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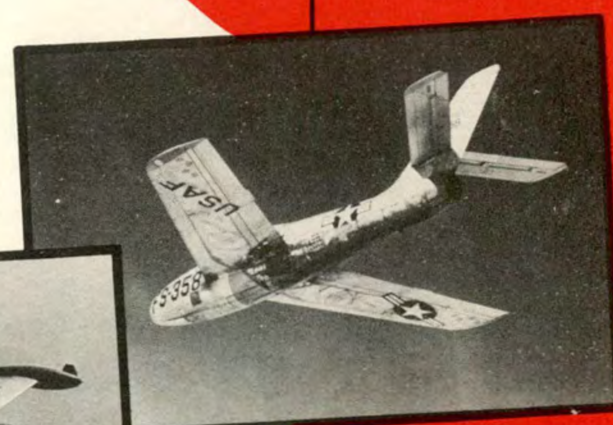
FLYING SAFETY

UNITED STATES AIR FORCE



ANNUAL JET ISSUE—Part One

FLYING SAFETY

VOLUME TEN NUMBER TWELVE

The cover is our holiday greeting to you, our readers. The staff of *Flying Safety* extends best wishes to all for the coming New Year.

ANNUAL JET ISSUE--Part One

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SUBSCRIPTIONS

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USAF PERIODICAL 62-1

In the not-too-distant past, many tigers had their whiskers bristling over what they called "this Gooney-bird pattern routine." They wouldn't buy a procedure that called for maintaining power-on in the pattern, that eliminated a steeply wracked-up break or one that had any semblance of a down-wind leg.

Sure, they flew World War II fighters that way . . . no sweat. Many of these growling tigers got away with it in jets, too, for a while. Some didn't.

In the files of the Directorate of Flight Safety Research there is case after case of those who didn't. And in many of them, weather and low fuel aren't even factors. Fortunately, such instances are the exception rather than the rule but when we dig back into the history of a pilot who is unfortunate enough to clobber an airplane, we invariably find an inherent weakness that came about as a result of early carelessness which was allowed to become a habit.

From the time a pilot starts his initial pitch-out, until the landing is safely effected, the entire pattern determines whether or not the maneuver will be successful.

Last March, FLYING SAFETY asked several of the top test pilots in the business to give us their views on power-on approaches in jet aircraft. The ensuing article was so well received by the field that we decided to reprint it in our all-jet issue.

This stuff isn't new. It's all in your Dash-Ones. However, our records show that a very small minority apparently have missed the chapter on "how to fly the airplane."

There follows a series of discussions by experienced men who really KNOW their business. If you'll take it to heart, be you a good steady pilot or a sizzling stone, we think it will pay dividends . . . to you!

Experts Discuss POWER APPROACHES

Tony LeVier, Lockheed Aircraft Corp.

IN DISCUSSING this business of approaches and landings in an airplane, I feel that this combination is one of the most difficult to accomplish. By that I mean, the most difficult maneuvers to accomplish consistently. From the time a man takes the first flying lesson until he actually soloes, approaches and landings seem to take up the major portion of instruction time.

You spend hours grinding around the circuit only to get back to that situation where a landing is inevitable. Maybe it is easy for some people. I don't know. For me it was plain hard work to learn. I had to develop judgment in speed and altitude and finally, depth perception. Sure, you learned a bit of everything else, too, but mostly it was up and down, up and down. Bounce. Gun it. Take it around. Down again.

In my book, a landing draws more comments from onlookers and passengers than any other maneuver you might make. You bounce a little bit and immediately get comments from every witness in the area. Make a nice smooth one, grease it in, and nobody says a word. *You* may comment about an especially smooth one, but such remarks fall on deaf ears!

I remember when I first started flying. My instructor was very fussy about approaches. When I got the airplane on a base leg, things had to be right. I had to put it in a certain position, have a certain altitude, maintain a certain attitude, keep my power right where he wanted it and above all, fly the airplane. He wouldn't tolerate any sloppy attempts. It was darn good training, too. I've never forgotten his lessons.

Of course we didn't have drag flaps and things like that in those days. The landing gear was welded down too. But, those early planes were light. They'd glide a long ways and you really had to chop the power back and slow 'em down to get in. Slips and fishtailing aided a lot too, but that sort of thing was confined to the old OX-5s, Eaglerock and Waco class, certainly not F-94s.

Well, we've progressed a lot in the last 20-odd years. We've seen airplanes get faster and faster and at the same time, a whale of a lot heavier. They're certainly fast today, but the airplanes of the future, those for the Air Force and the rest of the military, will have performance bordering on the missile. Of course a true missile is a pilotless projectile but as long as we still have pilots flying airplanes, we'll continue to improve performance. Stuff in the 2000 mph class will probably show up in the not-too-distant future, and pilots will be flying them too.

In spite of this thinking, we've got to consider the fact that airplanes will still have to operate in the 150 and 200-knot category insofar as takeoffs and landings are concerned. No matter how fast a plane may fly at maximum performance, we'll still have to plan to bring it down at reasonable speeds. We can say that 200 or so is an average figure, but that's still smoking right along. So, even at that comparatively low speed, we've got to have a definite pattern and approach to insure safe operation. Okay, let's discuss those factors that make up safe operation. These will be just as applicable to T-33s as stuff in the 100 series.

I believe the easiest way to define satisfactory approach and landing procedures is to diagram the whole thing. I've sketched out what I call the "ideal pattern." Probably there are many who will disagree with me, but it's the way I feel about it. After twenty-odd years of flying everything from Jennies to F-94s, I still use the tried and true approach and landing technique that was taught way back when . . . and . . . I'm still here to discuss this technique.

Let's take a typical approach. I've been out on a mission or a training flight or maybe a shakedown. It doesn't matter. When I get home, fuel is down to critical limits. I can't fool around with more than one approach and so I plan everything carefully *before* I drop off all of my altitude.

My system has always evolved around the theory that it's easier to put an airplane where I want it by using a modified approach, than any other. By that I mean it's a compromise between the true, power-off approach and the long drag-in with everything open but the windows. One reason particularly governs my thinking along these lines. As speed and weight of aircraft continue this upward spiral, it will become increasingly necessary to use power for a safe approach. Sooner or later, power will be a *must* to complete a safe approach and landing. Therefore, while still on the borderline of such equipment, why not learn the logical technique until it becomes second nature? It's the cheapest kind of insurance, believe me.

Now, let's take a typical pattern and landing in . . . well, let's say a T-33. Maybe you're just going through school. On the other hand maybe you've got several thousand hours under your belt, but it's all conventional stuff. Okay, whether you're a student or an old hand, you still want to learn to fly this machine right.

For the sake of discussion we'll assume that you have a thorough working knowledge of the airplane. The actual mechanics of flying are things already mastered and the art of a good landing is an assured fact. But, we still have one problem to overcome. How do we *consistently* bring the plane into traffic, establish a good pattern and then put the buggy on the ground *exactly* where we want to? I don't mean a good one now and again. I mean good approaches and landings all the time.

This T-33 isn't the hottest piece of machinery going today, but it is the transition airplane you'll be exposed to for some time to come. It's clean and fast and comfortable. You won't have any trouble with this bird upstairs, or downstairs either for that matter. It gives you good control in all speed ranges and doesn't have any nasty habits.

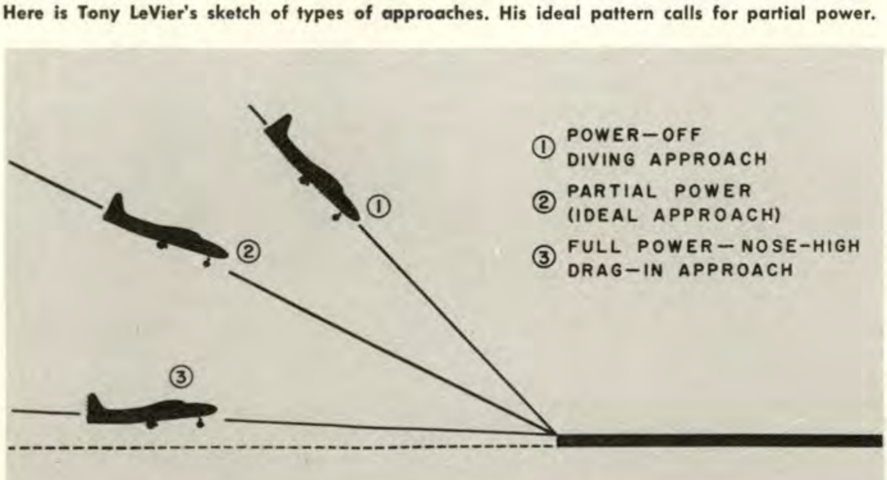
Okay, so you're coming down for a landing. What's the first procedure? Plan your pattern. I mean PLAN it. You've got a breeze of about 15 knots on the deck and it's almost down the runway. There's no real problem here except to establish a good pattern and follow through.

On the upwind leg, over the runway, you've already lowered the dive flaps and knocked the airspeed down to 175 or maybe 200. About a third or possibly half way up the runway you roll into the break. This doesn't have to be violent. Just make a nicely coordinated turn and keep it going for 180 degrees. If you happen to be of the "two 90-degree turn school," that's okay too. No matter how you do it, make certain that you get the airplane on a definite downwind leg and then take off most of the power and get the gear and flaps down. Keep the altitude a constant factor and let the speed fall off normally. Above all, don't wrack around through the early part of this maneuver like a mad-man. Sure, I know you may be hot. Possibly you even sizzle a little bit. That's swell. Save that stuff until you're upstairs. Down here in traffic, play it easy. You're not going to impress anyone with screaming tactics down here near the ground.

Once you're on a definite downwind and the gear and flaps have been extended, run that power up to at least 60 per cent. Remember, acceleration time from 60 per cent to 100 is darned fast. Acceleration from idle to 100 per cent is darned slow. That's the most important thing to remember. Keep that mill turning in the upper speed ranges and you'll stay out of trouble.

The rest of the pattern is pretty

Here is Tony LeVier's sketch of types of approaches. His ideal pattern calls for partial power.



". . . hold things constant until you are assured of making the runway, then, as you start to ease back on the stick, start to ease back on the power."

much standard. Make a definite base leg and turn on final with ample speed. By that I mean, keep the airplane well above the stall range. That doesn't mean that you should bring the plane in like a bat out of you-know-where, but do keep a reasonable head of steam on. Fly it at 130-140 knots, somewhere in that area. Keep enough power on to steady the airplane all the way down. A good approach is one that compromises between a diving glide with no power and a long, nose-high, power-on drag for the runway.

Here's something else to remember, too. You who have been flying conventional aircraft are generally used to having the nose of the airplane pretty much follow the actual flight path. In the jet however, you'll find that the relation of the horizontal axis of the plane to the actual flight path varies considerably to that which you expect. For example, in a true power-off glide, the nose will be tucked down at an alarming angle. The rate of sink will curl your hair and you'll be quite concerned as to where to start breaking the glide for round-out.

In the full throttle type of approach, gear down, flaps down, speed brakes open and throttle at or near 100 per cent, the nose will be high. You'll feel as though you're hanging on the ragged edge of nothing. It just isn't comfortable. Bear in mind, I do not imply that this sort of approach is dangerous. I certainly do not. In fact, there may come a time when you'll *have* to drag one in, but, in this discussion we're kicking around the subject of normal approaches.

Okay, now for the normal, partial-power approach. With the throttle set at between 60 and 70 per cent you'll find that the plane is extremely stable. The nose of the ship appears to be following the actual glide path and the rate of sink is minimized. Control is good and the airspeed is within tolerance. You have the feeling that you're flying the airplane correctly. Know why? Because brother, you are. That's the way the plane should be brought in. I think my diagram explains this type of approach clearly.

Right here I'd like to inject some positive thinking about glides. Every airplane has a definite *glide factor*. By that I mean a factor that remains constant. You should take this into consideration each time you set up a pattern.

Suppose, for example, the stalling speed of your airplane is 100 mph and factory tests have established a glide factor of 1:35. Here's what you do. Multiply the stall speed by the glide factor and you come up with the ideal approach speed. In this case, it would be 100 x 1:35 or 135 mph. Then, should you lose an engine or find it necessary to make a power-off approach, you'd still have the correct speed to assure a safe round-out and touchdown.

Every pilot should be familiar with the glide factor for the particular airplane he's flying.

Now it's just a case of holding power, speed and attitude right on down to the deck. Hold it until you've got it made. By that I mean, hold things constant until you are assured of making the runway, then, as you start to ease back on the stick, ease back on the power. Learn to coordinate this action and you'll never go wrong.

About the only other thing I'd like to mention is the effect of wind. I don't care whether you're flying a Cub or the latest blow-torch, you've still got to consider the breeze when you're ready to set down. Of course a strong wind has compensating factors. It automatically stretches the runway, but you've got to allow for it in any plane.

Let's say for example that you're coming in with a stiff breeze right on the nose. You may get the impression that the plane is stalling because you're not making normal progress in relation to the ground. The rate of sink appears to be excessive and finally you start jamming on more power. That's okay, up to a point. It's best to be a bit on the high side in a heavy wind, especially if it's gusty, but too much power can mean too much speed and then you're laying yourself wide open for a galloping or porpoising ride down the runway when you try to get stopped. So you say, "Well, what is safe?"

Here's a good rule of thumb: *Take the known wind velocity and add 50 percent of that factor to your approach speed.* If the surface wind is 50 knots, add 25 knots to your approach speed. This will take care of any sudden changes, such as gusts above or below the average velocity.

Use flaps and power as needed. Stay a few jumps ahead of the airplane, and stay loose. I mean it. Make yourself be relaxed and anticipate the little buggy. After all, it's a mechanical thing at best. You are human.

That's about all I have to offer on this subject. Learn to fly your airplane right and it will take care of you. Don't ever run out of altitude and brains at the same time. Use that old throttle to get you down just the same as you use it to get upstairs. It's a two-way proposition.

J. J. Quinn, Northrop Aircraft, Inc.

WE HAVE long been advocates of the power-on approach, particularly since flying the F-89. In it we have a fast and heavy airplane; it weighs plenty and is just a great big piece of equipment. In spite of its size and weight, it's a darn good flying airplane. However, what I try to pass along to every squadron is just this: learn to make each and every approach the easy way.

Let's look over what I consider to be a normal pattern. You make a nice easy break and slow the plane down to around 200 knots. Maybe I should say that the other way. Slow her down as you come up the active runway and then make the break. In any event, remember, you're going to do either two 90-degree turns, or one big 180. Either way you prefer is okay but this is important; you should plan for and make a definite downwind leg in order to get oriented and plan the rest of the approach.

Okay, let's say that we're down to about 200 knots in the '89 and on a definite downwind leg. Right here we dump the gear and set the speed brakes the way we want them. Of course the Scorpion is a bit different than many fighters in that we can visually check the position of the gear. You can see the main wheels and then feel the nosegear when it chunks into place. On top of that we have the visual indicators for a further check, plus the hydraulic gages. When the pressure comes back up and all indications are normal, I know I've got wheels under me. That's important.

I advocate carrying 80 per cent power in the F-89 all the way round. This has the advantage of giving steady performance; it gives you the feel of your plane. I realize that when I speak in terms of 80 per cent power, this must of necessity apply to the '89 only because on this aircraft we've got the deceleron system to aid us. I'll speak of that a bit later.

As you come in on final, you slow the airplane down to between 140 and 150 knots but you have power on all of the time. Of course you have the speed brakes out and the landing flaps down too. With this sort of airbrake system working you can establish almost any rate of descent you want. Remember, with full flaps you're getting a lot of drag but have complete control of the airplane.

