training of any kind is much better than none at all. Gyms with a combination of equipment types are preferable and probably more attractive to the fliers.

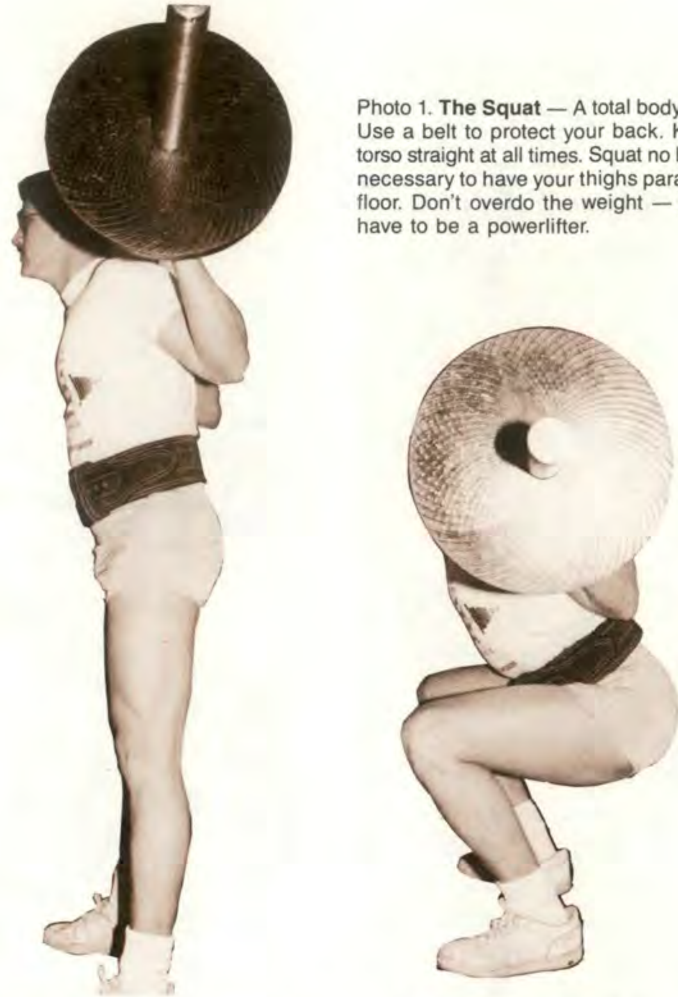


Photo 1. **The Squat** — A total body exercise. Use a belt to protect your back. Keep your torso straight at all times. Squat no lower than necessary to have your thighs parallel to the floor. Don't overdo the weight — you don't have to be a powerlifter.

Which Muscle Groups?

Next, we need to look at which muscle groups are most important to a successful straining maneuver to determine which exercises should be considered. The muscle groups which work in concert with the inflated anti-G suit to minimize blood pooling in the lower extremities are the muscles of the thigh, buttocks, and abdomen. The muscle groups primarily responsible for increasing airway pressure in the chest cavity are the muscles of the upper back and chest.

Another goal of the straining maneuver is to raise mean arterial pressure (MAP). The contraction of any skeletal muscles will assist in raising MAP, but the larger muscle groups already mentioned make the greatest contribution. It is also critical that we include the muscles of the neck and lower back. This is not so much for the benefit of the strain but to avoid injuries commonly encountered in the high-G environment.

Lower Body Exercises

Probably the best resistance exercise available for improving G tolerance is the squat, a total body exercise that stresses the muscles of the legs, hips, lower back, and abdomen, as well as involving most of the larger muscles in the upper torso. The squat, more than other commonly used resistance exercises, is capable of causing tremendous increases in MAP. Some of powerlifting's better squatters, especially in the heavier weight classes, are often plagued with nosebleeds and "redeye" (due to the bursting of several small blood vessels) as a direct result of short, but drastic elevations in blood pressure. The ability to elevate MAP is exactly the training effect we're looking for to provide high-G protection.

Of course, we're not out to make powerlifters out of you, so let's not overdo it. Start with a comfortable weight until you get used to the exercise. Don't let your ego force you to try and stay with a strong training partner. This mistake is made all the time. It takes just a few seconds to change the weight. You'll probably never have to use much more than your body weight in the squat.

The squat still has a reputation of being bad for the knees when, in fact, it has helped many athletes recover from serious knee injuries. You may have some minor discomfort initially, as with any new exercise, but eventually your knees will be healthier than ever. Do the squat with your feet slightly wider than shoulder width apart, and go down to where the thigh is nearly parallel with the floor (photo 1). To protect the back, use a belt, and keep the torso upright at all times.

Other exercises that should be considered for the legs and lower torso include leg presses, hack squats, front squats, leg curls, leg extensions, any variation of situps, or any other type of abdominal exercises. Other exercises offered by various machines, such as leg adductor/abductor, hip flexor/extension, and abdominal exercises may be helpful, but should not be considered primary exercises in your program.

Preventing G loss of consciousness requires constant attention both before and during flight. An important part of your pre-flight prevention program is a regular schedule of weight training, so keep on pumping!

Upper Body Exercises

On to the upper body, chest, and upper back. Probably the most important exercise for the upper torso is the benchpress. If done with free weights (this exercise is definitely more productive using free weights), the benchpress will not only stress the pushing muscles of the upper body (pectorals, triceps, anterior deltoids, etc.), but it may also involve — depending on technique — the pulling muscles (latissimus dorsi, biceps, trapezius, posterior deltoids, etc.) to control the weight and start the bar moving off the chest.

Exercises for developing the upper back ("lats") include lat-pulldowns, wide grip pullups, bentover rows, or any other type of rowing exercise. To avoid lower back injuries when doing bentover rows, use dumbbells, and do one side at a time, placing the opposite knee and hand on a bench or another appropriate elevated surface (photo 2). Also, with this exercise, avoid simply bending the elbow. To work the upper back, you must allow the shoulder to extend all the way up

continued

Photo 2. **Bentover Rows** — An upper back exercise. Use dumbbells and do one side at a time, supporting the other side as shown. To properly work the back, you must lift the dumbbell high enough and lower it far enough to extend your shoulder all the way up and down.

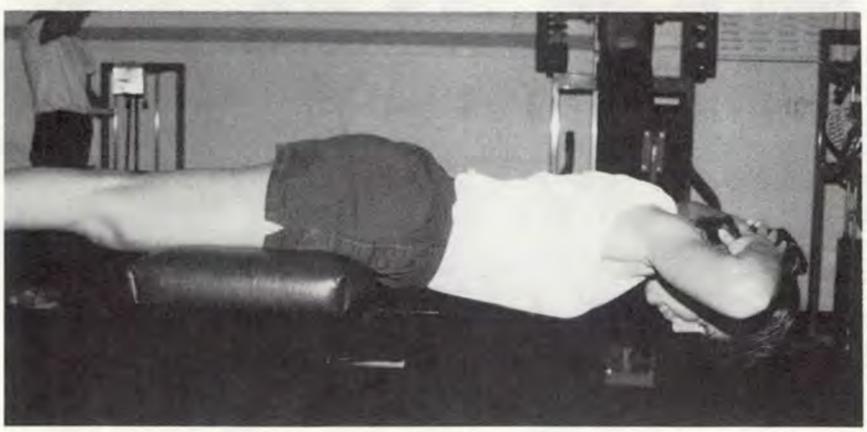
and down. Other exercises for the chest include inclines, declines, flys, pec-decks, and pushups. Pullovers are also excellent for both the chest and upper back.

There are many different exercises that isolate the muscles in the shoulders and arms, but since these muscles are used in the upper torso exercises already listed, and since these smaller areas don't contribute as much to the straining maneuver, you shouldn't spend much of your limited training time with them. I'm not saying you have to give up your "curls for the girls," guys. As a matter of fact, it would be a good idea to incorporate a few sets of some type of curling exercise in your program, since the biceps are usually involved automatically in the straining maneuver as you pull back on the stick. One centrifuge study demonstrated a correlation between increased biceps strength and improved G tolerance.

Abdominal, Lower Back, and Neck Exercises

Abdominal and lower back exercises are your best defense against lower back injuries. As a matter of fact, many doctors now prescribe shorter bedrest and more exercise for patients who have suffered back injuries, resulting in faster recovery and fewer recurring injuries. Probably the best lower back exercise is the hyperextension, which is not as awful as it sounds. It's basically an inverted situp (photo 3). Do hyperextensions very slowly, and don't come up any higher than where the torso is parallel with the floor. The Nautilus low-back machine is also very effective. There are many trunk-twisting exercises which will work both the abdomen and lower back. When doing situps, keep the knees bent.

Photo 3. **Hyperextension** — A lower back exercise. This is not as hard as it looks and will strengthen your lower back muscles to help prevent injuries. Do the exercise very slowly and raise up until your torso is parallel with the floor. Don't go any higher.