If there is any question in your mind about landing you can continue the approach with takeoff flaps at 30 degrees and 85 per cent speed brakes to slow you correctly. As I've said, there are any number of combinations that you can establish to derive the maximum benefit from the braking system. Your internal and external load will have a lot of bearing on the braking configuration you'll need. And this isn't the time to try to discuss each and every landing condition. The Pilot's Handbook will clarify such situations which *must* be planned for in advance.

One point I want to make clear, however. If you'll plan your approach for about 140 knots and power at 80 per cent, you'll have almost enough push to keep on going if necessary to make a go-around, and believe me, you won't have to sweat out any thrust lag if you really need some additional power.

If you learn this technique of the power-on approach at the very beginning of your training, I can't see how you'd ever lose a thing by it. Some people still talk in terms of losing an engine while in the pattern. Well, of course, it *could* happen, but the chances are almost nil. If that

J. J. Quinn has long been an advocate of the power-on approach. "Keep some power on all the way around to the deck. That's doing it the easy way."

power plant functions normally throughout a mission, and you don't manage to run yourself out of fuel, I can't believe that the engine or engines will fail just because you're over the home base. It just doesn't make sense. So—let's depend on that available power, and use it.

Remember this too. If a pattern is learned well, it will take care of the pilot. If he gets into the habit of making his pattern the easy way, and in what I feel is the safe way, then everything will be all right. You've got to bear in mind that some days a guy will be real sharp. On others maybe he won't be so sharp—well, if he has the habit of flying right—the easy and safe way—it won't matter too much. He'll still make it okay.

Actually there isn't much more to it. You learn to set up a good pattern. You practice until it's second nature. Then all you've got to remember is to sustain the power of the airplane for the rate of descent you want. Certainly you won't be pulling enough power to fly the airplane level, and you don't want complete power off. You just want an easy rate of descent once the plane is on final. I can't say definitely how many feet per minute you'll want but you'll figure that out for yourself. You don't want the plane hanging on the ragged edge of a stall, nor do you want to be pouring black smoke out all over the place. Just hold enough power for a really easy descent.

In my own flying, I keep a little power on all the way to the deck, or just before the touchdown. I pull off the power when I have it made. That, to me means when I'm over the runway numbers. This may be a bit too conservative for some of the younger pilots but I think it is right, and that goes for any airplane. As far as I'm concerned, power means control. As long as I've got control, I'm not going to bust up any airplane.

Previously, I mentioned the deceleron system. That means merely split ailerons. These give you drag only, no lift at all. The system is controlled by a handle that operates over a full range. We call it the third throttle. You can pre-select any amount of drag for the landing approach and have any amount of speed that you want. I guess that's about the only difference between the '89 and other jet fighter aircraft.

In summation I feel that the whole business of patterns and approaches can be boiled to just a sentence. Plan your pattern, fly the plan, use the power you need and set the bird down where you planned. It's that simple.

Rusty Roth, Republic Aviation Corp.

AS FAR as I'm concerned, good traffic patterns and power-approaches are completely synonymous. The two tie together right straight through.

There's one thing about using that engine that too many pilots overlook. I'm speaking now of present-day equipment. If that power plant is going to function for an entire mission, it's a good bet it's going to run for the entire landing pattern.

Originally, when we first started flying fighters, they used to load up like mad after the power was closed off. Naturally you always assumed the worst situation when planning the approach and made a pattern that would insure getting in even if the mill quit. If it suddenly became necessary to get some power out of the engine, especially the in-lines, it was strictly nip and tuck. If the power plant was loaded up, well, maybe you got some push in time, maybe not.

In any jet engine that I know of, you already have that worst condition if you pull it back to idle. It's automatic and I don't mean it loads up either. It's just that it's going to take time to get that power back on. You've got a built-in lag, starting from idle, that can get real deadly unless you play your cards right. How do you draw a good hand? Well, let's analyze the situation.

First, we have to remember that in a jet airplane the reliability of the engine at partial power is much better than with the throttle in idle. Right there is the first good card to play. Why select a power setting that automatically puts you behind the well-known 8-ball?

Next, and this is mighty important, you're going to draw that second card on the break. Your speed has got to be right for the particular airplane you're flying and you've got to fly it around cleanly and smoothly. Once that break is made, you've established a great many things to come.

At this point I advocate pulling the power back until the horn blows. You've got to kill off some speed anyway. Get that warning horn blowing while you're rolling around from peeloff to downwind, then, as your speed falls off, you dump the gear. One advantage here is that when the racket stops, you know that the gear is ready for business. Of course you check the indicators too, for there's no use in getting careless at this point.

After you've checked the gear, you've got adequate time to start easing on power again. I usually use between 60 and 70 per cent. The amount of power you put back on is again dependent upon the speed at which you initially broke—how far out you had to go to slow down and so forth.

Once you have the power that you feel is necessary, hold it as a constant factor and plan the rest of the pattern. Keep everything right in the groove and work your way around to final approach.

Now here's another card for that pat hand you're working up for yourself. As you come around on final, you can start to ease off slowly on the power. Normally you'll find that the power you used on downwind and base is a bit excessive for final approach. After you've got the runway lined up correctly you'll be continually bleeding off all the way in, until you finally reach the idle stop. Of course you're still carrying power all the way down to the deck because of the inherent lag in jet engine deceleration. What that boils down to is this: As in acceleration time to get thrust in a jet engine, it also requires a little time to lose that thrust once you chop it. With practice you can anticipate ahead of time and chop it a little sooner than you normally would in a conventional engine.

Now here's still another card you'd better be holding: Keep this in mind and you'll be increasing your longevity by the numbers. The biggest difference between the old World War II fighters and the airplanes we're flying now is the gross weight. The old tonnage has gone up tremendously, and consequently when you put the gear and flaps down and haul that power off, your rate of descent from gross weight alone, is almost double that which it used to be. And in order to make a round-out at a terrific rate of sink, you need a great amount of airspeed.

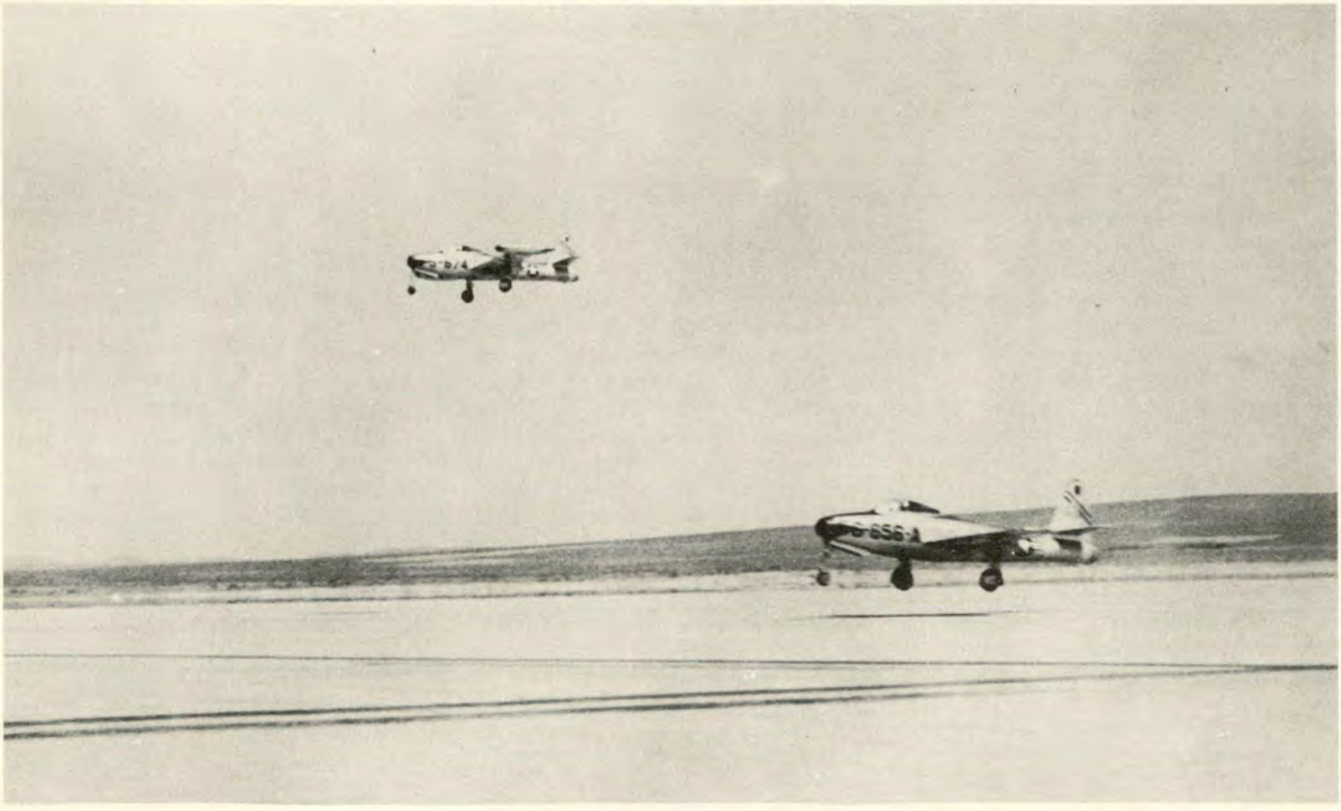
If you're planning to flatten out that glide on final approach, there are two ways to do it—you can keep the airspeed well above stalling so that your flare is short of the end of the runway and then coast up to it or you can use a reasonable amount of power and maintain a nice shallow rate of descent and thereby eliminate that sharp corner where it's necessary to get the nose up—but fast!

Getting back to the pattern business for just a moment, I find that if I play a pattern right, again comparing it with the old propeller driven airplane, I'll put my gear and flaps down on downwind. Then I regulate my power for desired rate of descent all the way in to the end of the runway. With a properly executed pattern I never worry about losing an engine. Incidentally, in several thousand landings with jet aircraft I've never lost an engine. In any event, if that ever happens, I know that I can suck up my flaps to compensate for the power loss and still make it.

Here's one more card for that pat hand you're trying to build. Draw this one and you'll be holding a royal all the way through: Accident reports show that even on short runways where individuals set up an undershoot pattern, they sometimes hit the jackpot and overshoot. Why? Well, let's look at it this way. Take a theoretical case of a pilot trying to crowd a modern fighter onto a short strip. He sets up a landing pattern and is trying to slap the wheels right on the end of the runway. Okay, everything is going along pretty good until he suddenly realizes that his pattern is leading to an undershoot. At this point he's in real trouble. He's waited too long to correct the situation but goes ahead and slams in full bore anyway. Unfortunately this hypothetical soul is just about three steps behind the airplane and by the time he feels that he's got it made, it's too late.

He's neglected to take deceleration time into consideration and even with the throttle in idle, the old mill is still delivering push. End result? Chalk up another overshoot. In other words, you've got to lead a jet airplane all of the time. You can only get the know-how from experience. So—play it cool and get sharp. ●

"I regulate my power for desired rate of descent all the way to the end of the runway. The main thing is, keep power on until you have it made."



Don't End Up Short

A JET training aircraft was taking off at an air base located about a mile high. When it failed to become airborne after a ground roll of approximately 6400 feet on an 8000-foot runway, the pilot aborted. The plane slid off the end of the runway and was destroyed. The pilot received major injuries.

Although the elevation of the field was only a bit over 5000 feet above sea level, the density altitude at the time of the accident was 8700 feet. A computation of factors affecting takeoff performance showed that a ground roll of 6500 feet was required for takeoff at the temperature, pressure and aircraft weight involved in this instance. In other words the pilot aborted his takeoff attempt one hundred feet short of the point where the aircraft would have become airborne. It is apparent that the pilot was not aware of the longer takeoff roll required under the atmospheric conditions existing at the time that this accident occurred.

Recurring accidents of this nature have resulted in a TWX revising AFR 60-16 requiring jet pilots to compute the runway roll required for their particular aircraft and entering such in the remarks section of the Form 175. No longer can the pilot leap into his aircraft and take off with complete disregard for field atmospheric conditions. He must understand the effects of air density on the performance of his plane and consider these conditions when planning his mission.

Although this problem is relatively new to the pilot, aircraft and engine designers have always considered air density in their calculations. The performance of both aircraft and engines is dependent upon the density of the air in which they are operating. That's just plain common sense.

In the past the relatively good takeoff performance of reciprocating engine aircraft overcame this problem, and runway lengths were adequate under all but the most extreme conditions. With the advent of jet aircraft, however, the picture changed.

Without getting technical, density of the air varies with temperature and barometric pressure. Since the airspeed indicator operates on pitot pressure, which in turn is dependent on air density, the indicated takeoff and stalling speed will remain approximately the same for all density altitudes in the lower atmospheres. However, since the lift of the airfoil and thrust of an engine varies with the density of the air, the groundspeed and distance required for takeoff will increase as the temperature increases and/or pressure decreases.

The takeoff roll for an F-86D from a field elevation of 5000 feet with the temperature indicating 23°F. is 3800 feet. Approximately the same roll is required when taking off from sea level if the temperature is up around 95 degrees. Thus, it is fairly evident that both pressure and temperature enter into the picture when computing your takeoff distance.

Aircraft performance under varying atmospheric conditions has been calculated and tabulated in the Flight Handbook. The procedure is simply a matter of obtaining the pressure altitude and temperature from the weather station prior to filing your flight plan. With these two factors available, plus the known weight of the aircraft, the pilot can determine when the aircraft will become airborne by consulting the charts in the handbook.

Obtain the runway temperatures if possible, rather than ambient. It is not uncommon on hot, calm days for the temperature of the air near the surface of the runway to be as much as 10°F above the air temperature recorded at the station. A look at a takeoff chart will prove that under certain loading conditions such a spread could increase the takeoff roll to the critical point.

The Air Weather Service has recognized the importance of this condition and published a regulation (No. 55-33 dated 6 Aug 52), directing weather personnel to offer runway temperature observations for the pilot's benefit.

Obtaining a Dash-One and finding the correct table, then computing the takeoff roll is sometimes a lengthy process, especially when there are four or five guys ahead of you waiting to use it. Normally there is only one copy in Base Operations and thinkers at a few Air Force bases have come up with a streamlined method of accurately computing takeoff distances.

Blown-up charts for individual aircraft are prepared, indicating takeoff distances required for various fuel configurations under certain atmospheric conditions. After obtaining the temperature and pressure a pilot needs only to consult the chart on the wall to come up with the takeoff roll.

Granted, the requirement of obtaining the takeoff roll requirement and entering it on the Form 175 takes some extra time. It may come under the heading of a "headache" to many, but check this for size — since the inauguration of this requirement, there has been no recorded accident due to miscalculation of takeoff roll. ●

The flight planning portion of a mission has many facets. A systematic method of obtaining and applying this information is a necessity. A pilot must . . . .

PLAN IT - FLY IT

MANY TIMES in the past FLYING SAFETY has pointed out to its readers the importance of the old saw . . . Plan your flight, then fly your plan. And we intend to keep hammering on the point until every USAF pilot and air crewman realizes the truth in the saying.

How will we know when such a time comes? Easily. Accident causes involving poor or improper flight planning will dive toward the bottom of the statistical compilations prepared by the Directorate of Flight Safety Research.

To paraphrase Thursday's famous Friday, "All you need are the facts, men." Getting the facts, all the facts, and applying them correctly is a necessity in any flight planning. In flight planning for jet aircraft it is more than a necessity; it's a must. Not because the problems differ when flying jets as compared with reciprocal aircraft. They don't. The same old problems of range, endurance and weather are there. But in jets they are magnified and become more acute. Short endurance is coupled with long range; various types of weather are encountered on one flight; letdowns are complicated by high fuel consumption at lower altitudes, and a pilot must think and react fast to stay ahead of his fast moving plane.

Consequently, jet flight planning must be detailed, more detailed than ever before. Weather, facility charts, NOTAMS, climb charts, cruise charts, letdown and low approach procedures all must be checked. Flight logs must be filled out accurately.

Sounds complicated and time-consuming, doesn't it? Actually it's not. About 30 minutes should suffice to prepare your flight plan and leave you with enough information to fill a small book. And remember, those 30 minutes might turn out to be one of the most important half hours in your life. At the very least, they can save you a ride on the silk and a long walk out of the boondocks.

Weather Check

Before going in to beard the forecaster in his den, know exactly what you want in the way of information. You'll want to know what to expect at destination, while en route, at alternates and the forecast for your takeoff point.

Tell the forecaster the type aircraft you're flying, your proposed route, ETE, altitudes you expect to fly and any additional information that will assist him in visualizing your particular flight.

When the briefing is over your information should include:

Destination: Ceiling, visibility, freezing level, tops of clouds and precipitation, by type.

En Route: Ceilings, visibilities, cloud types encountered at various altitudes, turbulence at various altitudes, freezing level, temperatures aloft and winds aloft at various flight altitudes.

Alternates: Ceiling, visibility, freezing level, tops of clouds and precipitation, by type.

Takeoff Point: Forecast ceiling, visibility, freezing level and temperatures and winds up to flight altitudes.

Sounds like an awful hatful of facts, doesn't it? Actually, it takes only a few minutes to get the information. Once you have it, and apply it to your flight, you're all set. You know what to expect at destination, alternates and on-course in the event of an in-flight emergency.

Knowledge of the ceiling, visibility and freezing level at your destination is imperative. It's vitally important also to know the type and intensity of the precipitation which exists at your destination. Poor cockpit visibility may turn an otherwise routine approach into a fast session of low level acrobatics with disastrous results. And don't forget, knowledge of the precipitation, especially if it has occurred in the last hour or two, will warn you of possible poor braking action. Being forewarned about slick or wet runways can be the difference between an uneventful landing and one which resembles the sweeps and swirls of a champion figure skater.

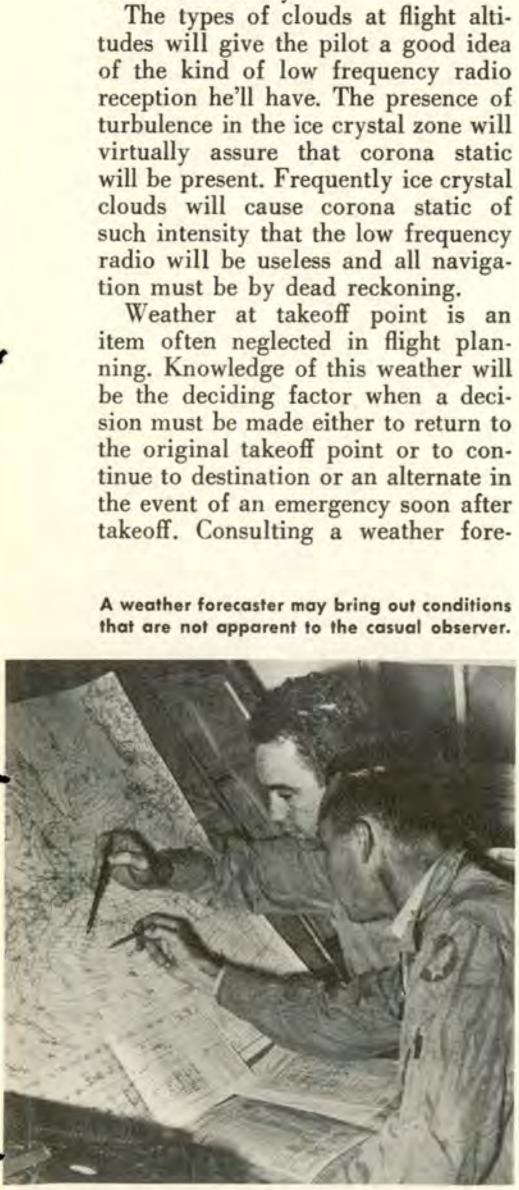
Temperatures and winds up to flight altitudes must be known to compute the distance to be covered during your climb and fuel to be consumed.

With a complete picture of en route ceilings and visibilities, valuable time is saved when an aircraft malfunction or other emergency forces you to decide where it is possible to land with the least difficulty.

The types of clouds at flight altitudes will give the pilot a good idea of the kind of low frequency radio reception he'll have. The presence of turbulence in the ice crystal zone will virtually assure that corona static will be present. Frequently ice crystal clouds will cause corona static of such intensity that the low frequency radio will be useless and all navigation must be by dead reckoning.

Weather at takeoff point is an item often neglected in flight planning. Knowledge of this weather will be the deciding factor when a decision must be made either to return to the original takeoff point or to continue to destination or an alternate in the event of an emergency soon after takeoff. Consulting a weather forecaster prior to takeoff may bring out a future weather condition that could make quite a difference in the pilot's flight planning.

A weather forecaster may bring out conditions that are not apparent to the casual observer.



Alternates should be chosen approximately 200 miles apart, or if possible, within gliding distance of the aircraft. Once selected, they are then readily available if the need for an alternate arises anywhere along the route of flight.

The facts on wind directions and velocities at the 10,000, 20,000, 30,000 and 40,000-foot levels must be accurate. Climb, cruise and letdown are predicated in part on winds aloft. Whether or not winds are beneficial or detrimental will play a part in determining your range. Remember, It may appear that headwinds on one leg will be compensated by tailwinds on another leg, but in jet operations this is not necessarily true.

The forecaster can give you the optimum altitude for your flight. This is the most efficient altitude at which the aircraft can proceed to the destination. Optimum altitude is given as density altitude and converted into pressure altitude, which the pilot reads directly from the altimeter, taking into consideration the temperature correction. The pressure altitude varies with warm and cold air advection aloft. In warm air, fuel is saved because the jet can fly at a lower indicated altitude and still be at optimum altitude for the flight.

During the briefing, you and the forecaster should go over a map which covers a large enough area to show the pressure system and frontal locations that will be in evidence during your flight. A pictorial cross section, if available, will show exactly what to expect in connection with the synoptic situation. Weather information portrayed graphically is much more easily assimilated and understood.

Under IFR conditions a minimum altitude below which the aircraft will not descend in the overcast should be decided upon. There is no problem at an established base where the latest altimeter setting is available, but a great change in setting is possible over a relatively short distance and a forecast altimeter setting can be cheap insurance. This is true particularly when letdown is made over mountainous terrain.

Inherent error in altimeters at high speed is a problem, but there is a simple rule-of-thumb method for compensating for error that can be used. For every mile per hour increase in airspeed over 200 mph, the altimeter will indicate one foot too high. As an example, at 600 mph the aircraft will be 400 feet lower than the altimeter reading.

A word from the weather man on turbulence also is important. Turbulent areas can cause real grief to a jet traveling at high speed. What might be merely light turbulence in a Gooney-bird traveling at 140 knots becomes severe turbulence when encountered at 450 knots.

Operations Facilities

Loaded with your weather information, you're then ready to visit the operations office for a check of the radio facilities along the proposed route of flight. The Radio Facility Chart is your best source of this information. Your destination should be checked for length of runways, airport elevation, type of fuel available and jet starting unit. You should also check the status of radio range, GCA or ILAS, homing facilities, VHF/DF homer and obstructions (found in Pilot's Handbooks).

This information should be collected for each alternate airport. A check of NOTAMS will give the latest information pertaining to radio facilities and airport condition.

When you've completed your check of weather, radio facilities and airport condition, then make the final plans on your route of flight. If maps are used to plan the route, be sure to check all radio facilities against the Radio Facility Charts, NOTAMS and The Airman's Guide.

At this point in your planning, you are a fountain of information, but, as stated previously, you find that it didn't take a prohibitive amount of time to get the facts. Starting in the weather office and then working into operations eliminates those many trips back and forth picking up information which could have been gained in one chat with the forecaster. Then, too, if one piece of the information which you have helps to avoid walking home from your flight, you'll have saved one whale of a lot of time in the long run.

Forecasting your fuel requirements and flight time is your next step. Using the proper climb, cruise and letdown techniques, as required for your particular aircraft, it is possible to forecast fuel requirements within a few gallons and flight time within several minutes.

PENETRATION ... and Low Approach

JUDGMENT is a word that comes in two sizes, good and bad. Pilots have been exercising both sizes in airplanes for over half of a century.

Until the arrival of jets on the aviation scene, only a certain few phases of flight really taxed a pilot's ability to analyze a flight situation and exercise the proper judgment to take himself and his aircraft through the situation successfully.

With jets the frequency of situations demanding good judgment is stepped up considerably. The climb, cruise and the descent all present peculiar problems calling for sound judgment in any jet flight. The greatest of these three is the descent. The success or failure of many jet flights will depend solely on the judgment exercised in planning a descent from cruising altitude, whether conditions are VFR or IFR.

The Descent Chart in the pilot's Flight Operation Instructions contains the data necessary to plan a descent with the most favorable range-fuel ratio for your particular aircraft. The chart indicates the distance from destination at which a descent should be started, under a no-wind condition. It also shows the proper airspeeds to be used and the fuel which will be consumed in the descent, together with prescribed rates of descent. The data on the chart are based on a standard day with the power set at idle and the aircraft "clean," unless otherwise stated.

To illustrate the use of the chart, assume a cruising altitude of 35,000 feet on a standard day in a T-33. With the throttle in IDLE and the aircraft "clean," the initial rate of descent will be 1750 fpm at 230 mph (200 kts) CAS. The letdown should be started 54.5 nautical miles from a destination with a sea level elevation. The time required for the descent will be 8.9 minutes and the fuel used will be 18 gallons. The rate of descent and CAS are increased with the loss of altitude as shown on the chart, and these changes should be constant and smooth throughout the descent.

The Descent Chart just about whips the problem in a VFR descent. However, if the destination is IFR, other factors must be considered in planning a descent at destination. If the destination is IFR, a plan must be made for a penetration that is reliable, expeditious and positive, one that can be controlled by the appropriate control agency and which places the aircraft in the most advantageous position to make the type of low approach contemplated.

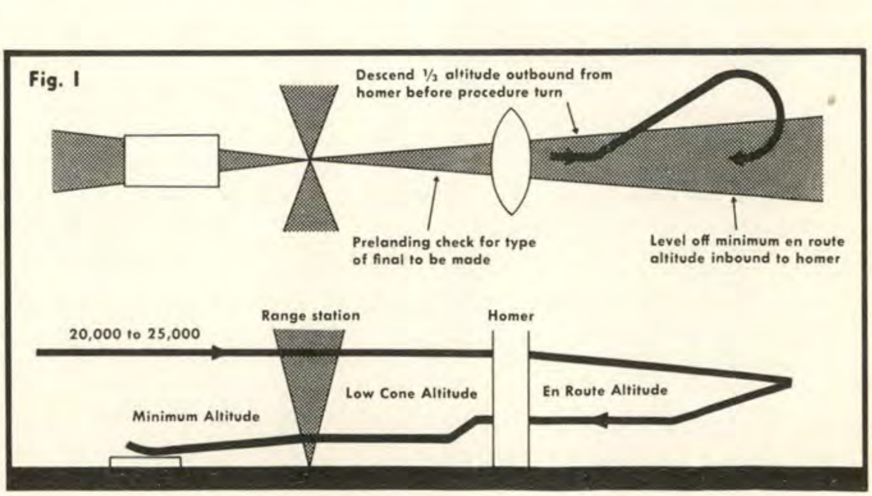
Experience has proved that it is very poor judgment to descend below 20,000 feet en route to a destination that is IFR, even if an expedited approach is assured. For example:

A jet reports over the fix at 10,000 feet. The pilot is advised to hold because ARTC has an aircraft at a lower altitude in the vicinity that has not reported over a designated fix, or Approach Control has cleared an aircraft to take off and the pilot of the departing aircraft has forgotten to report passing a designated fix. As a result, the incoming jet pilot must declare an emergency and descend through altitudes without positive aircraft separation.

Another illustration: A severe rainstorm has moved over the field and GCA cannot pick up the jet fighter, which has approximately 1/6 the reflecting area of an F-51. The ceiling and visibility are too low for a range approach and the jet, at 10,000 feet, does not have sufficient fuel to climb out and go to the alternate. The result is obvious.

If, however, the pilot remains at a minimum of 20,000 feet until reaching the fix and receives clearance, he is then in a position to make an approach within his capabilities or to proceed to an alternate.

Twenty to twenty-five thousand feet is a good altitude range in which to report over your destination fix. From this altitude your time for penetration is not excessive and you have altitude working for you in the event you must proceed to an alternate. If cruising at altitudes higher than these, use the Descent Chart in planning a descent to arrive over the fix at the desired altitude. By subtracting the



figures opposite the new desired altitude on the chart from those opposite the cruising altitude, you can determine the fuel, time and distance for the descent.

For example, a T-33 aircraft cruising at 40,000 feet is cleared to cross the destination fix at an altitude of 20,000 feet. Under a no wind condition, the chart indicates that the descent should be started 53.7 nautical miles from the fix; the descent will take 9.0 minutes, and 15 gallons of fuel will be consumed.

When the fix is reached, there are several methods of making a penetration, depending upon traffic conditions, terrain, fixes and approach aids available. It's a good practice to simulate penetrations in VFR weather from altitudes between 20,000 and 25,000 feet to determine the amount of fuel consumed during the penetration and low approach, the total elapsed time for the descent and approach and the ground pattern covered by the aircraft while making various types of penetrations.

There are many types of penetrations that can be accomplished successfully. Some of the various penetration and low approach procedures are described and illustrated on the following pages. Although the airspeeds, power settings and techniques are those specifically applicable to the T-33, by applying the proper airspeeds in knots they can be used in other jet aircraft.

Types of Approaches

Approach Using Homing Facility on Approach Bearing: (Fig. 1)

This type of penetration and approach is ideal for jets when the homing facility is located on the approach leg of the range so that the low cone altitude provides terrain clearance for an aircraft descending inbound from the homing facility to the low cone.

The penetration is made from the homing facility, on the reciprocal of the approach bearing. Lose one-half the altitude before starting the procedure turn. Any airspeed, gear, flap and power combination can be used during the penetration, but the indicated airspeed must be held constant and the rate of descent must not be permitted to decrease. The aircraft must remain within reception distance of the radio aid and sufficient power must be used so that the pilot will get a reasonable amount of acceleration from the engine if needed and so that sufficient heat for the defrosters and anti-icers will be assured.

The recommended conditions for the F-80C or T-33 are 152 kts. IAS, full flaps, dive flaps, gear down and 65 per cent power.

After the procedure turn is completed, the level off is started 1000 feet (2000 feet in formation) above the minimum en route altitude for the range leg. The level off is accomplished by retracting the wing flaps completely without hesitation, raising the landing gear, and when 200 feet above the desired altitude, retracting the dive flaps. Research has shown that this is also the most satisfactory sequence for instrument level-offs.

The aircraft then proceeds to the homing facility at the minimum en route altitude at a power setting of 65 per cent. When over the fix, make the pre-landing check in preparation for the final approach, whether it be a GCA, ILAS, radio range or a combination of any of these approaches.

If for any reason the aircraft (T-33) should have to hold at a low altitude, the power should be adjusted to maintain a fuel pressure of 60 psi. Sixty psi fuel pressure usually can be held at 65 per cent rpm and a fuel consumption rate of approximately four gallons per minute results. Sixty-five per cent rpm is sufficient power to maintain airspeed and altitude in a turn using up to a 30-degree angle of bank with a fuel load of 200 gallons or less.