To strengthen and protect the neck, there are some simple exercises to use. Some of your gyms have acquired neck machines which are very effective. An exercise I use and prefer is a manual resistance neck exercise. This is done by placing both hands on the back of your head and moving your head from a chin-down to a chin-up position while providing resistance with your hands. After doing several repetitions in that direction, repeat the exercise with the hands on the forehead and then either side of the head, moving the head from side to side against the resisting pressure (photo 4). This is a very effective way to strengthen your neck, but I must warn you that your collars may seem a bit tighter after several weeks of this activity.

A Coordinated Workout

Now let's look at my prescription for pumping up nature's G suit.

Lower Body

Squats — 3 sets: 8 to 12 reps
Leg extensions — 3 sets: 8 to 12 reps
Leg curls — 3 sets: 8 to 12 reps
Situps — 3 sets: 20 to 35 reps
Hyperextensions — 3 sets: 10 to 20 reps

Upper Body

Benchpress — 3 sets: 8 to 12 reps
Bentover rows — 3 sets: 8 to 12 reps (using dumbbells)
Neck/manual resistance — 3 sets: 8 to 12 reps
Dumbbell curls — 3 sets: 8 to 12 reps

General Considerations

■ Always do plenty of stretching prior to your workout. Breathe with each repetition, inhaling on relaxation and exhaling during the hard part of the lift.

■ Start with weights that you can handle fairly easily, then slowly add weight as you become comfortable with the movement. Don't be concerned with quantity of weight — look at quality of the movement.

■ Always do a few warm-up sets with lighter weights before you begin the three sets with the heavier weight you have chosen.

■ Use spotters for safety, when appropriate, and training partners for motivation whenever possible. If you are not sure about form, don't hesitate to ask the experts — most of them love to demonstrate.

■ Go through your entire routine at least two, but no more than three times per week, allowing at least 1 day of rest between workouts exercising the same body part.

■ Establish reasonable goals. Write them down, and monitor your success. Example: "Before my next birthday I will be able to bench-press my body weight for five reps."

■ Don't use the excuse that you are TDY or too busy to work out. You can always find a gym and the time if you are willing. There is nothing wrong with pushups and situps which can be done in your Q-room and will hold you over until you get home.

■ Don't forget to do some aerobic work. There is no scientific evidence to support the myth that moderate aerobic training degrades G tolerance. Get at least 20 minutes (continuous) of some moderately intense aerobic activity three to four times per week. This will not only assist your strength training, but it will do a lot for getting you through those days when you're logging three or more sorties. Some highly trained aerobic athletes have had problems in the centrifuge, so don't overdo it. Aerobic activity that involves the upper body is preferable — rowing and swimming are two excellent forms.

■ Vary number of reps, amount of weight, and rest between sets (not all at once) in order to get through "plateaus" in your lifting where you don't seem to be progressing towards your goals. Basically, you should stay with the same weight until you can do 12 reps for 3 sets before increasing the weight.

■ Of course, good nutrition, adequate rest, and plenty of water are as important to a good workout as they are to a safe mission. If you don't already think of yourself as a professional athlete, think again — you are! Happy hunting! ■

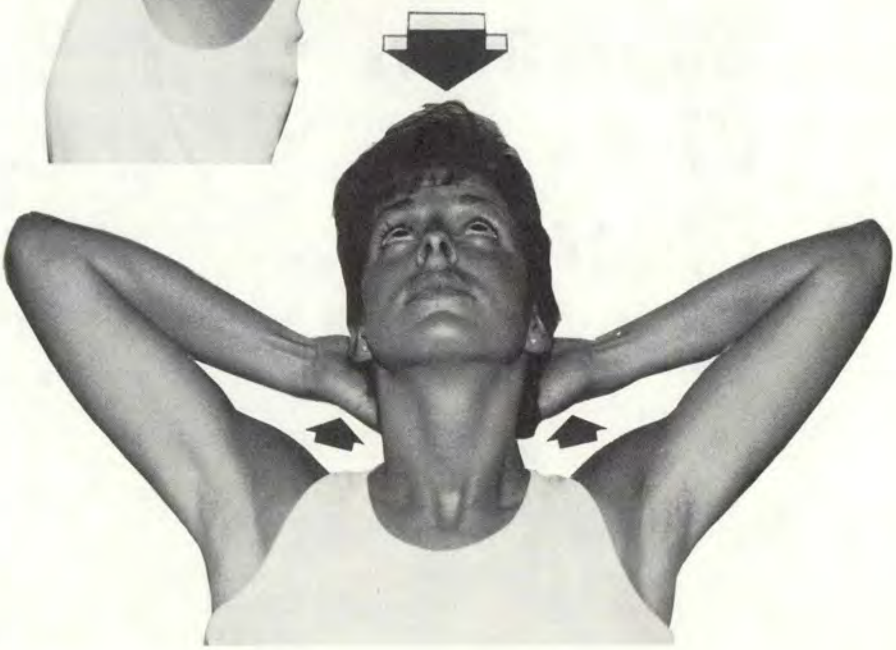


Photo 4. **Neck Manual Resistance** — A neck strengthening exercise done in four stages. In each stage, use your hands to resist the movement of your head from full forward to full back; full back to full forward; far left to far right; and far right to far left. Perform the exercise slowly and do each one several times before going on to the next one.

A Superbowl Of A Different Sort

CAPTAIN ROE McGRATH
67th Aerospace Rescue and Recovery Squadron

■ It was 2200, and Superbowl XXII was only an hour away. Although I am no great Superbowl fan, it is fun to watch. And besides, the game would help time pass as the rest of the crew and I sat out our week-long rescue alert at Keflavik, Iceland.

I had just settled in a chair, half reading an aviation magazine and half watching the pre-Superbowl hoopla, when I heard the phone ringing next door. It was the aircraft commander's room. Because he wasn't there, I answered it. On the other end of the phone was the Detachment 14 commander, inviting our crew to participate in a search and rescue mission. That set in motion the alert process which would get our HC-130 airborne in as little time as possible. The Superbowl was an hour away — it looked like we weren't going to be one of the millions who would watch to see if Elway would qualify to have his face plastered on Wheaties boxes.

As I hung up the phone, I yelled to the copilot that we were alerted and it was time to rock and roll. We threw on our flight suits, met up with the aircraft commander, and proceeded in haste to the Det 14 Ops Center. In the meantime, our flight engineer, loadmaster, and radio operator readied the airplane with the aid of our two crew chiefs. The two pararescue specialists were checking their gear in case it would be needed.

As our flight crew approached the Ops Center, we wondered if we would be sent to look for an airplane that was overdue or running out of fuel and would not make land, or if a ship had an injured sailor that needed air evacuation to a hospital. After all, we were missing the Superbowl, and there had better be a pretty good reason to make us miss this "world-class" event.

We teamed up with the HH-3 helicopter crew and found that the reason we were missing the Superbowl was indeed valid — very valid. There had been a "snow flow" in one of the Icelandic parks that left one hiker missing. Although the weather was good, the temperature with wind chill was well below zero degrees Fahrenheit. The Icelandic rescue forces requested the HH-3 airlift a doctor, two dogs, a five-man team, and 500 pounds of supplies to the search site. The site was 190 nautical miles east of Keflavik. The HH-3 would need air refueling to safely make the mission and return to base.

We activated our scramble flight plan and flew to the search site as a weather ship for the helicopter. As the helicopter came on scene, we rendezvoused and transferred 1,500 pounds of fuel. The helo then flew to the search site which sat at the base of some snow- and ice-capped mountains. Our HC-130 would now provide communication, navigation, and weather support for the HH-3 as it downloaded its cargo. By this time, the Superbowl was over, yet here in the obscure mountains of Iceland, another Superbowl was starting. Brave and determined people were combining in an effort to beat the odds — especially weather — to find the missing hiker.

Our job was almost finished. The rescue team decided to wait until daylight — 1000 in Iceland this time of year — to start the search for the young man. We were heading home, but our troubles were not over.

The air refueling hoses on the HC-130 weren't operating properly. This, combined with the turbulent air, left the fuel-short HH-3 crew wondering if they would themselves end up in some obscure, remote area of Iceland's southern coast. However, through expert airmanship and mechanical knowledge, the two airplanes were able to rendezvous once again and pass gas as the helicopter's fuel low warning lights were blinking.

Both our aircraft recovered ops normal. The time was now 0500. The celebrations in Washington DC were still in full swing as people made merry over their victory. We had missed the event. Someone on the crew had joked that an air medal was in store for us because we missed the Superbowl. But deep down inside, we all knew that working to save others is part of our job. After all, *this we do* — missing the Superbowl included — *that others may live.*

The sad part of the story is that the Superbowl on the barren Icelandic slopes had, too, its winners and losers. The hiker was found, but not as a survivor. Our sympathies to the family. ■

To complete its rescue mission safely, the HH-3 required air refueling by the HC-130 Hercules. First flown in 1964, the HC-130 Hercules is an extended-range, search and recovery version of the C-130 transport aircraft. Twenty HC-130s were modified with refueling drogue pods and associated plumbing for rescue missions. These aircraft are capable of refueling HH-3 and HH-53 helicopters in flight, thus greatly extending the helicopters' range.