If a GCA or ILAS approach is used, lower gear, dive brakes and 35 to 60 per cent wing flaps on final approach and reduce the indicated airspeed to 130 knots. Add five knots per hour to the above airspeeds for each 100 gallons of fuel remaining in

Jet Letdowns

JET penetration procedures are established so as to provide the least interference with conventional type aircraft, and to provide for the accomplishment of jet letdowns when conventional aircraft are held on the primary fix where the jet aircraft is executing letdown. In almost all cases the low cone altitude and the procedure turn altitude published in the jet instrument procedure are identical to the standard range approach.

* *Initial penetration altitude.* The altitude at which aircraft crosses radio facility for beginning penetration procedures. This altitude will be established for each procedure and will normally be specified as 20,000 feet MSL.

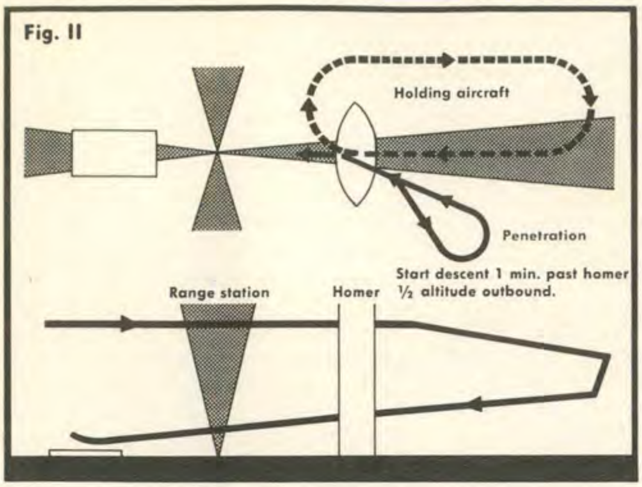
* *Penetration turn.* A one and one-half degree per second turn is made during the jet penetration procedure to return the aircraft to an inbound heading to the radio facility being used for the penetration. (The penetration turn may be either a level turn or a descending turn.)

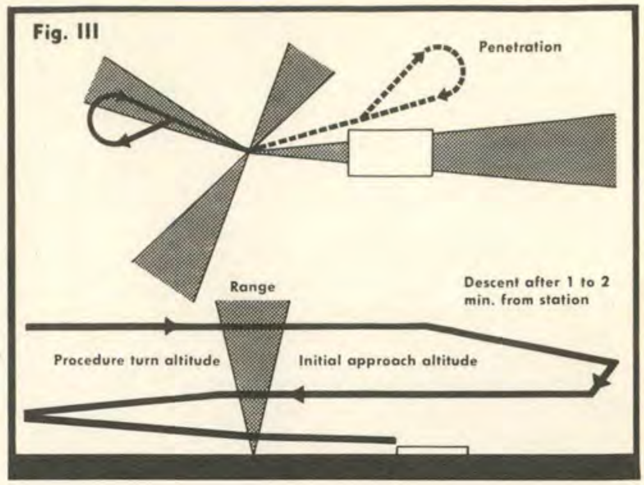
* *Minimum penetration altitude.* The minimum altitude for the jet penetration procedure turn to an airport will be the initial approach altitude for the standard instrument approach procedure.

* *Initial approach altitude.* The initial approach altitude will normally be as shown for the standard instrument approach procedure. Where no initial approach altitudes have been established, a clearance of at least 1000 feet above all obstructions within a radius of 10 miles of the radio facility and 10 miles to either side of all penetration courses within an open quadrant for a distance of 40 miles from the radio facility must be provided except in mountainous areas. In all parts of the United States designated as mountainous areas a clearance of at least 2000 feet must be provided.

* *Procedure turn.* Will be executed as shown in the standard instrument letdown criteria.

* *Emergency altitude.* An altitude which will clear all obstructions within a radius of 100 nautical miles of the radio facility by 1000 feet except in mountainous areas. In mountainous areas the clearance will be 2000 feet.





excess of 200 gallons. Descend to the altitude which will intercept the glidepath at the proper point. Then adjust the power to maintain altitude and airspeed. The amount of fuel used in this type of penetration and low approach for the T-33 will vary from 65 to 70 gallons.

If a straight-in range approach is made, lower the gear after passing the fix inbound and descend to low cone altitude holding 174 knots. Upon reaching the low cone altitude, level off, permit the airspeed to drop off to 139 kts., then add power to 74 per cent to maintain this airspeed. The total fuel used in this type penetration and low approach from 20,000 feet in the T-33 is 60 to 65 gallons and the total time for the approach should be between 10 and 14 minutes.

Approach Using Radio Range Only (No Lower Traffic)

Cross the radio range station at 20,000 to 25,000. Proceed out the range leg opposite the procedure turn leg. Lose one-half the altitude outbound as previously outlined. Return to the range station at the en route altitude of the leg you have just flown or at the procedure turn altitude, whichever is higher. Upon crossing the range station, execute a normal range approach as published for that station. Proceed from the station out the procedure turn leg not over one minute and thirty seconds at approximately 174 kts. (65 per cent in T-33) and descend to procedure turn altitude with dive brakes down. Upon reaching procedure turn altitude, raise dive brakes. Execute the procedure turn, and when on course inbound, lower the gear, hold 174 kts. and descend to low cone altitude. At low cone altitude, level off and permit the airspeed to drop to 139 kts., then add power to about 74 per cent to maintain 139 knots. Use dive brakes to descend from low cone altitude to minimum altitude, retracting them after reaching that altitude. This approach will take 60 to 68 gallons of fuel and 15 to 17 minutes total time. It can be made with a formation.

Approach in Open Quadrant Using Homing Facility (With Traffic Holding at Homing Facility) (Fig. 2)

Proceed to the homing facility at 20,000 to 25,000 feet. Upon passing the fix, steer 45 degrees off the range leg into the quadrant which does not contain the stack. If there are no aircraft holding within 5000 feet below your aircraft, a descent can be started immediately. Descend one-half the altitude outbound as described above, continue descending in the procedure turn, return to the homing facility at the assigned altitude and make an approach straight in; GCA, ILAS or radio range.

If aircraft are within 5000 feet below you, proceed out into quadrant one minute or more before descending. Then proceed as above. This type of penetration and approach takes 60 to 70 gallons of fuel and approximately 14 to 15 minutes.

Approach With Traffic On All Legs of the Range and No Homing Facility Available (Fig. 3)

In the event through traffic or holding traffic have all legs of the radio range occupied, proceed as follows: Cross the range station at 20,000 to 25,000 feet and proceed outbound (terrain permitting) on the bisector heading of either of the quadrants which has the landing field located on the range leg separating them.

To avoid descending through occupied altitudes on the range leg, level flight is maintained on the outbound bisector heading until clear of the range leg and/or the airway, normally one or two minutes depending on ground speed. The penetration is made as described above for the radio range approach except, instead of descending on the range leg, the penetration is made in an open quadrant. Return to the range station at an assigned altitude from which a normal range approach, GCA or ILAS can be made. Eighty to ninety gallons of fuel will be consumed and the approach will take 16 to 18 minutes total time.

If a GCA is made using a rectangular pattern after returning to the range station, approximately 110 gallons of fuel will be consumed and 18 to 23 minutes required for the complete letdown from 20,000 feet to touchdown. It's a good idea to request GCA to pick you up inbound upon completion of the procedure turn for a straight-in GCA. With proper planning, a track can be flown from the range station to get in position for a straight-in GCA approach.

These are only a few of the basic types of jet approaches that are available to a pilot in the event a letdown is necessary. As you can see, no one type of penetration fits every situation. Judgment, once again, determines your choice of method.

The old, old method of "Ready or not, here I come" just doesn't fill the bill for jet IFR letdowns. ●

ENGINE ICING

THE GRADUAL but definite transition of the Air Force from reciprocating engines to gas turbine power plants has demanded a corresponding change in operating procedures, techniques and planning.

Many of these changes are strictly operational in nature and are readily understood by pilots, while others are more technical and somewhat vague in the minds of most operating personnel. Into which category the problem of dealing with jet engine icing falls is controversial, but it is interesting to note that the operating commands at this time try to avoid flight in icing conditions even though their aircraft may be equipped with anti-icing provisions. Also, many present operational jet aircraft are powered with gas turbine engines which do not incorporate anti-icing provisions and therefore should not be flown in icing conditions.

All current operational turbine engines that have anti-icing features suffer definite limitations with which pilots should be familiar. A deficiency is encountered in the anti-icing systems during flight at medium and lower power setting and is an inherent characteristic of this compressor bleed type anti-icing principle.

There are two definite limitations that affect actual engine operation in icing conditions. The first is the effect of ice accretion blocking airflow into the engine, subsequently causing overtemperature conditions in the turbine section or loss of thrust, or both.

The second limitation is the inability of an axial compressor to digest chunks of ice without damage. These chunks of ice may be dislodged from forward inlet components such as inlet cowl lips, duct dividers and accessory dome. Several instances have been recorded during which J-47, J-35, T-38, J-21, J-73 and J-65 engines have been damaged by ice ingestion. One of these occurred on a B-47 during flight in which one engine completely disintegrated and the five remaining engines were damaged beyond repair. Obviously, engine damage due to ice ingestion on a single engine aircraft could result in loss of the aircraft.

Ice ingestion tests have been run on some gas turbine engines in an effort to establish their resistance to ice ingestion but no definite conclusions have been reached. It must, therefore, be assumed that all current axial flow gas turbine power plants are susceptible to compressor damage by ice ingestion.

The initial indication of jet engine icing is increased exhaust gas (tailpipe) temperatures. This is all too often the only indication prior to complete engine failure.

Ice forms on the fixed or extended inlet screens and compressor inlet guide vanes (stator) and restricts the flow of inlet air. This causes a loss of thrust and a rapid rise in tailpipe temperatures. As the airflow decreases, the fuel-air ratio increases, which in turn raises the temperature of the gases going into the turbine. The fuel control attempts to correct any loss in engine RPM by adding more fuel, aggravating the condition.

Complete turbine failure may occur in a matter of seconds after ice builds up in the engine air inlet. Critical ice build-up on the inlet screen can occur in less than one minute under severe icing conditions.

The idea that heating due to ram pressure at high speed will prevent icing is erroneous. The heat generated at subsonic speed is insufficient to prevent ice formation.

Serious inlet duct icing can occur without the formation of structural ice, and it is necessary to understand what causes this icing to anticipate it. When jet aircraft fly at velocities below approximately 250 knots TAS and at high power settings, the intake air is sucked instead of rammed into the compressor inlet. This suction causes a decrease of air temperature (adiabatic cooling). Under these conditions, air at an ambient temperature above freezing may be reduced to sub-freezing as it enters the engine.

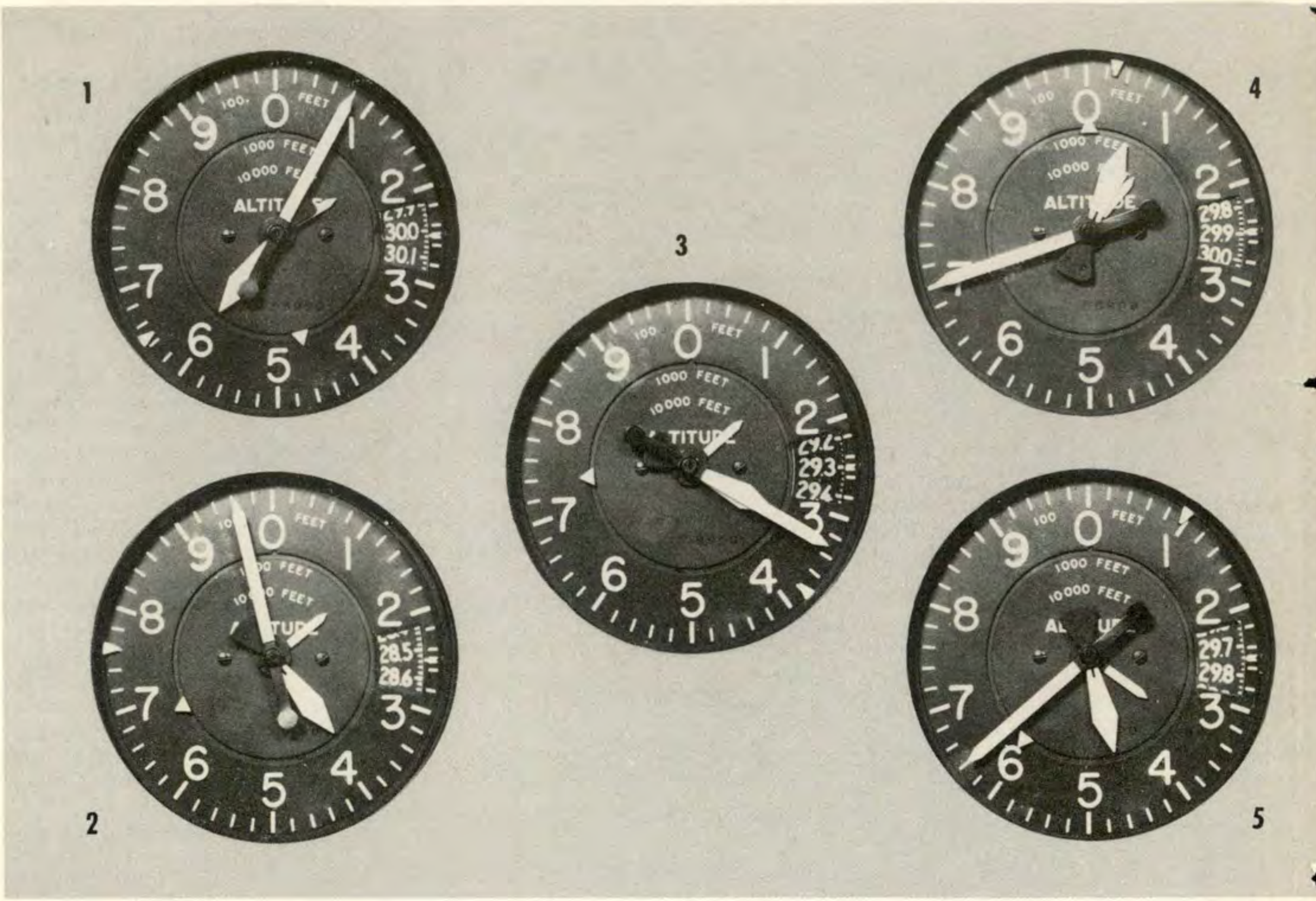
The maximum temperature drop which can occur in most jet engines is about 5°C. The max temperature drop occurs at high RPM on the ground and decreases with decreasing RPM and increasing airspeed.

In sub-freezing temperatures, the *rate* of icing increases rapidly at speeds above 250 knots but the *amount* of accretion decreases. Therefore the pilot may either increase speed to get out of the area quickly or decrease speed and reduce the rate of accretion if rapid departure from the icing area is impossible.

Procedures to be used in the event icing conditions are encountered are covered in most pilots' operating handbooks and should be followed to the letter. However, in that some Dash Ones are completely devoid of any instructions pertaining to jet engine icing, Technical Order 01-1-469 (Operation of aircraft with jet engines under icing conditions—all jet aircraft) was reissued. Although somewhat general, this T. O. contains important operating instructions which should be read and adhered to by all personnel cleared for operation of jet aircraft. It outlines recommendations with respect to operation of non-anti-iced axial flow turbojet engines in icing conditions.

If icing is encountered, immediate action should be taken to get the engine anti-icing system into operation; change altitude or vary course to avoid clouds; reduce airspeed when in freezing air, and reduce engine RPM as necessary to prevent any excessive tailpipe temperatures.

It is well to remember that present anti-icing systems are not always adequate protection from all meteorological conditions. Therefore, it is still good advice to pilots to "refrain from flight in icing conditions unless the mission dictates it." ●



Don't Chance a GLANCE!

Reading an altimeter ought to be as easy as telling time, but is it? Studies by the Aero Medical Laboratory show that at certain settings, the three-pointer altimeter is particularly susceptible to misreadings of 1000 and 10,000 feet.

This is most likely to occur when the sensitive pointer is approaching zero on the scale. If a pilot misreads his altimeter by a wide margin the results are obvious. And recent accidents prove how easy it is to do just that. Don't be a statistic. Be sure you read your altimeter correctly.

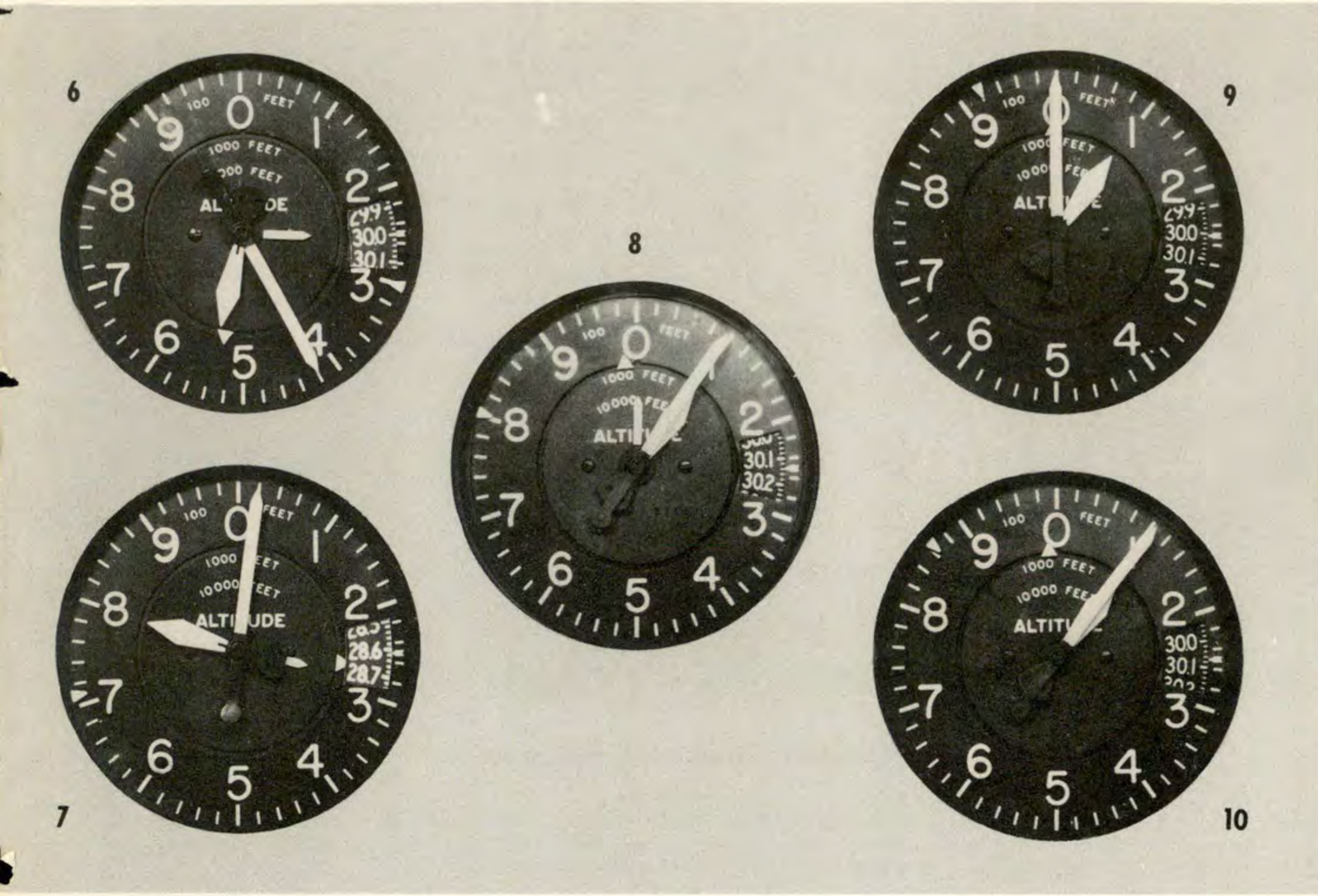
Check your answers to the above altimeter quiz on page 22.

SLAP A layman into the seat of a modern jet fighter and the mass of dials on the instrument panel will send him off talking to himself. One of his more classic remarks may be "I don't see how those pilots can keep up with all those whirling, jiggling needles and dials." He has a point, you don't keep up with *all* of them.

Any pilot could tell him that there are only certain ones you watch at certain times. The primary instruments to watch during level flight differ from those used during an IFR letdown. You concentrate on a specific few and merely glance at others for cross-checking and reference.

This brings up the important consideration of how much can you see at a glance? Under marginal cockpit visibility often a glance isn't enough and it can result in misreading an instrument. Tests conducted by the Aero Med Laboratory indicated that for the conventional three pointer altimeter, 11.7 per cent of all readings were in error by 1000 feet or more. To further prove a point, pilots used in these tests were given approximately seven seconds, which is considerably longer than a glance.

Magazine articles, flying safety meetings and hangar talks have been centered around this subject, and most pilots are cognizant of the altimeter's inherent readability limitations, yet incidents continue to occur.



The problem seems to be that while a pilot is concentrating on flight attitude instruments, radio conversation and instrument procedures, that quick look at the altimeter often results in misinterpretation.

A flight of three jet fighters recently accomplished three low approaches to a field that had a 4000-foot ceiling. They never became contact! During their letdowns the recommended altitudes were relayed to the flight leader by the PPI controller. (PPI approach equipment does not incorporate elevation indicators.) On one approach the controller instructed the flight leader to descend to 800 feet and vectored the flight right over the field. The flight leader acknowledged but still never broke out of the solid soup. Following the third attempt, all three pilots abandoned their aircraft because of fuel shortage. Three minutes later another flight of three broke out VFR at 4200 feet after a similar PPI run.

Investigation definitely established that the leader of the first flight misread his altimeter by 10,000 feet and never descended below 10,800 feet.

Several months later, thousands of miles from the scene of the first incident, four more jets were making a night IFR beacon approach. Procedure turn was to be performed at 11,000 feet. The flight reported procedure turn, and upon turning inbound, suddenly broke out of the overcast with their airscoops just clearing the tree tops. Yes, they were at 1000 feet, not 11,000. Another case of misreading the altimeter by 10,000 feet.

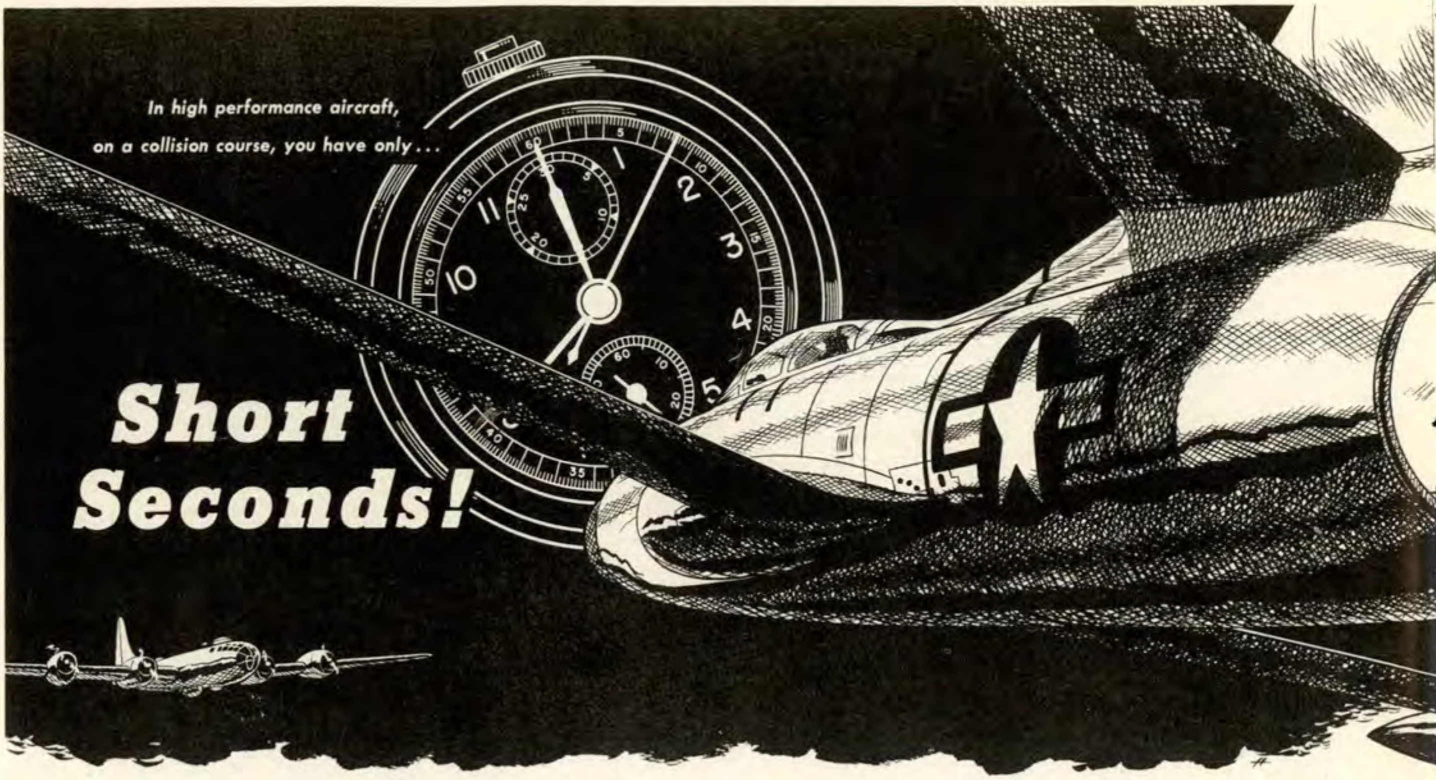
Inspection of the altimeter will readily show that at certain altitudes the 10,000-foot indicator is completely covered by the 1000-foot needle. Even with the needle not covered, it is small and hard to see, especially at night.

Although the 10,000 indicator is the big problem child, there are many recorded incidents where errors of 1000 feet jump into the picture.

A pilot of a bomber plane began letting down from an altitude of 6000 feet. At 1000 feet the copilot expected him to level off. Instead the pilot kept right on letting down until the copilot took over. The trouble was that the pilot had misread the altimeter by 1000 feet.

Just how many unsolved accidents involving aircraft flying into the ground on IFR approaches were caused by misreading the altimeter is problematical, but it should make you think. It should make you think, then assume, "that it doesn't always happen to the other guy."

Wright Air Development Center realizes the problem and is currently developing and testing new instruments designed to give a clearer presentation of altitude. But, until a new one is developed, we have to live with the hard-to-see altimeter with the hide-and-seek 10,000-foot needle. ●



Short Seconds!

Colonel H. G. Moseley, USAF (MC), Chief, Medical Safety Div., D/FSR

RECENTLY a pilot who was undergoing training in a jet fighter aircraft returned from a skip-bombing mission and was somewhat concerned when his crew chief pointed out several dents in the leading edge of the wing, scratches on the bottom of the aircraft and pieces of Yucca cactus embedded in an air scoop.

In this foliage-gathering mission, the pilot's wingman, who was flying behind him, was impressed with the low level of the pass, so low indeed that jet wash raised considerable dust in the passing.

All of which might be placed in the "Tut-tut, don't-do-it-again" category except for the fact that a number of other pilots have had similar experiences but leveled off a few feet lower, with rather dramatic results. If the pilot had stopped to calculate his dive angle and closing speed toward the ground, he would have realized that at the time he began his pull-out he was angling toward the ground at the speed of some 500 feet per second, and if he had delayed his pull-out as much as 1/50th of a second more, well . . . ??

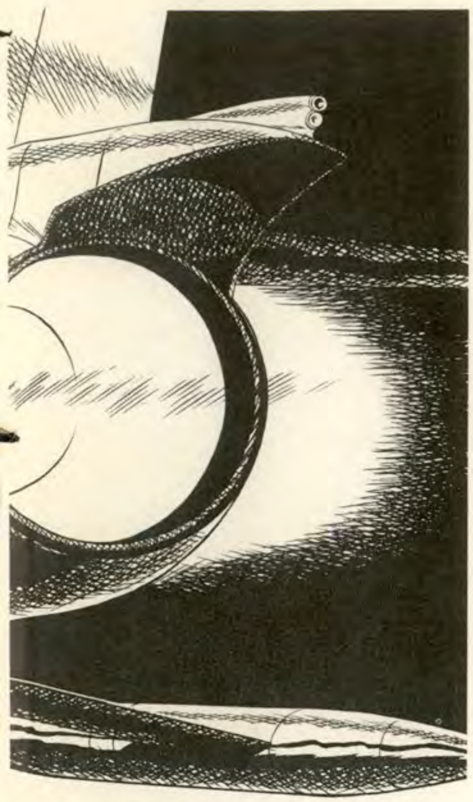
There is little doubt but that the pilot was sincerely attempting to fulfill his mission of bouncing a bomb through a target and that he did not wilfully intend to give his wingman a case of near-nervous collapse by the maneuver. His near-miss was inadvertent for he would never have had this mishap had he realized the vital importance of two factors, both of which every jet jockey needs to know and respect. These factors are, first, the terrific, almost unreal rate of closing speed in high performance aircraft and, second, the built-in limitations of man whose reactions are appallingly slow when pitted against the rapidity of events that may be encountered in high speed flight.

Closing speed of high performance aircraft is something rather new to the human race. To grandfather it never meant much more than an occasional collision between a buggy wheel and the front porch step during the haste of getting grandmother to church. Even to father in the day of the Model T it seldom meant more than a crumpled fender and a ruffled disposition which could be straightened out by means of a pair of pliers and a bottle of cold beer, respectively. The driver of the modern car, however, has begun to learn more about closing speed and to respect it. The relative ease with which man has encompassed this new challenge is somewhat of a tribute to his ingenuity. Within a very few years he has learned to glance at oncoming traffic and decide with a certain degree of accuracy his ability to pass safely the truck in front of him. Subconsciously he has developed a third dimensional gage of a new phenomenon. And, one might add, Monday morning's papers contain some interesting observations on those who were unable to learn.

Yet, in spite of his experience on the highway, when man pilots a jet aircraft he encounters closing speed which has no earthly comparison, and whose significance he has not yet learned to interpret at a glance. Therefore, it may be appropriate to take a more or less typical fighter mission, dissect it, and look at the anatomy of this strange new force.

Typical Fighter Mission

Inasmuch as high-angle strafing and bombing attacks are common maneuvers, we can take a high-angle strafing mission in an F-86 and roll in at 10,000 feet and pull out at 1000 feet above terrain. Fortunately, it takes no Einstein to understand the time-space anatomy of this situation. There are just three factors in it: *direction, speed and recovery.*



In this mission direction is simple; once the nose of the aircraft is pointed 45 degrees below horizontal, it is established. There is only one nasty little complication. This will become apparent later.

The next factor is speed. This also sounds simple; once a velocity of approximately 450 knots is established we have the speed. Any questions?

At this point all who have no questions might reconsult their insurance agents, because just as two and two equal four there are two factors built into the problem which, if unaltered may add up to an untimely end.

These factors are vital because the direction is down, and, to state it mildly, the aircraft is moving. As a result a collision with the earth is sooner or later inevitable. Therefore, in any mission where speed toward the earth is established there must be an accompanying and equally important consideration of time. Not knowing the minimum length of time that the speed and direction may be maintained before change is essential can be placed in the same category as not knowing the gun was loaded.