The HH-3E "Jolly Green Giant" is well equipped for its rescue operations from either land or water. Originally developed for aircrew rescue missions deep into North Vietnam, it is currently used for search and recovery of people and aerospace hardware in support of global air and space operations. The Jolly Green Giant can accommodate 15 patients on litters, or 25 combat-equipped troops, or 5,000 pounds of cargo.

THE LONG AND SHORT OF IT

CMSGT AUGUST W. HARTUNG
Directorate of Aerospace Safety

■ Soon after takeoff during the initial climb to flap retraction altitude, the KC-135 pitched down from its normal climb attitude. The pilot had to use excessive back pressure to regain the required attitude. Later, even with the yoke full forward, he was unable to level the tanker.

The aircrew declared an emergency and used the stabilizer trim to control the aircraft's pitch. Two T-37 chase aircraft confirmed the horizontal stabilizer was near the full nose down position (leading edge up) and the elevators were split.

Through some skillful flying, the crew was finally able to land their tanker uneventfully.

Looking Back

A review of aircraft maintenance records showed a left elevator control pushrod had been changed 3 days prior to this mishap flight. When the investigators checked the left elevator control rod, they were surprised to see the rod installed was actually a right-hand control rod. Although both rods look the same, the left side rod is 2½ inches shorter than the right side rod.

Setting the Stage

Going back a little further, a 5-level aero repair (AR) technician had found a broken grease seal on the left elevator control pushrod while the aircraft was undergoing a phase inspection. The technician went to the applicable −4 aircraft parts book and attempted to order a left-hand elevator control rod, but because of a confusing group assembly parts list (unclear differentiation as to left or right control rod), he inadvertently requested a right-hand control rod. When told the part was not on hand in supply, he backordered what he thought was a left control rod "BQ" status.

A few months later, supply delivered a right-hand control rod to the AR shop. (If you recall, the technician thought he ordered a left-hand control rod.) Ironically, on this same day, a different AR technician troubleshot another KC-135 aircraft and, finding a defective left-hand control rod on this second aircraft, removed and brought it to his shop.

There the AR technician and his shop chief compared this rod to the new one just received for the other aircraft. When the two determined the supply-issued control rod was not the one required because it was too long, they placed the new control rod in the parts holding area within their shop.

The Deed is Done

Now a shift change occurred in the AR shop. When the swingshift came in and started checking for things to do, someone noticed the backordered "BQ" elevator control rod in the parts holding area. So the swingshift AR supervisor disthe same, he counted the threads on both ends and installed the new rod. With assistance from his team members, the supervisor performed an elevator travel check.

During the check, he found no binding. So he pulled the elevator down to check for the fairing of the elevator to the stabilizer and, considering the wind velocity, thought it seemed pretty good. After the two team members returned from the cockpit, the area was cleaned up and the 781 forms signed off.

Lessons Learned

This incident is a reminder that even routine tasks that have been carried out successfully many times in the past, can result in a high accident potential situation when there is any change to expected conditions.

Probably the most obvious change to expected conditions in this incident was the inexperienced 5-level technician, with less than 5 months in the AR shop, attempting to order a part for the first time from a confusing parts listing.

Another change was that the unit was undergoing a major command inspection. This may have contributed to the confusion at shift change.

With an incomplete shift turnover of tasks, the swing shift saw a new flight control rod to be installed and pressed on. But they changed their normal procedures by dispatching to several jobs and taking the control rod with them, instead of removing the old part, bringing it to the shop to compare and adjust the new one, and then returning to the job.

The team leader changed his established procedures when he left the job site to return to his shop, get the supervisor, and work still another job.

And then there was the change in weather. The gusty wind may have added additional pressure for the technicians to complete the task.

Only through vigilance and by learning from incidents such as this can we avoid repeating situations with such high mishap potential. After all, that's what flight safety is all about. ■

patched three of his technicians to remove and replace the control rod with the worn grease seal on the aircraft that had been through the previous phase inspection.

Since the trio had several jobs to work on the flightline, they took the new control rod with them. What they didn't know was this part was a right-hand elevator control rod which is 2½ inches longer than the one they needed for the left side.

Their procedure this time of taking the part with them was contrary to their established procedure of removing an old part and bringing it to their shop. There they would compare the new part to match the old, and then take the new one to the aircraft for installation.

When the AR team arrived at the aircraft and found the control rod access panels still installed, their team leader directed his two associates to remove the panels while he returned to the shop to get the supervisor to work another job. When the team leader and supervisor returned to check on the workers, they found the panels and control rod nuts removed, so they assisted with removing the old control rod. The weather conditions at this time consisted of winds at 19, gusting to 28 knots.

The supervisor grasped the two rods about ⅓ of the way down from the threaded ends, held them a foot apart, and saw they looked alike. To make sure the rods were adjusted

WIND-SHEAR UPDATE

MAJOR LINN L. VAN DER VEEN
Directorate of Aerospace Safety

This is the first of two articles that will update USAF aircrews with the latest wind shear information, particularly microburst wind shear. The first article will pass on the basics of how wind shear occurs, the effects it has on aircraft, and the latest techniques for detecting microburst wind shear. The series will conclude next month with a discussion of the latest alerting and recovery guidance systems in use on many commercial aircraft, the FAA's recommended recovery techniques, and some microburst probability guidelines to assist you in weather assessment.

■ When you hear "wind shear," what do you think of? — frontal passage, massive thunderstorms, microbursts, and airline pilots ignoring obvious warnings? Not a problem for *you* because you avoid it, and if you do encounter it, your skills and your jet or your crew can pull you through? Between 1976 and 1986, wind-shear related mishaps accounted for nearly 40 percent of the fatalities that happened in U.S. air carrier mishaps. Because of this, an industry-wide study was under-

The aviation community is experiencing wind-shear mishaps at the rate of one every 18 months. In most cases, investigators point to weather clues that should have been apparent to the crew, but were ignored, misunderstood, or misinterpreted.

taken in 1986 to analyze past wind-shear mishaps and incidents. Additionally, National Aeronautics and Space Administration's (NASA) National Center for Atmospheric Research, National Transportation Safety Board (NTSB), National Weather Service, and National Oceanic and Atmospheric Administration's (NOAA) Environmental Research Labs have continued extensive research into wind-shear characteristics and effects.

As a result, we've learned much more about how microbursts form, how they evolve after ground contact, and how to avoid and survive them. This article will present the findings of these studies, and will also relate the latest methods recommended by the FAA for flight crews to improve their ability to avoid wind shear, and to react quickly and correctly if they do encounter an unexpected wind shear on takeoff or landing.

Before we go any further, though, let's emphasize one point: There is no "safe" way to encounter wind shear. The recommended solution is to *avoid* it. This article will update your knowledge of detection and avoidance methods and offer survival techniques only for those instances where it cannot be avoided.

The National Weather Service defines severe wind shear as a rapid change in wind velocity/direction that results in an airspeed change of more than 15 knots, or a vertical speed change of 500 feet per minute. The fatality statistics mentioned earlier speak dramatically of the lethality of these encounters.

Wind-Shear Conditions

As you probably remember from UPT or IRC, wind shear can result from a variety of conditions. The most dangerous shears are produced by either nonconvective frontal conditions or convective air masses such as thunderstorms. Nonconvective frontal conditions are usually predictable and easily tracked, making them fairly easy to avoid. Unfortunately, dangerous "microbursts" can be generated by any convective airmass, from single cells to supercell thunderstorms.

A microburst is a downdraft that is only a few hundred feet to 2.5 miles in diameter. These are usually caused by a heavy rain shaft that generates an intense, violent outflow of air near the ground (figure 1). One obvious result is sustained downdrafts. Short duration reversals in vertical winds and severe horizontal rotational vortices can also travel outward from the downdraft. Some other facts:

- Microbursts may not be symmetrical; the outflow on one side of a microburst might be more severe than the outflow from the other side (figure 2). In the worst case, this may mean that flying into an area is survivable, but flying out of it is not.
- Most microbursts are "wet," occurring in conjunction with thunderstorms and heavy rain. There's also another type of microburst that forms when precipitation (called "Virga" in this case) falls from convective clouds with bases from 500 to 15,000 feet MSL. This rain may evaporate before it hits the ground, but these "dry" microbursts are as severe as those generated by thunderstorms and more insidious, since they occur without many of the visual cues that accompany thunderstorms.

continued

Wind-Shear Update

continued

■ The average wind speed change in 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. 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.

■ 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*.

■ 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.

Statistically, microbursts usually occur in midafternoon, during summer months. Five percent of the cells and thunderstorms studied generated microbursts.

Effects of Wind Shear

The recent efforts to understand microbursts, and microburst mishaps, brought together pilots, engineers, and meteorologists. One of the earliest results was computer models of mishap wind components. These models were then used in simulators, as investigative tools to compare reactions to information recovered from the mishap flight data recorders, and also as training aids to teach recognition and recovery techniques. Several interesting and significant discoveries came out of the simulation and investigation experience:

■ Most who encounter moderate wind shear without warning will crash.

■ Even if warned, a pilot not trained to respond will usually crash if severe wind shear is encountered.

■ Expectation of wind shear, a valid warning system, and response training increase the probability of a successful response.