There are many charts showing how long it takes to lose altitude in various degrees of dives at various speeds. An example is Chart A. In this mission we start at 10,000 feet and pull out at 1000, indicating that we have 9000 feet of altitude to lose. As can be seen by the chart, at 450 knots 9000 feet in a 45-degree dive will be lost in approximately 17 seconds. However, if we hold the dive for 17 seconds we will commit one more unpardonable error—that is the error of allowing insufficient time for recovery. Recovery is the last major factor in the relatively simple anatomy of a dive. However, we should take a long, careful look at this item, for recovery from a high-angle strafing mission brings into sharp focus some of the most critical hazards of closing speed.

Flight surgeons and scientists have gone into long dissertations and have written reams concerning acceleration, G force and other physical laws of time, motion and space that are involved in changing the speed and direction of flight.

Momentum and Inertia

The factors which most directly confront us in recovering from this dive are the forces of momentum and inertia. One of the peculiarities of nature is that when something is moving, it keeps right on moving in a straight line until it meets some form of resistance. And the heavier the object and the faster the speed, the more resistance it takes to slow it, turn it or stop it.

This tendency to keep on going is due to the object's momentum and inertia, and for the sake of simplicity we can think of these forces together as momentum. A baseball, after being pitched, continues in the direction it is thrown, due to its momentum, and it is stopped by the resistance of the batter, the catcher, the solid earth or the friction of air. If a rock the size of a basketball is thrown with any force, neither the batter nor the catcher can stop it effectively, and it will take considerable friction to overcome its momentum.

In the F-86 high-angle strafing mission we have committed several streamlined tons of aircraft to a speed approximately that of a .45 caliber bullet. Here we have momentum in truly awe-inspiring proportions, and it is momentum which will require tremendous resistance to change. Unlike the baseball, the only acceptable form of resistance we can use is the friction of air. With this friction we must both slow down the dive and change the direction of the aircraft by at least 45 degrees.

A speed of 450 knots is considerable, and a jet aircraft, even with dive brakes extended, does not offer much surface for effective atmospheric friction. Therefore, we need both time and distance to overcome speed. In fact, we need so much time and distance to slow a nose-down dive that reduction of speed is only of minor importance in our problem of recovery. What is of paramount importance is a change of direction.

It is the item of change in direction which is the toughest problem of all. It is something that every pilot is constantly confronted with, and it is so closely tied to fundamental laws of nature that it must be given monumental respect if human flight is to be successful. As we mentioned above, momentum tends to keep an object going at the same speed and in *the same direction* until it meets resistance. Thus, when an aircraft's nose is pulled up, the pilot tends to go on in the original direction, and G forces are created. These same G forces work on the aircraft structure and wings, and the more rapidly the direction is changed the greater becomes the physical laws pushing the aircraft and the pilot straight ahead. After a point neither the pilot nor the plane can any longer defy this force, and unconsciousness or disintegration occurs.

Required Pull-out Time

It is appropriate here to look at Charts B and C to see the length of time which will be required to pull out of a 45-degree dive at 450 knots, at both 4 and 6G. At slower speeds less altitude is needed than is shown on the charts. However, the amount of G that can be used effectively on the aircraft and the time required to recover at this speed, must be computed well in advance. If insufficient time is allotted and the aircraft is committed to too low an altitude before recovery is begun, momentum and inertia, following the inexorable laws of nature, will take over and commit the aircraft to disintegration in the air or collision with the earth, no matter what efforts, threats or appeals the pilot may use.

The amount of altitude needed for recovery must be carefully computed, because it is least subject to compromise, and this altitude must be added to the distance above the

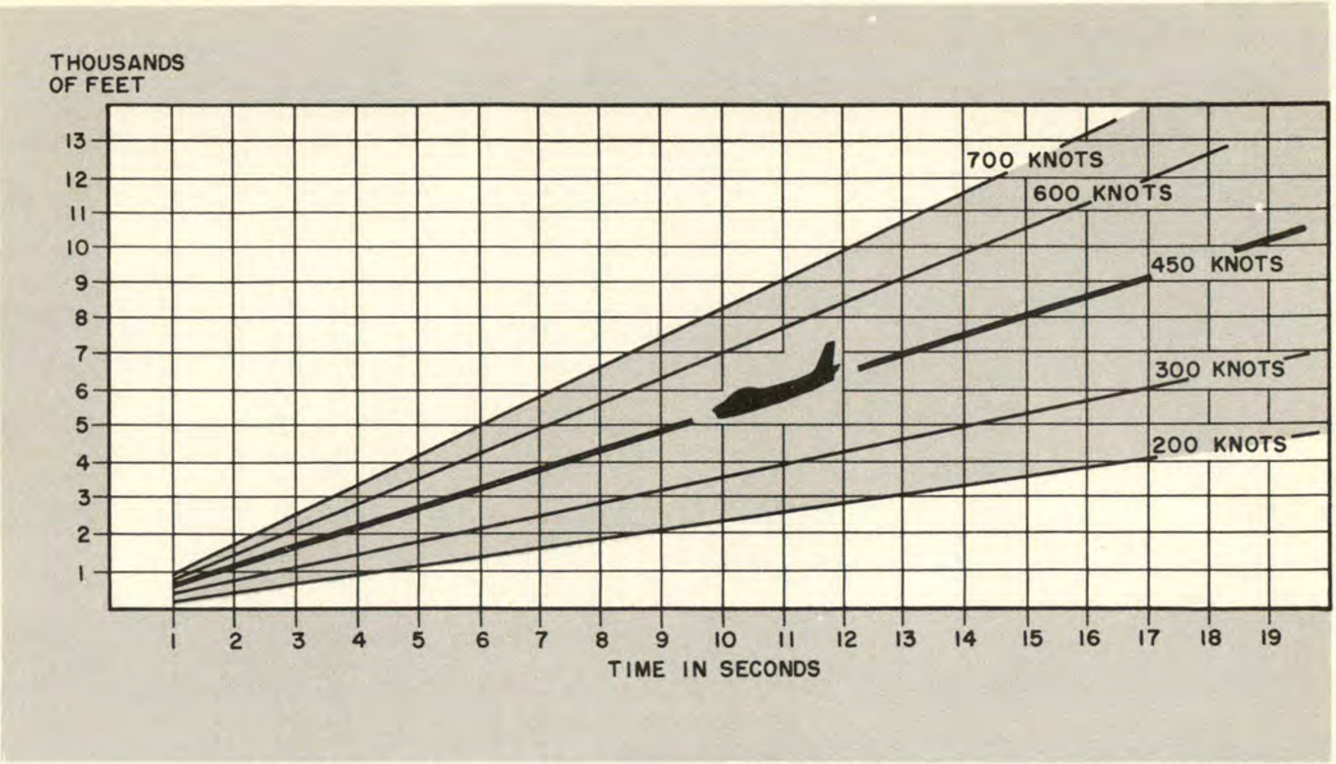


Chart A. As shown by the chart, at 450 knots in a 45-degree dive, 9000 feet will be lost in about 17 seconds.

ground wherein level flight is desired. Above that can be found the time allowed for aligning, sighting and firing. The successful pilot will know full well this time factor, because the seconds computed will be far more exact than his altimeter, and frequently more reliable than his vision.

For those who wonder why the altimeter is not reliable, it is relevant to note that a target and an altimeter cannot be simultaneously watched, and it is even more relevant to note that in high-speed dives the altimeter lag places the aircraft many hundreds of feet nearer the earth than is shown by the instrument. For those who wonder why vision alone is not a good substitute for timing a dive, it is well to consider the limitations of man and his reactions.

In considering man and his reactions, we can briefly review another accident. It is also true. It is chosen because it is typical rather than bizarre. The factors which caused it are still present. These causes are unchangeable. Only by knowing them can we prevent repetition.

This accident had its inception when a pilot, flying a jet interceptor found it rather monotonous making the usual camera gunnery passes at a bomber and requested permission from the bomber pilot to make a head-on pass. Permission was granted, and the interceptor pilot moved out ahead, oriented himself and waited for the bomber to appear. Eventually he sighted it approximately three miles distant and coming toward him. He swung in for his pass and then pulled up over the left wing of the bomber and away. He immediately noticed a severe yaw accompanied by buffeting and found that he had a ruptured right tiptank. He determined that his aircraft was controllable and returned to his home station and landed successfully.

The fate of the bomber was different. With a piece of the wing sheared off by the interceptor tiptank, it went out of control, partially disintegrated in the air and crashed. There were no survivors.

Neither the bomber nor the interceptor pilot realized the odds against them when they set up this simulated attack. It is certain that had they realized it, they would never have tried the maneuver. Let us review the cause factors in this accident, because, as mentioned before, they are still present.

Primarily this simulated attack, like all head-on attacks, created a formidable closing speed. The bomber was traveling at 170 knots indicated, and the interceptor was coming toward it at 350 knots indicated. Thus, at their altitude they had established a closing speed of approximately 1100 feet a second. The rest is a story of human reactions.

Reaction Problems

In considering man's reactions when confronted with such closing speed one finds that the first problem is one of visibility. Even on perfectly clear days it is difficult to see an approaching aircraft until it is quite close. The greatest distance at which a bomber can be seen is a little over seven miles, and a fighter a little over five miles. However, the probability of seeing an aircraft at such distance is about as great as seeing a grain of sand somewhere on a rug. It is not until an object is near enough to be relatively large that it is usually seen, even when searched for. So, the interceptor pilot first recognized the bomber when it was about three miles away. In some respects he was lucky, he might have been much closer before recognition dawned. If he had not been searching, he might not have seen it at all.

However, the interceptor pilot did locate the bomber at a distance of approximately three miles. Here is where the plot really thickened, because while closing at a rate of 1100 feet a second, a stubborn, uncompromising factor called time lag stepped in.

What does time lag mean? It means it takes approximately 1/10th of a second for the nerves to carry what the eye sees to the brain. And it takes approximately one second for the brain to recognize what it sees.

In turn, it takes approximately five seconds for the brain to make a decision when there are several choices. For instance, to decide whether to turn the plane up or down, right or left.

It takes approximately 4/10ths of a second for the nerves to carry that decision to the muscles and make them move.

What did this time lag mean to the interceptor pilot? It meant 110 feet in the 1/10th of a second for sight to reach the brain. It meant 1100 feet in the one second for recognition to take place. It meant 5500 feet in the five seconds spent in deciding how to line up. It meant 440 feet in the 4/10ths of a second to react. All in all, it meant 7000 feet from the time the bomber was seen until it was lined up.

The die had been cast. Now the end was inevitable. Considering that the bomber was first seen at about three miles, or approximately 16,000 feet, and considering that 7000 feet were lost in the line-up, we now have 9000 feet separating the two aircraft, and it's time to fire away.

Here, again, time factors are encountered. We hold the course and squeeze the trigger. Four seconds and 4400 feet. We recognize we are getting close. One second and 1100 feet. We decide to break away. Luckily, the decision was made in advance of the attack to break up and to the right. No complicated choice here. Only one second for a decision. Only 1100 feet. And now only 4/10ths of a second to react to that decision; only 440 feet.

However, we have precipitously obliterated another 7000 feet of vital separation distance.

How much space remains? Approximately 2000 feet now separate the aircraft, and evasion has begun. Only it is started too late. Here, again, time lag steps in. This time it is not the lag inherent in the reaction of the pilot, but the time lag in the aircraft itself. It takes time to stretch the cables. It takes time to move the rudders. It takes time to change the airflow over the controls. Especially, it takes time to change the tons of momentum from their near-irresistible course. How much time elapses between pressing the controls and significantly changing the course of an aircraft? That isn't known exactly. Certainly more than a second. Probably more than two seconds. Some observers say five seconds.

In this case there were two thousand feet between the two aircraft; 1100 feet a second. Time ran out. This pilot learned the hard way.

Yet, those who cannot remember the past are condemned to repeat it. Recently two experienced pilots in jet fighters, disregarding instructions, decided to fly a head-on pass. It was the same story. The pattern was similar. Not much distance when they first saw each other. A fraction of a second for sight to reach the brain. A second for recognition. A few seconds for decision. A fraction of a second for reaction; another few seconds to decide upon the breakaway. It was their last earthly decision. Little else could be expected. Their closing speed at this point was approximately 1700 feet a second.

However, the true significance of closing speed and human reaction does not lie in making head-on passes. It lies rather in the fact that in spite of high velocity and man's slow chemistry, flight can be eminently successful. Although the laws of nature appear to stand rigid and immutable in the paths of aerial conquest, they can be circumvented. To this end man has established the codes and rules of flying. Thus, the warnings of minimum altitude are designed to neutralize the momentum encountered in a strafing mission, and the rules of air traffic are established to avoid the awesome closing speed of on-rushing aircraft.

It is a wise pilot who will know well and abide by these rules of the game. He cannot change the laws that make them necessary. Nor can he alter the penalty of disregard. ●

Chart B shows altitude lost in pull-outs from 30, 45, 60, 90-degree dives from 10,000 ft. at 6G.

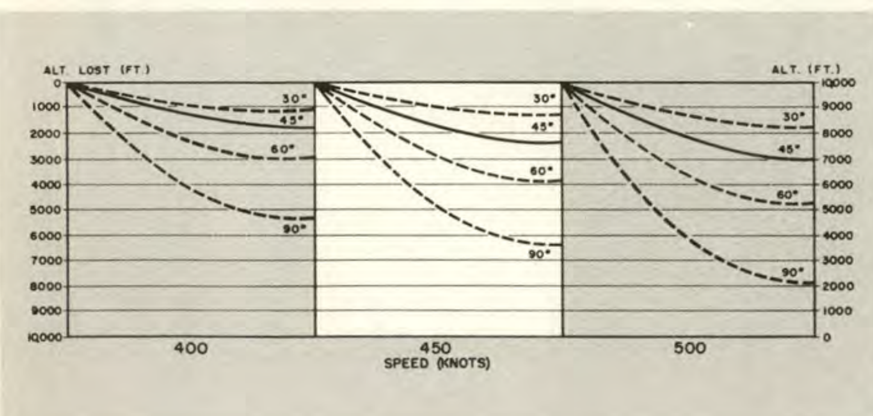
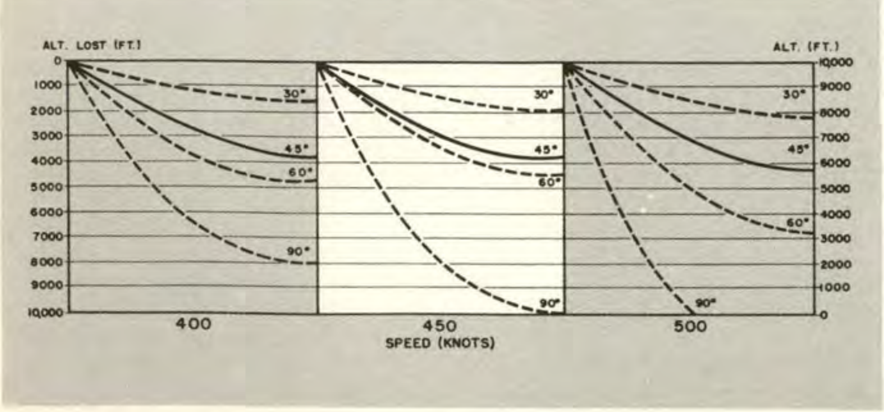


Chart C shows the increased altitude loss when pulling 4G instead of 6G at various dive angles.



THRU the GREENHOUSE... at 800 FEET!

WITH the introduction of high performance jet aircraft, the development of the ejection seat logically followed as a solution for escape at high speeds during an emergency. Naturally this escape device is intended for use only when the pilot has no alternative except to eject.

The ejection seat has met a great many needs associated with in-flight emergencies; however, it is felt that all the advantages of ejection have not been exploited fully.

Emergency ejection from a high speed airplane must meet one requirement. Namely, the pilot must clear the aircraft structure just as he did in older conventional aircraft. The ejection seat is doing the job, but there are complications, particularly when we consider the complexity of the various systems and the all-important *time* factor. The pilot, being attached to a heavy seat structure, must have time in which to separate from it, prior to deployment of the chute.

In other words, there is a time element involved in separation from the seat which, at low altitude, has been precarious because of the delay between unbuckling and kicking free of the seat and opening the parachute.

It is the opinion of many pilots that the ejection seat trajectory can be put to excellent use by utilizing the traversed arc. Additional altitude above the terrain can be realized if separation from the seat is possible at or near the top of the arc thereby giving the pilot additional time in which to deploy his chute.

We may be asked, "What should be the objective in successful ejection from an aircraft relative to terrain clearance?"

It is our belief that all jet fighter pilots would categorically state that the objective should be successful ejection and parachute deployment at *any elevation* immediately following their takeoff.

It is realized that this objective may never be reached; however, it is possible at *this time* to evacuate an aircraft at extremely low altitude provided certain conditions are met. Ideally, these conditions are:

- Ejection through the canopy of jet fighters at the *choice* of the pilot.
- Automatic separation from the seat.
- Automatic deployment of the parachute.

Time is of the essence in an emergency bailout at low altitude and the pilot should be given the choice of jettisoning the canopy or ejecting through it. Incorporated within this article is a list of jet aircraft that employ emergency systems which give the pilot that choice. It is the belief of the Directorate of Flight Safety Research that a pilot should be given the choice, because an ejection system that is first dependent upon successful jettisoning of the canopy could be made inoperative by battle damage or other malfunction and the pilot would thereby be trapped.

Some non-believers have been against ejection through the canopy at the pilot's choice because of the possibility of injury to the pilot as the canopy is penetrated.

We believe the ejection seat can be designed in such manner that it can penetrate the canopy without injury to the pilot. This requires a penetration device that would precede the pilot's head and shoulders and would only be impractical in those cases where the canopy had been strengthened to a point where no ejection seat could break through.

We now have positive evidence that it is possible to go through a canopy successfully, protected only by normal flight gear. In the instance that follows, the pilot was given two of the three essential escape devices. He had the *choice* of ejecting through the canopy and he had an automatic lap belt. However, he had to deploy his parachute manually.

Recently 2d Lt. William R. Hill, an instructor pilot at Williams AFB, made a successful low-altitude bailout through the canopy of a T-33. The Directorate of Flight Safety Research, realizing the value of wide dissemination of his story selected this means of spreading the word.

This is the first successful ejection through the canopy, at very low altitude, on record. The pilot who was involved in this ejection got clear of his aircraft at an altitude of approximately 800 feet above the ground. Airspeed at the moment of ejection was nearly 280 knots.

The following are direct quotes from Lt. Hill's narrative account of his emergency ejection.

"The events leading up to my bailout were, in general, very much routine. I was scheduled to take a four-ship flight out for formation practice, and since this was the final trip prior to formation checkout for all of the students in the element, I believed this would be just another mission.

"As it turned out, I was completely wrong. For even though the Air Force furnishes almost everything in the way of equipment, a crystal ball is not standard-issue equipment.

"As a matter of fact, it *was* a routine flight until we headed back for the field and started our letdown in normal formation.

"The flight had been briefed prior to the mission that if time permitted we would make a high speed pass across the base before entering the traffic pattern.

"A fuel and oxygen check was made at 10,000 feet, and everyone had sufficient oxygen, while the fuel supply ranged from about 160 to 170 gallons in each ship. So far everything was normal, so I called traffic control and requested a pass across the field in formation at 3500 feet. Permission was granted.

"We came across the base at 3500 feet indicated altitude with the airspeed pegged at 360 knots. At the far end of the field we pulled up in a climbing turn to the left and the formation was put into echelon. Power was reduced to 80 per cent at this time.

"We continued the turn until we were on the outside downwind and dropped on downhill to 1200 feet above the terrain. This put us in a position to swing around again for initial approach. I had the flight slow down a bit more, to about 290 knots, then called for 'dive flaps down, now . . . push it up to 90 per cent.'

"Upon completion of this last call, I rolled into a 40-degree bank to the left. After swinging around for about a quarter of a turn I looked to the right to check the position of the flight, and it was then that I realized that No. 3 man was out of position.

"I can't actually recall whether he was a bit forward or high. I do know that I could see almost all of his airplane and that I realized only the tail should have been visible. Instinctively the thought flashed through my mind that here was trouble.

"The next few moments are merely blurred impressions in my mind. I think they always will be. The No. 2 and No. 3 aircraft appeared to be running together, and I knew there was no way to duck out of the way. A collision was inevitable; and just that fast it happened.

"I was slammed around in the cockpit in a completely confusing manner. Then things became almost black. Maybe it was the impact shock. I don't know. I could feel and hear but I couldn't see.

"It seemed to me that the airplane was snapping or rolling over and over. First I experienced a terrific amount of G forces and seemed to be thrown against the left side and up toward the canopy. Next, the G forces were reversed, becoming unquestionably negative in nature.

"I thought right then that 'This is it. I'm too low for an ejection — there just isn't time.' I reached down, trying to get hold of the right armrest, and at first was unsuccessful. The suddenly reversing G forces were throwing me back and forth so that I couldn't get hold of a thing.

"I guess it's funny how your mind works during an emergency. I wanted to blow the canopy, but I couldn't get the left armrest up. In fact, I couldn't touch it, and I knew that I'd never be able to pull the manual jettison handle back even if I could get hold of it. There was just one thing left to do.

"When my hand finally got the right armrest it was already up, but I don't recall pulling it to that position. I believe that probably the collision impact had broken the armrest and it had sprung up into the raised position. The only thing I had to do was squeeze the trigger. I grabbed it and did just that.

"I know that my body was not in the proper position for an ejection. I couldn't get my feet in the stirrups and I wasn't able to brace my head at all. I think that my feet were off the rudder pedals, for, as I remember it, they were just hanging in space, and I was more or less suspended from the seat belt.

"I can't remember any impact when the seat went off. There was an explosion, of course, but I didn't feel it, and then suddenly I realized that I

Following is a list of aircraft in which it is possble to fire the ejection seat through the canopy. It should be noted that on some aircraft it is necessary to actuate the canopy jettison controls in order to arm the seat; then if the canopy fails to separate from the aircraft, the pilot can eject through the canopy.

Aircraft	*Procedure*
T-33A (series 51-9036 and subsequent)	Actuate the seat firing mechanism.
F-80B and C	Actuate canopy jettison controls then the seat firing mechanism.
F-84G	Actuate canopy jettison controls then the seat firing mechanism.
F-84F	Actuate the seat firing mechanism.
F-86E (series 51-13046 through 51-13069)	Actuate the seat firing mechanism.
F-86D-40 and subsequent	Lift left hand grip then actuate seat firing mechanism.
F-86F (only if T.O. no. IF-86-161 complied with)	Lift left hand grip then actuate seat firing mechanism.
F-86H	Check Dash-One for details.
F-89 (all models)	Actuate the seat firing mechanism.
F-100A	Check Dash-One for details.

was out of the plane. I don't remember any sensation of going through the canopy and I don't remember if I even thought of my lap belt. I do know that I didn't try to unbuckle it. Luckily I was wearing an NA-1 type and it released automatically after a couple of seconds.

"I reached for the D-ring and don't recall any trouble in finding or pulling it. The next thing that I can remember clearly was the feel of the shroud lines tangling around my right leg as the chute was coming out of the pack, and I don't recall any hard opening shock.

"All of this time I couldn't see a thing. I had no vision whatsoever until that beautiful umbrella opened. Then, all of a sudden I could see the canopy, and I turned and looked at the ground and began to realize that I was alive after all.

"My drift was backwards at the time of impact but the landing shock was very slight, and it took but a moment to get out of the harness. I was down and intact.

"In looking back now, I sincerely believe that there were several factors that were effective in saving my life. Perhaps these points may be worth passing on to others.

"I was flying with my visor in the down position, although I don't believe it was full down and latched. I had an oxygen mask that was two or three days old. It was very tight. In fact, it was too tight.

"The chin strap was not attached to the helmet. The mask itself was equipped with a spring clip which was utilized, being attached to the mask.

"My helmet came off sometime after I left the airplane, although I don't know when, but I'd certainly be a goner if I hadn't been wearing one. The helmet showed severe damage where my head apparently penetrated the canopy glass.

"I know there's been a lot of discussion lately about parachutes. Apparently some people believe that the seat pack is best. Others go for the back pack. It seems to me that such a choice would rest mostly with the size of the pilot. Being of medium build I prefer the seat pack. In fact, I was wearing a 28-foot seat pack when I bailed out and it worked just fine.

"Like everybody else, I've always wondered if it would be possible to bail out at low altitude. After this experience I *know* that it can be done. Of course I didn't have my belt and shoulder harness unhooked. As I said before, I just didn't have time.

"I was thinking about altitude though. We were at 1200 feet when the collision occurred and I know that the time lag must have been very short from the moment of impact until I was out, but, it seemed like an eternity. I do know though, that I *got out of the plane at about 800 feet above the ground.*

"I'm sorry that I can't give a more accurate picture of the attitude of my T-bird when I ejected. The aircraft felt to me as though it were tumbling end over end or rolling over and over. Either one may have been possible for the whole tail section, including the engine, had been torn away.

"I can state positively that I owe my life to two things: First, that *I was able to eject through the canopy and second that the automatic seat belt functioned.* If it hadn't been for the automatic features of the belt I wouldn't have had time to go through the usual procedures of unhooking and kicking free of the seat. The helmet itself is proof that it saved my head from a terrific blow, for it is split down the back and on one side.

"Although I did get scratched up a bit in this caper, actually I didn't realize that I had been injured at all until I'd been on the ground for about 15 minutes.

"It was then that I noticed that my right knee was cut. I had abrasions on both shins that ran down across the tops of my feet. I had flight boots on when I jumped and for some reason they didn't come off, but the inner lining of the right boot is pretty well ripped and torn.

"I caught a few more wallops too but believe me, I'm not complaining one bit. I still have abrasions on both elbows, the right arm and leg of my flying suit was ripped and I've got a beautiful bruise about the size of a baseball right at the base of my neck.

"Incidentally, I'm sure I got the leg abrasion from the canopy rather than from under the instrument panel even though I wasn't positioned right for the bailout.

"Well, I guess that's about it. Only one thing more that may have helped a bit. My seat chute was equipped with the new type foam seat cushion and heavy kidney pads in the back, and I think that may have helped, for my back feels fine."

It is hoped that the foregoing will help to explain one experience in ejecting through the canopy at low altitude. It can be done. Certainly this officer was lucky, for the odds were pretty much against him when we consider altitude, attitude and airspeed. Go through the canopy when the terrain clearance is at a minimum. *It works!* ●

QUIZ ANSWERS

1 — 16,080	6 — 25,420
2 — 13,960	7 — 28,020
3 — 13,330	8 — 1100
4 — 10,700	9 — 11,000
5 — 34,640	10 — 11,100

the LOUD silence

FLAMEOUT... a word all jet pilots well know. It's a word that is easily defined, too. No more fire. No more push. No more engine. Perhaps the best description of all was that of a young jet jockey relating his experience after several futile airstart attempts, "It was silent. Really silent. I never heard a silence so loud."

It was quiet, he was alone, and perhaps he was a mite uncertain as to just what he was supposed to do.

That's where the definition may vary slightly from pilot to pilot. A pilot who has practiced, who knows the proper procedures used in a flameout landing, has confidence in his ability to handle the emergency. He has an SOP and follows it. The man with no simulated landings under his belt, and with an incomplete knowledge of flameout procedures, may have another version of the term. To him a flameout is synonymous with trouble. Real bad trouble. He doesn't know his aircraft's high key point, low key point, best glide speeds or any other of a wealth of information that could have been learned through practice and study.

Fortunately, the latter pilot is in the minority. Nowadays, most jet drivers are firm believers in practicing flameout patterns and landings in their go-buggies.

At the request of the Directorate of Flight Safety Research, the Air Research and Development Command ran a series of simulated flameout patterns for various jet fighters during the past several years. The results of some of these tests have been published in previous issues of FLYING SAFETY; the results of tests of later models are incorporated in this article along with the earlier information.

The basis for the claim that this research has paid off in terms of aircraft dollars saved, is in the letters received from many USAF major commands, outlining the number of successful (minor or no damage) forced landings accomplished in each command.

These figures, coupled with data researched by the Directorate's Records and Statistics Division, indicate that the U. S. Air Force-wide "practice" or simulated flameout landing program has been very successful.

By comparing two periods of time, one before the simulated flameout program was instituted and one after it had been in operation for a year, it was proved that the accident rate in this category decreased 29 per cent in the second period. This point is emphasized further by the fact that although total jet flying hours increased 48 per cent in the second period, the dollar loss increased only 11 per cent, an estimated saving of several million dollars. Because of 175 successful forced landings during both periods, the savings in airframe costs alone is estimated at nearly 20 million dollars.

The study of jet flameouts is not static. It is set up on a continuing basis by Air Research and Development Command in order to obtain ultimate information on jet flameout landings under all conditions in present and future jet fighter types. In addition, the Directorate of Flight Safety Research continues to study and recommend new techniques, based on thorough analysis of jet fighter accidents. This information will be disseminated to pilots through Pilot's Handbooks, magazine articles and other printed media.

In the past, flight tests were conducted at Edwards AFB to determine the best possible procedure in flameout landings for F-84G, F-86E, F-86D and F-94C aircraft. Recently patterns were established for the F-86F, the F-84F and, in part for the F-89D, and are included in this article, along with some new data on the F-94C.

In the analysis of this information it was discovered that certain basic changes would improve the previously recommended landing patterns.

ACTUAL FLAMEOUT DATA

	F-84G	F-84F	F-86E	F-86D	F-86F	F-94C	F-89D
Best Glide IAS—Kts. (gear up)	190	225	185	185	185	185	
** Rec. Rate of Turn—Degree/Sec. (gear up)	3	3	3	3	3	1.5	
*** Rec. Alt. for Lowering Gear (normal system)—Ft.	12,000	**see note	12,000	12,000	12,000	15,000	10,000
Avg. Time for Gear to Lock Down—Seconds	25	7 to 8	15	27	27	19	
High Key Alt.—Ft.	5500	6000	6000	6500	6000	6000 / 8000	**** 7000
Best Glide IAS—Kts. (gear down)	180	220	185	160	185	175	155
Rec. Rate of Turn—Degree/Sec. (gear down)	3	3	3	3	3	1.5	
Low Key Alt.—Ft.	2500	3000	3000	3500	3000	3000 / 4000	3000
Base Leg Alt.—Ft. (270 degree point)	1300	1500	1500	1500	1500	2000	
* Rec. Final Approach IAS—Kts.	150	200	150	150	155	160	140
* Rec. Over the Fence IAS—Kts.	140	140	130	135	135	140	
Avg. Test Time from High Key to Touchdown—Minutes	2.2	2.2	1.7	1.8	1.8	3.3	

* Assuming no wind and approximately 600 lbs. of fuel remaining.

** Completely elastic, depending on position and altitude.

*** Only if field is definitely within gliding distance.

**** Limited data available as complete flameout tests not run. Figures are those recommended by Edwards Flight Test Center and WADC. All figures are based on engine windmilling with hydraulic pressure available.

The major change was the modernization of the circular (360-degree over-head) landing pattern and the readjustment of key point altitudes as shown on the accompanying charts.