■ Although most aircraft are designed to survive the average microburst wind speed change of 40 to 50 knots if recovery is commenced early, some microbursts are so strong they cannot be successfully traversed regardless of superior piloting skills and excess thrust. An event at Andrews AFB, Maryland, in 1983, had headwind and tailwind differentials measured in excess of 200 knots, and it occurred minutes after Air Force One landed with the President on board.

■ Because of the pressure differentials that occur within microburst areas, the pitot-static instruments may significantly lag actual airplane performance.

■ Wind shear onset was quite difficult to recognize, and there was very limited time available to react — often no more than 5 seconds.

■ Takeoff Wind Shear

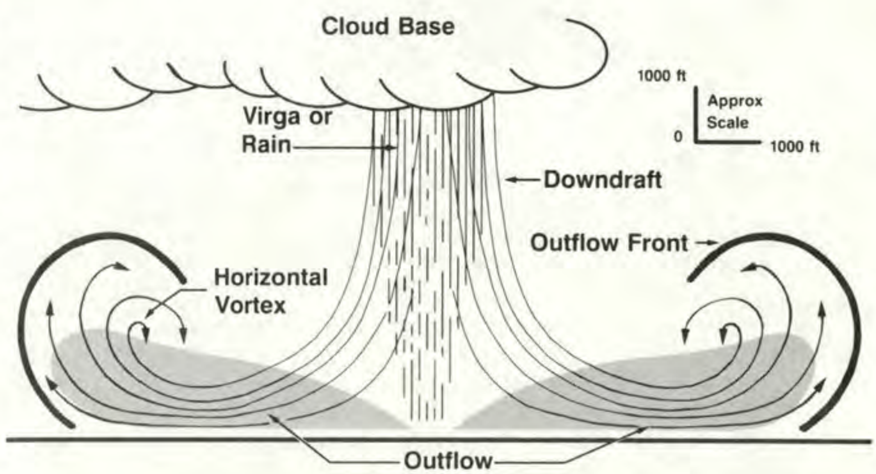
— If the wind shear was encountered before a stabilized climb was established, it was more difficult to detect. If not immediately recognized, decreasing airspeed and the resultant loss of lift, and the natural pitch-down tendency of most aircraft, resulted in a reduced climb rate or a loss of altitude.

— In many cases, pitch attitude was allowed to decrease 5 to 10 derees below the normal value before the crew took corrective action to control the flightpath. This sometimes required using unusual stick forces. However, if pilots took this action and accepted the low airspeed, critical flightpath degradation could usually be prevented.

— Wind shears on the runway were especially difficult to recognize, since the only indication might be a slower-than-normal airspeed increase. If taking off at reduced thrust, an immediate increase in thrust was necessary to provide increased performance potential. Higher-than-normal pitch attitudes and control forces might be required to keep flying.

■ On approach, researchers noted that a decreasing performance trend could be masked by gradual increases in thrust. They also speculated that the poor weather often associated with wind shear caused an increased workload that detracted from proper instrument monitor-

Figure 1.



Symmetric microburst. An airplane transiting the microburst would experience equal headwinds and tailwinds.

ing, which also contributed to delayed wind-shear recognition.

Detection

While avoidance is the obvious answer to this threat, the question of how and what to avoid is not so simply answered. There is no system capable of predicting the intensity of wind shear along the intended flightpath. Even the latest weather forecasting equipment, such as Doppler radar, cannot adequately forecast wind-shear situations. However, there are some very important clues that indicate the potential for microburst wind shear may exist.

Departure or arrival weather calling for gusty winds, heavy rain, or thunderstorms should alert pilots to the potential for "wet" microburst conditions. A reported 30- to 50-degree Fahrenheit temperature and dewpoint spread, combined with surface temperature above 80 degrees, should be a warning that conditions are right for "dry" microbursts. Dry microbursts tend to occur in the mountain and high plains regions of the United States. Terminal weather may even include a low level wind-shear forecast derived from National Weather Service observations. The preflight weather check should also include a check of convective sigmets.

Visual clues of wind shear may be encountered by the pilot. In fact, in every one of the seven fatal wind-shear mishaps that have occurred since 1970, the pilot continued the approach or takeoff in visible and known thunderstorm conditions. Other visual clues include Virga from high based cumulus clouds; localized blowing dust, especially in circular or elliptical patterns; rain shafts with rain diverging away from the core of a cell; and of course, any indication of tornado-like activity.

The Low Level Wind-Shear Alert System (LLWAS) is another source of information about potential wind shear activity. It is in use at over 100 U.S. civil airports. The system detects wind speed and direction variances between five outlying sensors and a reference sensor located at, or near, center field. LLWAS was designed in the 1970's to combat what researchers thought was the biggest threat — frontal wind shear.

It proved not only that microbursts were the worst threat, but that many microbursts were small enough to enter the sensor array undetected! LLWAS can detect the outflow of the microburst, but since it's already on the field, the warning may be too late. However, LLWAS does assist air traffic control in detecting relevant terminal wind information that can then be passed to the pilots.

On-board weather radar should be scanned for convective weather echoes in the immediate terminal area, although in some cases, such as the "dry" microburst, a hazardous wind shear may reflect weak echoes or no echoes at all.

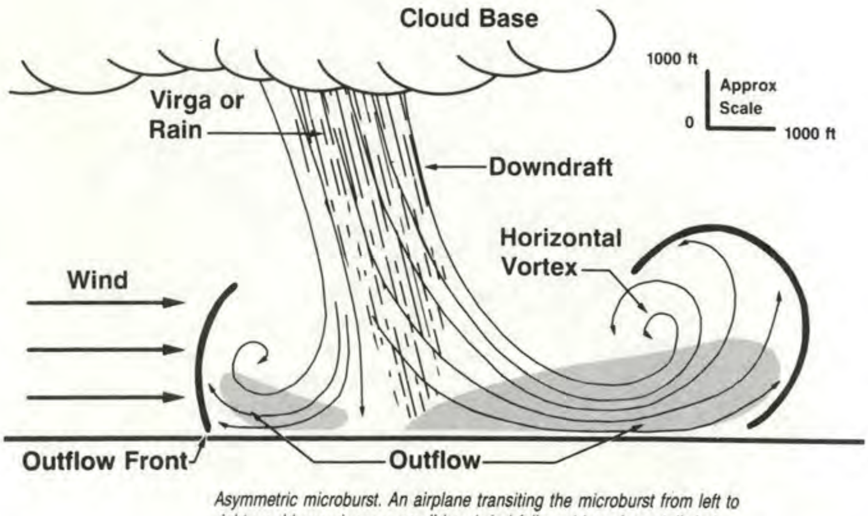
The PIREP is one of the best sources of wind-shear information. The PIREP should include the location where the shear was encountered, an estimate of its magnitude, the type of airplane involved, and most importantly, a description of what was experienced, such as turbulence, airspeed gain or decrease, glidepath problems, etc. Since microbursts are known to move and intensify, though, don't "press on" just because the guy in front made it through.

All of these clues should be kept in perspective, since some are obviously more important than others. It's important to understand that each piece of evidence is cumulative, and as more of the indicators become present, the potential for microburst wind-shear activity is higher.

Next Month

Use these clues to help avoid wind shear. Next month, I'll continue the update with the latest on alerting systems, both airborne and ground based. You will also learn about the recovery guidance system in use on many commercial aircraft. Finally, I will include the FAA's latest recommendations for recovering from a wind-shear encounter and some microburst wind-shear probability guidelines to help you assess weather. In the meantime, continue to approach spring and summer weather with extreme caution! ■

Figure 2.

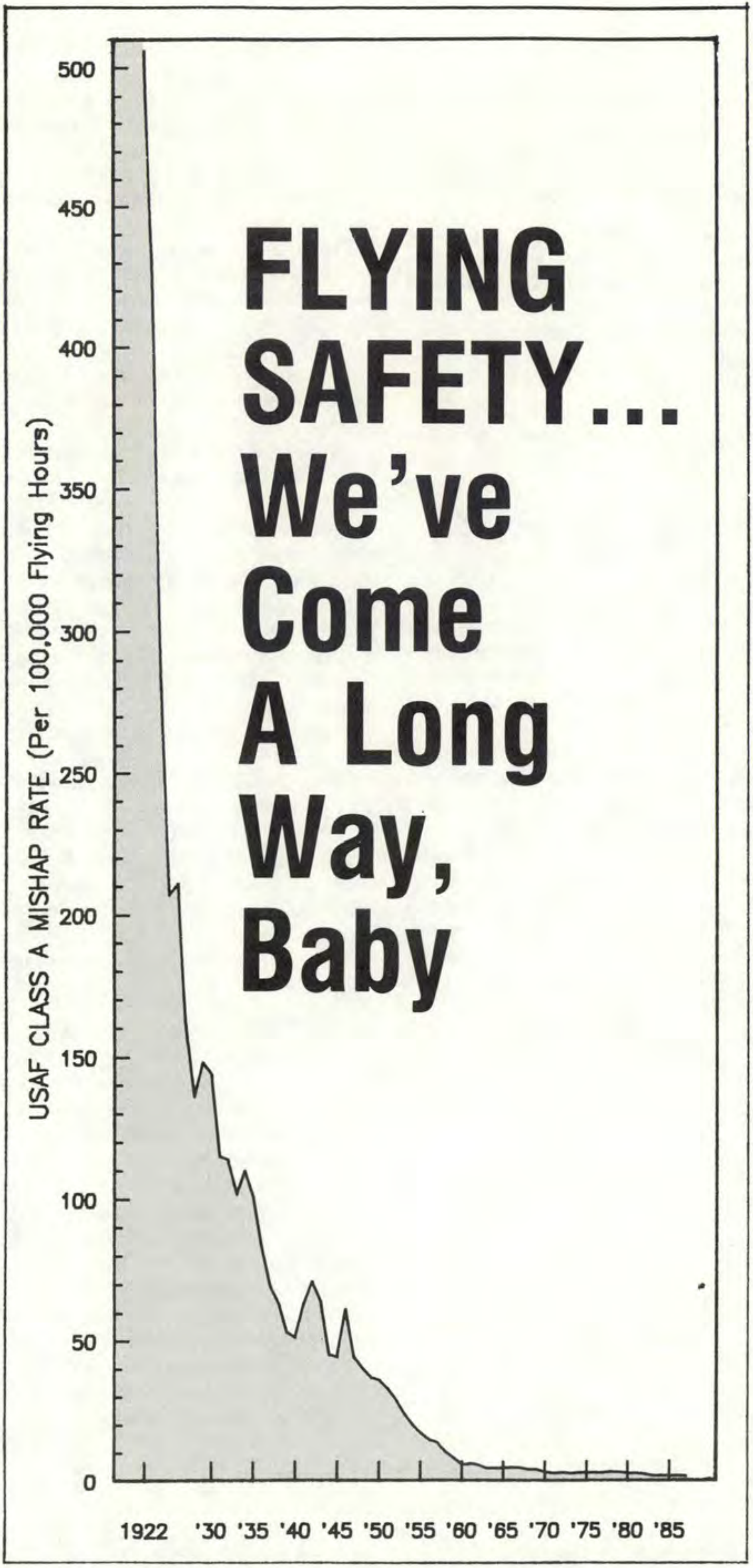


Asymmetric microburst. An airplane transiting the microburst from left to right would experience a small headwind followed by a large tailwind.

Sources for this information are:

1. *Windshear Training Aid*, U.S. Department of Transportation, Federal Aviation Agency, February 1987.
2. Papers presented to, and notes from seminars, at the Second Aviation Problems Seminar on Low Level Wind Shear, conducted by National Weather Service and Federal Aviation Agency, 2-3 December 1987.

FLYING SAFETY... We've Come A Long Way, Baby



LT COL JIMMIE D. MARTIN
Editor

■ The first U.S. military aviation mishap involving powered flight occurred before the Army even owned an airplane. The crash was at Fort Myers, Virginia, on 17 September 1908. The occasion was the final flight in the acceptance trials of the first aircraft purchased from the Wright brothers.

Lieutenant Thomas E. Selfridge was flying with Orville Wright. After they had been airborne about 3 or 4 minutes, the aircraft suddenly nosed over and crashed at a steep angle. Lieutenant Selfridge was fatally injured and died several hours later. Orville was seriously injured and hospitalized for 7 weeks. Thus, the first powered flight of a military man ended in his death — not a very auspicious beginning for military aviation and flying safety.

The Army ordered an investigation to learn the cause of the mishap. The investigation consisted of observing the remains of the crashed aircraft and taking witness statements. The board found a new, longer propeller contacted a rudder guy wire and eventually caused the wire to come out of its socket. This allowed the rudder to fold sideways, and the pilot lost control.

This first mishap investigation was very unsophisticated as compared to our investigations today. But, so were the aircraft. The purpose was the same — to find out what happened so it could be prevented from happening again. And it worked; the Wright brothers designed an improved version of their aircraft with structural changes that ensured the propellers could not hit any guy wires. This marked the beginning of the flight safety program that is so familiar to us today.

Safety Warrior

Lieutenant Thomas E. Selfridge suffered the sad fate of being the first military man to die in an aircraft crash. In this photo, rescuers are removing Lieutenant Selfridge from the wreckage of the Wright Flyer while Orville Wright is tended by the people on the right.

This aircraft crashed near El Paso, Texas, in the early 1920's. It was during this period that the Army first began to keep records of mishap rates. The chart on page 20 shows how far we have come.

By the time this ground collision occurred in 1932, the Army's mishap rate had dropped to about 20 percent of what it had been only 10 years before. Safety had come a long way, but still had far to go.

Early Safety Program

The safety record of the early military fliers was dismal to say the least. Fortunately, they usually walked away from the crashes uninjured or at least, not seriously injured. The first serious mishap occurred during training at Fort Sam Houston, San Antonio, Texas, on 10 May 1911. Lieutenant G.E.M. Kelly took off on his primary pilot qualification flight in the Army's second aircraft, a Curtiss. The aircraft crashed during landing, and Lieutenant Kelly died a few hours later due to a skull fracture.

This was the final straw for the commanding general of the Maneuver Division who was fed up with the many crashes that had been occurring. He took the first positive action to solve the flying safety problem — he prohibited further flying at Fort Sam Houston. Problem solved.

The fliers were not satisfied with this solution. They moved the flying school back to College Park, Maryland, where it had started. The instructions and rules they operated with were much simpler in those days. For example, the instructions issued with the 1911 Curtiss aircraft included the following gems.

- "When the mechanism is facing into the wind, the aeronaut should open the control valve of the motor to its fullest extent, at the same time pulling the control pole toward his middle anatomy.

"When sufficient speed has been attained, the device will leave the ground and assume the position of aeronautical ascent.

- "Should the aeronaut decide to return to terra firma, he should close the control valve of the motor. This will cause the apparatus to assume what is known as the 'gliding position,' except in the cases of those flying machines which are inherently unstable. These latter will assume the position known as 'involuntary spin' and will return to earth without further action on the part of the aeronaut.

- "On approaching closely to the chosen field or terrain, the aeronaut should move the control pole gently toward himself, thus causing the mechanism to alight more or less gently on terra firma."

The Army didn't track mishap rates in those days. But, in 1914, the War Department issued a memorandum recapping the mortality record in army aviation. Between 1908 and 1914, there were 11 fatal mishaps. These cost the Army 12 commissioned officers, 1 noncommissioned officer, and 1 civilian.

In 1921, the Army began keeping track of mishap rates. That year the Army flew 77,000 hours and had 361 major mishaps. When converted to the type of rate we use today, that equates to 467 mishaps per 100,000 hours. If we flew like that today, we'd be crashing 1,350 aircraft per month and use up our entire inventory in 7 months.

The following year, 1922, gave us our highest mishap rate on record — 506 per 100,000 hours. But, as our aircraft and our training improved, the mishap rate also slowly improved. By 1934, when the Army was involved in carrying the mail, the rate was 110 per 100,000 hours, but we lost 54 pilots. Oscar Westover, the Army's Chief Aviator, tried to solve the problem with an approach similar to the one used at Fort Sam Houston in the early days. He sent a message to all his zone commanders saying: "There will be no more accidents." B.Q. (Barbeque) Jones put things in proper perspective when he wired back: "There will be no more flying."

The War Years

The history books are full of stories of the combat losses of men and aircraft during World War II, but you don't read much about the noncombat losses. We lost more aircraft and crews in training and routine flights than in combat. The worst year for total numbers was 1943. In

continued

that year, we had 20,399 major mishaps in the CONUS alone, killing over 5,600 aircrew. We lost 1,100 more people and destroyed 1,200 more aircraft due to noncombat flying mishaps than we lost in combat.

Since we flew over 32 million hours, the rate didn't look all that bad at 64, but it worked out to 56 aircraft per day. The slogan that year at B-25 conversion training in Tampa, Florida, was "One a day in Tampa Bay." That was also the year a formal flight safety program was begun.

In 1944, *Flying Safety* magazine began as a part of the Army Air Force's flying safety program. A few excerpts from "Letters to the Editor" in 1948 attest to the magazine's effectiveness.

■ "The November issue of the magazine *Flying Safety* is the first copy which I have been privileged to receive. I believe that this magazine has more to offer of interest to the pilot than any magazine which I have ever read. Every article is well written and easy to read.

"Although flying safety should always be foremost in a pilot's mind, a story which tells what happened to some other pilot, who did not keep this thought foremost, always 'sticks' a little better." (February 1948)

■ "Having been a devotee of *Flying Safety* since its initial issue, I'm one of your most avid readers and I'm certain that the effect of your excellent and hardhitting publication on my piloting has been beneficial." (September 1948)

■ "The officers in this Command Headquarters read with immense interest copies of *Flying Safety*.

"This publication has done much to enhance the Flying Safety and Accident Prevention Program of the RCAF Air Transport Command." (October 1948)

The flying safety program continued after the war with slow, but steady improvement in our mishap rates. By the time the Air Force became a separate service in 1947, we were down to a little over 1,500 mishaps a year and a rate of 44 per 100,000 hours.

Major Change

The next major turning point came in 1949 when Major General Victor E. Bertrandias took charge of the Air Force's safety program. Prior to this time, the safety program had mainly consisted of keeping records and investigating major mishaps. Under his leadership, the emphasis shifted from reacting to mishaps to preventing them. Investigators used information from mishaps to discover patterns and common causes. Then they took action to prevent similar mishaps.

General Bertrandias also stressed building safety into our aircraft and systems. The Directorate of Flying Safety was moved from Langley AFB, Virginia, to Norton AFB, California, to permit closer liaison with the aircraft industry. He also recommended the name of the Directorate be changed to Flight Safety Research to better describe its expanded role.

As a result of the improved methods of investigating, reporting, and analyzing aircraft mishaps established by the Director of Flight Safety Research, it soon became apparent that a systematic technical inspection system was necessary to improve the caliber of aircraft maintenance in the Air Force. On 21 September 1950, the Vice Chief of Staff approved the creation of a Directorate of Technical Inspection at Norton AFB, California.

General Bertrandias was named the Deputy Inspector General for Flight Safety Research and Technical Inspection. His two directorates complemented each other. The Directorate of Technical Inspection made inspections and recommendations for improving the effective-

At the height of World War II, the U.S. lost a large number of aircraft and fliers in combat. These losses were tragic, but even more tragic was the fact that we lost more men and aircraft in noncombat flying in the continental U.S. than we lost in combat.

One of the most significant reasons for this high loss rate was the generally accepted philosophy of getting the job done at any cost. No one really stopped to count the cost in those days. However, with 20/20 hindsight, we can look back and say the cost was tremendous.

As Director of Flying Safety, Major General Bertrandias made major changes in the Air Force flying safety program. One was shifting the emphasis from placing blame for mishaps to preventing mishaps. Another was to design safety into the aircraft while they were being built. The Air Force was a leader in developing this important method of making flying safer for all.

By 1960, the aircraft mishap rate had dropped to an unbelievable 5.8. But there were still enough mishaps to keep investigators from the inspection and safety center busy. Here Major General Perry B. Griffith, Deputy Inspector General for Safety, inspects a mishap site.

In the mid-1960's, the Air Force again advanced the scientific approach by using specialists during investigations. Here Sid Berman, renowned metallurgist, briefs Colonel G.A. Simeral, mishap board president, on damage to a C-47 wing torn off in 100 mph winds.

ness and economy of aircraft, equipment, and weapon systems maintenance to provide increased aircraft utilization and safety. The Directorate of Flying Safety Research analyzed all aircraft mishap information to develop basic mishap cause factors and made recommendations for expediting corrective action.

You Can't Do That

The mishap rate continued to fall. By 1950, the rate had been reduced to 36 and by 1955, to 17; but we had 800 fatalities in 1955. There was obviously more work to be done. It was during this post-war period that the Air Force developed a penchant for solving mishaps by regulation. When there was a mishap, they regulated against whatever the pilot was doing at the time. It was during this period that we developed many of the aircrew "be no's" that we live with today.

Obviously, some of these "be no's" were badly needed — "There will 'be no' buzzing," and similar prohibitions. But there is a limit to how far this can be carried without interfering with combat capability. Continued indefinitely, the mission will be sacrificed to safety like the "There will be no more flying" approach used at Fort Sam Houston in 1911. It was this type of approach that gave Safety the "black hat" image that still lingers in some minds today. "Don't let Safety get involved, or you'll never get anything done."

Safety Training

The Air Force recognized that an effective safety program needed trained people. Therefore, in March of 1953, a special school for flight safety officers was opened under contract at the University of Southern California. This was the only

continued

No, this isn't a group of people cleaning up a junkyard. It is the aircraft crash lab at Norton AFB where mishap investigators are trained using actual crashed aircraft.

Safety officers and other potential aircraft mishap investigators receive hands-on training at the USAF Mishap Investigation Laboratory at Norton AFB, California. Better known as the Crash Lab, the facility not only has the complete remains of aircraft that have crashed, it also has individual pieces, such as wings or portions of engines, that are classic examples of different types of damage that lead investigators to discover the cause of mishaps. Here Professor Jack Hazlett leads student investigators through engine damage analysis.

SAFETY WARRIOR: Flying Safety . . . We've Come A Long Way, Baby continued

school of its kind in the world. It soon attracted the attention of civilian aviation organizations as well as foreign governments.

The school's purpose was to train flying safety officers in how to impress pilots, crews, and maintenance people with a greater realization of the importance of safe practices and also to foster a sense of flying safety consciousness. The subjects covered ranged from aeronautical engineering and aviation physiology to accident investigation and prevention.

Graduates of the school quickly established very effective programs that were instrumental in lowering the Air Force mishap rate. Today the Safety Education and Policy Division of the Directorate of Aerospace Safety at Norton AFB, California, manages many safety education courses. The courses are taught under contract by the Universities of Southern California, Washington, and Indiana, as well as the National Safety Council Training Institute, Air Training Command, and the Directorare of Aerospace Safety at Norton AFB, California.

In July of 1965, a unique outdoor classroom opened at Norton AFB — the "Crash Lab." In it, the wreckage from actual aircraft crashes is laid out in the same pattern as the original crash. Students at the aircraft safety schools then use the investigative techniques learned in the classroom to discover the causes of the mishaps. It is their first chance to put theory into practice, and it is done under controlled conditions which greatly increase the effectiveness of their training.

A New Ally

From about 1956 to 1960, we went through another transition period looking for a new approach to the flying safety problem. We began to concentrate on more efficient and effective ways to do the mission. Flying safety picked up a new ally — standardization. (Let Stan Eval wear the black hat.) As standardization became a way of life, safety improved. In 1960, the rate was down to 5.8 — a remarkable achievement in a few short years.

Commanders began to be charged more directly than they had in the past for their responsibility and role in safety. It was during the 1960's and 1970's that the function of safety grew and flourished as never before as a result of all the attention it received and the number of trained professionals available.

The Cost of Doing Business

By the late 1970's, the rate had dropped to — and appeared to have stabilized at — around 3.0. Some were saying that 3.0 was a reasonable rate if we were to continue to "train the way we fight." It was just the cost of doing business.

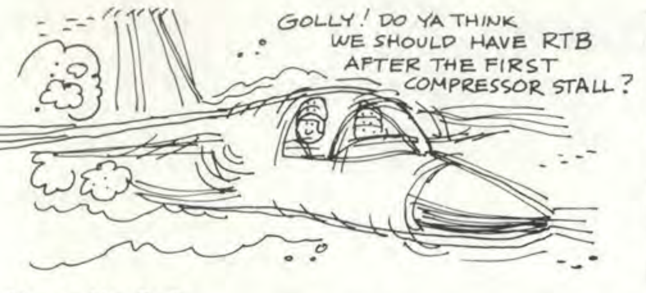
Fortunately, that philosophy didn't prevail and safety and ops continued to work together. Safety had evolved from the "be no" approach to trying to find ways to accomplish the mission more effectively and safely. Ops had discovered that making safety part of the planning not only reduced aircrew fatalities, but also resulted in more effective mission accomplishment and increased combat readiness.

The mishap rate continued its overall decline, and in 1983, it dropped below 2.0 for the first time. The rate that year was 1.80, and it has remained below that level for the last 5 years. Is this the cost of doing business? Our safety and ops professionals are not willing to accept that premise, and they continue to work to improve our safety record.

What's the Point?

Are we expending all this effort so we can produce ever more impressive rates for all the world to see? No. The rates are only a measurement of how well we are doing in what's really important — saving lives, equipment, and money while increasing our combat capability. It's a way of keeping score in a game we all win — the fliers, the Air Force, the Nation, and the free world. ■

OPS TOPICS



Go or No-Go?

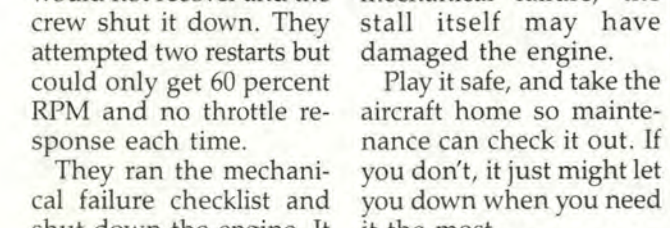
■ As the FB-111 moved from the contact position on the tanker to the observation position, its left engine experienced a minor compressor stall. The engine recovered immediately so the crew continued the mission.

Approximately 13 minutes later, the left engine experienced a hard compressor stall. The engine would not recover and the crew shut it down. They attempted two restarts but could only get 60 percent RPM and no throttle response each time.

They ran the mechanical failure checklist and shut down the engine. It continued to windmill with minor vibrations. On 15 mile final, the vibrations increased while the RPM decreased. The crew depressed the left engine fire pushbutton and landed uneventfully.

The point of this tale is, don't take an engine stall lightly. A stall is an indication of a problem. Even though the stall may not have been caused by a mechanical failure, the stall itself may have damaged the engine.

Play it safe, and take the aircraft home so maintenance can check it out. If you don't, it just might let you down when you need it the most.



Who's In Charge?

One of our heavy transports had been cleared to land from a night ILS approach at an overseas air base. On 6 mile final, the crew saw a flashing white strobe light on the approach end of the runway.

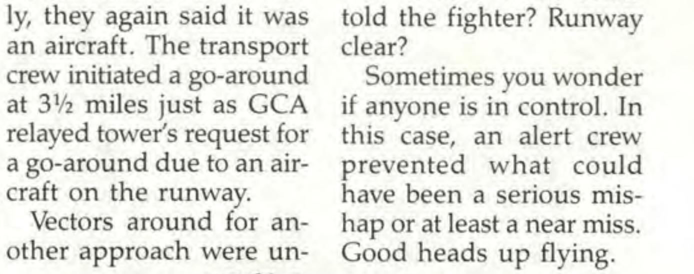
The pilot asked GCA if there was anything on the runway. GCA called tower who said the runway was clear. The transport was now at 4½ miles, and the crew could see a fighter on the runway.

A few seconds later, GCA reported that tower said there was a fighter on the runway. Then they said it was a vehicle. Finally, they again said it was an aircraft. The transport crew initiated a go-around at 3½ miles just as GCA relayed tower's request for a go-around due to an aircraft on the runway.

Vectors around for another approach were uneventful. However, just after the spoilers and thrust reversers were deployed on landing roll, tower called on guard for the transport to expedite and clear the runway without delay. The reason? A fighter on 3 mile final.

I wonder what tower told the fighter? Runway clear?

Sometimes you wonder if anyone is in control. In this case, an alert crew prevented what could have been a serious mishap or at least a near miss. Good heads up flying.



See and Avoid

A flight of two C-130s was inbound to a Navy base in a major metropolitan area. On TACAN final at 7 miles and 2,600 feet, tower advised them of traffic at 2,500 feet, 10 o'clock, and 1 mile.

The No. 2 C-130 immediately saw a Cessna at 10 o'clock, 2,500 feet, approximately 500 feet away and closing. The pilot initiated a climb, and the Cessna passed approximately 100 to 200 feet from the C-130.

The Cessna was operating VFR and was in contact with approach control. The pilot had been advised of the C-130 traffic and reported them in sight when 3 miles away. Apparently, the Cessna pilot wanted to see the Hercules "up close and personal."

Remember you can expect a lot of traffic near large metropolitan areas. Uncontrolled VFR traffic presents a constant midair threat to all other aircraft. Operating IFR doesn't guarantee separation from uncontrolled aircraft.

See and avoid is the solution. Make sure all crewmembers keep a sharp lookout for traffic. ■

FSO's CORNER

Organization-Level Flight Safety Training

CAPTAIN DALE T. PIERCE
919th Special Operations Group
Eglin AFB Aux Fld 3, Florida

■ A couple of weeks ago while I was talking to an FSO about his program, I discovered I was hearing about a program that possessed a lot of command support; an FSO with unusually high levels of energy, creativity, and determination; and an organization with a goal and the willingness to work to get there. It's no wonder the TAC Inspector General's FSO was so impressed with this program.

After talking with this FSO for the better part of an hour, the most challenging task was to figure out which part to write about in this article. Some of the things he's doing were previously covered in FSO's Corner articles. Some will still need to be written about when I'm done with this one.

After pondering the interview for a while, I realized his approach to training was one of the things that made his flight safety program stand out as something a cut above most others. Because of this, I decided to present an overview of his flight safety training program, with a couple of short delays en route to look at some detail.

The flight safety training program of the 56th Tactical Training Wing (56 TTW) is really a system to address a series of training requirements, using a series of interrelated training elements. The following two lists provide an overview of the training requirements and elements. Figure 1 shows the relationships between them. Specifically, it tells you who gets what training.

1. Training Requirements
   a. Primary Duty FSO
   b. Additional Duty (AD) FSO
   c. Maintenance FSO (MFSO)
   d. Maintenance Officer (MO)
   e. Newcomers
   f. Mishap Investigation Board (MIB)
2. Training Elements
   a. Program Outline (PO) Briefing
   b. Privileged Information (PI) Briefing
   c. MFSO Briefing
   d. MO Briefing
   e. ADFSO/MFSO Guide
   f. MFSO Meeting
   g. FSO/ADFSO Meeting
   h. MIB Training

Training Requirements

The 56 TTW's training requirements are not unusual. We all have to train primary and additional duty FSOs, any maintenance FSOs, and our mishap investigation board members. However, three things are a bit out of the ordinary.

The first is the number of MFSOs in the wing. Each maintenance organization has at least one. The advantages of this include the MFSO meetings which permit an enormous amount of communication among the maintenance organizations and wing flight safety people, and the ability of wing safety people to insert information into the maintenance organizations through a number of established ports.

A second unusual feature is the requirement to train all assigned maintenance officers. It is certainly the best of all worlds when every new maintenance officer receives flight safety orientation training during the first month on the job.

The third thing that is somewhat out of the ordinary is the interest in providing a flight safety newcomers' briefing. Ground safety has done this for years, but not all flight safety programs do so.

Now that we've skimmed over the requirements, let's go on to the training elements (the reason for this article).

Training Elements

Program Outline Briefing The title slide of the program outline briefing reads, "FLIGHT SAFETY MAKES COMBAT SENSE." The briefing is presented using the following outline:

1. Goals
2. Preventive Safety
   a. Areas of Responsibility
   b. HR/HATR Program
   c. BASH Program
   d. Trend Analysis
   e. Unit Committees
   f. Airfield Construction
   g. MACA
   h. MDRs
   i. MFSO Program

Figure 1. Training Matrix

TRAINING REQUIREMENTS

Training Elements	Primary Duty FSO	ADFSO	MFSO	MO	Newcomers	MIB
PO Brief	X	X	X	X	X	
PI Brief	X	X	X	X		X
MFSO Brief			X			
MO Brief				X		
Guide	X	X	X			
MFSO Meeting			X			
FSO Meeting	X	X				
MIB Training						X

3. Information Dissemination
a. Mishap Reports
b. Safety Meetings
c. Safety Publications
d. Training Integration
e. Safety Alert Letter
f. Cross-Tell Messages
g. Weekly/Monthly Safety Summary
4. Surveillance/Inspections
a. Monitor Flight Operations
b. In-flight Emergency Response
c. Spot Inspections
d. Annual Inspections
e. Inspection Scheduling and Tracking
f. Inspection Checklists
5. Training
a. Mishap Investigation
b. FSO Training
c. ADFSO/MFSO Training
d. Maintenance Officer Training
e. Pilot Orientation/Phase Training
6. Awards Program
7. Areas for Improvement

Privileged Information Briefing The privileged information briefing is mandated by AFR 127-2, The US Air Force Mishap Prevention Program, and AFR 127-4, Investigating and Reporting US Air Force Mishaps. Most organizations have such a briefing, and I'll not bore you with a discussion of it here. However, I will say that I like the simplicity of the approach used and the way the briefing slides were organized.

Maintenance FSO Briefing The MFSO Briefing expands on the Program Outline Briefing to cover the following:

- Reportable mishaps
- Program goals
- MFSO responsibilities
- Specific tasks
- Unit program management
- Overview of investigating and reporting mishaps
- Safety awards
- Applicable directives

Maintenance Officer Briefing The Maintenance Officer Briefing expands on the Program Outline Briefing to cover the following:

- A history of logistics-related mishaps (for their aircraft type)
- Flight safety issues
- Local concerns

ADFSO/MSFO Guide The Guide is a locally published document that covers flight safety training, unit program management, reports and investigations, safety awards program, inspections and visits, flight safety mishap reports, and flight safety points of contact. Most of these contain the expected information. The flight safety mishap report section contains a "fill-in-the-blank" Class C mishap report format used by squadron FSOs when drafting inputs to the wing FSO.

MFSO and FSO/ADFSO Meetings Meetings of those working the flight safety program occur on a quarterly basis. Minutes are taken, and a list of subjects to be discussed is made to ensure at least the required subjects are covered. That's where the structure ends. The meetings are highly informal and usually include cokes, chips, and the like. These "roundtable" discussion and training meetings can lead to very productive revelations and action items when motivated people interact.

Mishap Investigation Board Training Mishap investigation board training is conducted IAW AFR 127-2, AFR 127-4, and MAJCOM directives.

Summary

The flight safety training program of the 56 TTW satisfies the need for an integrated approach to accomplish required training in a sophisticated flight and maintenance environment. It does so without being a significant drain on the precious resources available to accomplish the rest of the mission.

Captain Robert R. Sarnoski provided this month's FSO's Corner idea. He's the Chief of Flight Safety for the 56 TTW at MacDill AFB, Florida, AUTOVON 968-2480.

The FSO's Corner needs your ideas. What are you doing in your program that could help other FSOs if they knew about it? If you have something, call me (Dale Pierce) at AUTOVON 579-7450 (SMOTEC) or send your name, AUTOVON number, and a brief description of your idea to 919 SOG/SEF, Duke Field, Florida 32542-6005. ■

Mail Call

EDITOR
FLYING SAFETY MAGAZINE
AFISC/SEPP
NORTON AFB CA 92409-7001

"LOOKS CAN BE DECEIVING"

■ I recommend the following commentary be published in the *Flying Safety* magazine, as soon as possible:

"Published in the Mar 88 issue of *Flying Safety* magazine was an article, 'Looks Can Be Deceiving,' pp 16-17, concerning the effects of cold temperatures on true altitudes. This article highlighted the experience of a Canadian crew flying their C-130 aircraft while receiving radar vectors at an assigned Minimum Vectoring Altitude (MVA) near Thule AB, Greenland. As explained in the article, the C-130 aircraft was lower than the Required Obstacle Clearance (ROC) because the MVA was not adjusted for the effects of colder-than-standard temperature conditions prevalent at the time. However, reference to the Canadian crew's nonunderstanding of these effects was incorrect. Rather, it was a case of the crew being unaware that unlike in Canada, US civil and military air traffic controllers do not temperature compensate Minimum Vectoring Altitudes. So the crew believed that their aircraft was flying at a temperature corrected MVA all the while they were radar vectored. Also, the source for the DOD approved temperature correction procedures outlined in the article was derived from Canada. The rationale to base American procedures on Canadian ones is that the Canadians have extensive cold weather experience, and so have developed and improved through years of exposure, the best procedures thus far."

Major E. J. Beth
Canadian Forces Exchange Officer
USAF Instrument Flight Center

Thanks for giving us the additional information. We regret the misunderstanding about what the C-130 crew misunderstood.

The article points out a problem in understanding the effects of temperature on indicated altitude. Your letter points out another problem — the importance of understanding the ground rules used by air traffic controllers when flying in different countries. ■

MAINTENANCE MATTERS

QUALITY IS JOB ONE

■ Not even Sherlock Holmes, Sam Spade, or Perry Mason would deduce that foreign objects would continue to be found in our aircraft fuel tanks. Yet, during replacement of a pump, maintenance people found approximately 30 nut plates, sealant material, rivets, and safety wire loose inside an aircraft fuel tank. The aircraft forms revealed almost 30 leaking nut plates inside a wing tank had been replaced 2 months before the pump maintenance.

The lessons learned from this incident are apparent. When you finish a job, clean up any debris before going to the next task. Not only is it carelessness, but also inadequate inspection and supervision that allow consumables to be left in the fuel tanks of an aircraft.

There's no substitute for self-discipline as a necessary ingredient of quality maintenance and safety. Strive to clean up your work environment when you complete a task. The Ford Motor Company is not the only organization that should go by the motto "Quality is Job One."

ATTENTION TO DETAIL

An unsafe nose gear indication appeared when the A-10 pilot extended the gear for his landing. Running low on fuel, the pilot was forced to land the aircraft with only the mains extended. Fortunately, there was no fire and the pilot ground egressed uneventfully.

Once the A-10 was hoisted for removal from the runway, the crash recovery team pried the nose gear doors open and discovered a bungee rod pin missing. This prevented the nose gear uplock from rotating and, thus, kept the nose gear locked in the "up" position. The bungee rod pin is normally secured by a cotter key.

Investigators determined the last maintenance performed on the nose landing gear was during a phase inspection.

Although a tech order "caution" instructs the mechanic to "install the bungee rod pin with the cotter key hole to the side that provides the most clearance from the upper bulkhead," someone installed this one incorrectly.

An incorrect installation had the cotter key hole on the side with the least clearance for the upper bulkhead. With the bungee rod pin installed in a reverse direction, the cotter key wore on the airframe as the nose gear uplock rotated. After repeated uplock rotations, the cotter key wore to the point of falling out of the bungee rod pin. Without the cotter key to secure it, the bungee rod pin was susceptible to aircraft vibrations which caused the pin to vibrate out of the uplock assembly.

Here is another mishap that was caused by the lack of attention to a critical aircraft area — the landing gear system. The improper installation of a rod pin and loss of a cotter key (so small an item) cost the Air Force $18,000. What does this mean? — That all of us, from the person performing the task to the supervisory inspection and the quality assurance followup, need to pay strict attention to our responsibilities.

Don't let inattention to detail ever make you wonder if your work on a system contributed to a mishap.

DISCIPLINE AND STANDARDS

Kaiser Wilhelm said that it was the one button left unbuttoned that is the ruin of the army. Now we know that no army ever lost a battle because of an unbuttoned garment, but we have lost individuals whose loose clothing started an unforgettable chain of events. Although an aircraft engine sustained minor damage, the individual in one such mishap is alive today to tell us his story. Here's what happened.

After engine start, the aircraft taxied to the quick check area. An end-of-runway (EOR) member wearing a loose field jacket was inspecting the right forward intake area when the engine vortex filled his jacket with air, pulling him toward the intake. As the EOR member twisted free of the intake, the right engine ingested the insert from his ear defenders.

The lesson here not only applies to EOR people, but to all of us who work around operating jet engines. It is discipline and standards, and attention to detail, that are important to any winning team — whether in sports or the United States Air Force.

Strict discipline in all areas is essential to success — especially when it comes to safety. ■

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UNITED STATES AIR FORCE

Well Done Award

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

CAPTAIN

John P. Regan

72d Tactical Fighter Training Squadron
MacDill AFB, Florida

■ On 20 July 1987, Captain Regan was making a full-stop landing in an F-16. As he aerobraked, the aircraft began to drift to the right. He used rudder to counter the drift, but the aircraft began to drop right wing low and drift further right. While countering the right roll with full left flaperon, Captain Regan quickly realized he would be unable to keep the aircraft on the runway and selected full afterburner to initiate a go-around.

Still holding full left flaperon, he felt the right ventral fin and right stabilator dragging the runway. Unsure if the aircraft would lift off, Captain Regan prepared for ejection by grabbing the ejection "D" ring in his left hand. The aircraft became airborne shortly before departing the right side of the runway. While on the go-around, Captain Regan quickly analyzed his aircraft malfunction, arranged for a chase aircraft, and established contact with the SOF.

The chase aircraft confirmed damage to both speedbrakes, the right ventral fin, and right horizontal stabilator. The right main gear appeared normal, but indicated unsafe in Captain Regan's cockpit. With only 900 pounds of fuel on board, he had the SOF read the checklist items and planned an approach-end arrestment.

Maneuvering for a straight-in, Captain Regan lost the runway due to a heavy rain shower on short final. With heading corrections from his chase aircraft, he found the runway, and skillfully used idle power and full speedbrakes to intercept a normal glidepath. He touched down in the first 500 feet of the runway and held the right wing up until engaging the approach-end cable. The right main gear folded as the aircraft was stopped with minimal damage.

Captain Regan, a student with only 32 hours in the F-16, used his time-critical decision making ability and superb flying skills to prevent injury, possible loss of life, and certain destruction of a valuable combat resource. WELL DONE! ■

USAF SAFETY AWARDS

DIRECTOR OF
AEROSPACE SAFETY
SPECIAL ACHIEVEMENT
AWARD
FOR 1987

INDIVIDUAL AWARDS

MS PATRICIA A. TERRILL
Aeronautical Systems Division
Wright-Patterson Air Force Base, Ohio

■ As Flight Safety Specialist for the Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio, Ms Terrill's leadership in the management of flight safety programs for the Aeronautical Systems Division has contributed directly to the success of the Air Force Safety Program. Her direct efforts in promoting safety awareness in the acquisition phase carries through to the procuring of safer weapon systems for the United States Air Force.

MASTER SERGEANT ROBERT A. BRENDLE
31st Equipment Maintenance Squadron
Homestead Air Force Base, Florida

As Additional Duty Safety NCO for the 31st Equipment Maintenance Squadron, Homestead Air Force Base, Florida, Sergeant Brendle's outstanding safety contributions to the 31st Tactical Fighter Wing's maintenance complex exemplifies the quality of performance that deserves recognition. His correction of a design deficiency on the replacement winch assembly of the F-16 ammunition drum hoist, and the discovery of a high accident potential on the hydrazine-powered emergency power unit, definitely contributed to a safer, healthier place to work.

ORGANIZATIONAL AWARDS

Alaskan Air Command
Elmendorf Air Force Base, Alaska

The Alaskan Air Command won this award for its outstanding weapons safety accomplishments. The command's 40 percent reduction in reportable weapons mishaps over the previous fiscal year is a noteworthy accomplishment. This achievement assumes greater significance when considering the daily loading and unloading of missiles and gun ammunition, the numerous simulated combat exercises and deployments, and the harsh climatic environment.

Detachment 1, Headquarters, District of Columbia Air National Guard
Andrews Air Force Base, Maryland

Detachment 1, Headquarters, District of Columbia Air National Guard, won this award for its outstanding flight safety record. The attainment of 100,000 mishap-free flying hours, spanning a period of 18 years while flying some of the USAF's oldest T-33 and T-39 aircraft, as well as the newest edition of the C-22 aircraft, is an outstanding record and worthy of special recognition. ■