In addition, the Edwards AFB test report stated that the hydraulic irreversible normal flight control system on F-86E and F-86D airplanes is fully operable with the power provided by a windmilling engine.

Improvement of the pattern used in the early flameout landing study as prepared by the Directorate of Flight Safety Research was recommended by test pilots at Edwards AFB. This revision called for three pattern points with corresponding altitudes, rather than the two points used in the original tests.

The first or "High-Key" point remains in the same geographical pattern location and is established on the initial approach at a specified airspeed and altitude with gear down and locked.

FLAMEOUT SIMULATION DATA

	F-84G	F-84F	F-86E	F-86D	F-86F	F-94C
Best Glide IAS—Kts. (gr. up)	190	225	185	185	185	185
Best Glide IAS—Kts. (gr. dn.)	180	220	185	160	185	175
Avg. Power-RPM-%—25,000 to 12,000 Ft.	65		72	79	68	79
Avg. Power-RPM-%—15,000 to S.L. (gr. dn.)	58		69	74	64	69
* Rec. Alt. for Lowering Gear—Ft.	12,000	......	12,000	12,000	12,000	15,000
Rec. Rate of Turn—Degrees/Second	3	3	3	3	3	1.5
** Best Across the Fence IAS—Kts.	140	140	130	135	135	140

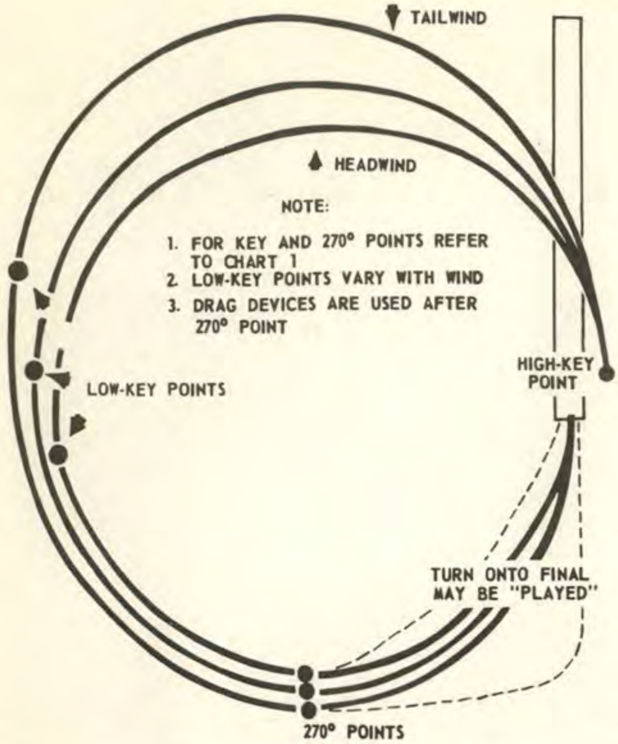
* Only if field is definitely within gliding distance.

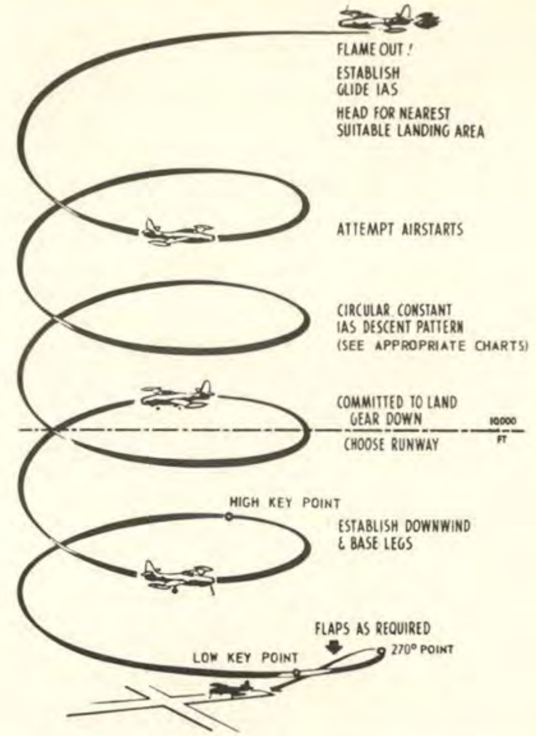
** Assuming no wind and approximately 600 lbs. of fuel remaining.

At this "High-Key" point a specific and constant rate-of-turn should be started and maintained until the 180-degree or downwind point is achieved. Here is the point where a positive decision must be made by the pilot, and depending on the prevailing wind, the pattern must be "played" from here on. As this 180-degree point is the location of resolution and is the spot where the pilot must make his first evaluation of his ability to properly hit the runway; it is known as the "Low-Key" point. The last significant altitude is at the 270-degree (base leg) point. From here to touchdown, a successful landing is effected through the proper use of flaps, speed brakes, and if necessary, controlled side-slips and fishtails. (Consult the Dash-One T. O. for slip restrictions on your aircraft.)

The aiming points on the runway remain unchanged. For a headwind condition, shoot for the midpoint of the runway; if a tailwind prevails, shoot for the first third of the runway. But the important thing is to put the plane where you want it.

As in all flying techniques, there must be a flexibility of patterns to conform to the hundreds of varying conditions. The figures shown in the charts on this page are for optimum conditions only, in the sense that the





resulting pattern is easily flown and gives accurate results.

It is possible to perform the entire 360-degree pattern at altitudes different from the values shown, depending upon the judgment of the pilot. If you happen to come out at the "High Key" point at an altitude lower than that specified, it is possible to complete the approach by making a smaller pattern with accompanying increased rates of turn. However, these steep, tight turns can become uncomfortable with boost off.

At this point the difference between emergency and forced landings should be emphasized. The following descriptions of a "forced" and an "emergency" landing still hold good.

An emergency landing is a precautionary landing made at the pilot's election, and under conditions where he has control of his power and of his flight controls.

A forced landing is a landing under conditions where loss of power control or partial loss of flight controls precludes further flight.

A word about canopies. Follow the Dash-One to the letter as to whether you should jettison or open your canopy on a forced landing. In the event of a wheels-up landing, or if an undershoot or overshoot occurs on a wheels-down landing and fuel spillage is a probability, do not jettison the canopy as firing of the mechanism will ignite the fuel. In this case, open the canopy manually or have it jettisoned before touchdown.

The recorded experiences of over 600 jet fighter pilots who have evacuated crashed aircraft indicate clearly the desirability of pre-crash canopy removal. Of these pilots, 110 experienced difficulty in canopy removal following a crash landing. As a direct result of post crash fires, six received fatal and seven received major burn injuries. Eight others were saved only by the prompt action of crash crew personnel. An analysis of these accidents proved conclusively that the majority of crash landing injuries were not caused by impact forces, and prompted the recommendation to jettison the canopy prior to execution of a forced landing.

Here is another moot point which you F-86E, F and D jockeys had better paste in your helmet. Comes a turbine seizure (and you will know it when you get complete, *but complete*, loss of rpm), get ready to go over the side. Of course if you are over an established airfield at a fairly low altitude, and you are sure that you can make the field, then best you ride it down. Remember though, in the F-86E, F and D models without engine windmilling, your alternate flight control is dependent on the battery and the battery may last only a few minutes. This information also applies to the F-84F-25 and subsequent aircraft. The F-84F-1 to 20 can be flown without hydraulic pressure because the controls contain mechanical linkages to the surfaces. The F-84F-25 and up can be considered, for this purpose only, just like the F-86F. The same advice, and experience shows it is really good advice, holds true for pilots flying the F-89-B, C and D models. In the unlikely event that you lose both engines and can't maintain sufficient windmill speed, be prepared to leap.

Another point along this line. With a seized turbine your rate of sink increases about 35 per cent over normal gliding ratio.

We cannot stress the point too strongly that the information contained in the studies of flameout landings be used constantly in the education of jet pilots, regardless of their experience level. These facts should be impressed indelibly on the mind of every man who flies a jet, until his reactions in making a flameout landing become natural reflexes.

This is one time when practice really counts. So it's up to you . . . only *you* know if you're proficient. ●

Ask The Man Who HITS One!

Barrier!

That's a word which is coming into every day usage more and more. You mention barrier to hot-rock Charlie or John Q. Public and they both think of that invisible wall. The sonic barrier is fast becoming an open door in spite of its name.

There's another type of barrier though that isn't quite as well known and this one is plainly visible. These barriers, unlike the sonic type, do not present any particular problem when an airplane slams into them. It's exactly what they are intended for. As a matter of fact, driving headlong into one of these arresting gears can mean the difference between a successful stop or a badly mangled aircraft. That is if a pilot overshoots a flame-out landing, suddenly runs out of brakes during the landing roll or loses the fire-pot on takeoff.

In terms of dollars saved, the units now in operation are paying for themselves many, many times over. And within the next few months more new units will be springing up all over the world, until eventually almost every USAF air base will have one or more.

FLYING SAFETY used the program now in operation at Nellis AFB as an example of how the barrier works. While not the first, it was one of the first in the ZI. Incidentally, all Crew Training Air Force bases now have barriers installed.

The Korean conflict established the value of barriers in fighter operations. The many saves in that theater indicated that a barrier was a must in an accident prevention program.

We do not intend to go into any of the finer details of the emergency arresting gear in this article. That is strictly an Air Installations problem and will be so handled by bases scheduled for these units. However, we do want to alert pilots of fighter aircraft to the fact that an extensive program is already under way and point out a few operational factors that are worth remembering.

A brief rundown on the main features of the barrier should help to better understand its operation.

In general, the following components make up a typical arresting gear:

Webbing Assembly—This assembly consists of an actuator strap to which are attached a number of vertical lifter straps. Each lifter strap is rigged to the arresting gear cable by means of six special lock type snap fasteners. These fasteners can carry a high load. The restraining strap, which is secured to the anchor end of the vertical lifter strap by two conventional glove type snap fasteners, is incorporated as a part of each lifter strap to insure that only a load of high magnitude will have a tendency to open the six main fasteners.

Five gets you ten that we lost you on that one. But, as it's not our intention to add confusion to this article just think of a nylon net, anywhere from 150 to 400 feet long and 40 inches high. That is a rough picture of the webbing assembly.

Releases—Two release devices are used to attach the ends of the actuator straps of the webbing assembly to the tension mechanism of the arresting gear stanchions. A replaceable shear pin is incorporated in the release and upon shearing, the actuator strap is freed from release assembly.

Runway Anchors — These anchors provide a means of anchoring the lifter straps to the runway. It is from these points that the restraining force is applied that unsnaps the six main fasteners on each lifter strap thus releasing the arresting gear cable during engagement.

Arresting Gear Cable — A flexible steel wire rope cable, $\frac{7}{8}$ inch, uncoated, improved plow steel, fibre core, is utilized as the arresting gear cable. This is the little gem that snaps up and grabs the blow-torch firmly by the landing gear. Each end of this cable is attached to the arresting chains.

Arresting Chain—This is the part of the barrier assembly that does the actual slowing down and stopping of an aircraft. The chain is placed parallel to both sides of the runway. At Nellis AFB they are using 273 feet of chain on each side and as each link weighs 57 pounds, it is apparent that any engagement means dragging a lot of weight.

Main Stanchions — The stanchions, mounted on concrete foundations, serve as end supports for the actuator and arresting cables. Each stanchion incorporates a hand operated winch for tensioning the actuator pendants. These stanchions, hinged at their bases, incorporate a cable with shear pins installed, instead of the old system of bungee cords. When aircraft contact the arresting cable, the shear pins break and allow the stanchion to bottom. Old tires are placed on

If a pilot overshoots on a flame-out landing, runs out of brakes after touchdown or loses his fire on takeoff, his best friend may well be the crash barrier.

An F-86 moves down the runway and is shown prior to and immediately after initial contact with nylon webbing. Arresting cable will spring up to engage main gear.

the concrete bases to prevent damage when the stanchion is flattened to the ground. The stanchions can be laid flat when the barrier is not in use.

Originally, the Nellis installation used intermediate stanchions to serve as supports for the webbing assembly. Now, pieces of soft, white pine wood, $1\frac{1}{2}$ inches in diameter, have been substituted for the stanchions. The wood poles are stuck into pipes sunk in the ground and are notched at the top. The top of the webbing is inserted in the notch and supported by the pole. The wood breaks when the barrier is engaged.

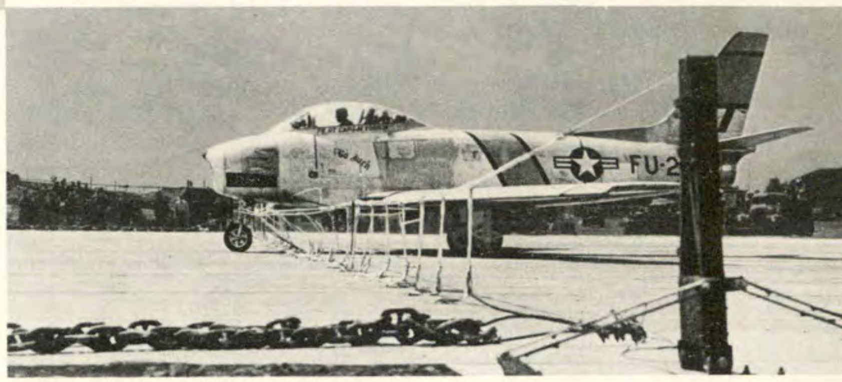
Barrier Operation

You're probably wondering at this point just how this little beauty works. We'll try to keep it simple. Between this copy and the pictures, you should be able to get a pretty fair idea.

As the nosewheel passes over the arresting gear cable lying on the runway, the webbing assembly is engaged by either the nosewheel strut fairing or the nosewheel well doors.

Continued forward motion results in the arresting gear cable being lifted off the runway by four lifter straps in such a fashion that the arresting gear cable rises *behind* the nosewheel, but *in front of* the main landing gear.

The four active lifter straps continue to lift and pull forward on the cable until they are taut between the nosewheel fairing and the anchors. Further forward motion unsnaps the retaining snap fasteners, pulls the



After nylon webbing is torn away by the nose gear and arresting cable has engaged the main landing gear, the pilot can expect the speed of the aircraft to diminish.

With the arresting cable now positioned and pulled taut, the aircraft begins to drag the heavy, linked chains which are stretched along both sides of the runway.

lifter straps through the inertia flaps, then unsnaps the six main snap fasteners on each lifter strap.

At this point, the arresting cable is off the runway, moving upward and slightly forward between the nosewheel and the main gear and is completely free of the lifter straps.

As the aircraft continues forward, the arresting gear cable is engaged by the main landing gear struts and further forward motion is restrained by pull on the cable transmitted from the arresting chain. The airplane then progressively moves more mass by reeling out the heavy doubled chain during the remainder of the arresting run. We did a bit of research and asked a lot of questions on the actual operation of the Nellis AFB barrier.

It is interesting to note that as this issue goes to press, six aircraft have been saved from almost certain destruction by the Nellis barrier. Add that up in dollars and you'll see that the $5,000 or so spent on its construction is but a drop in the bucket.

Unfortunately, three more aircraft failed to engage the barrier because the pilots did not establish the proper configuration for their aircraft, or didn't use the proper techniques. All external stores other than tiptanks must be jettisoned, and pilots should *not* use the brakes in an attempt to slow down.

Here is a description of some of the saves made at Nellis AFB:

• The pilot of an F-86F started his takeoff roll as the No. 2 man of an element. He ran up to 98 per cent and went wheeling down the runway.

As the leader became airborne the No. 2 man noted that his plane was dropping back. He glanced at the tailpipe temperature gage and saw that it was rising above the red line (700°). The pilot immediately stopcocked the throttle and aborted the takeoff. The airspeed indicator was crowding 150 knots at this time.

At Nellis the 23-foot drag chain is made up of 57-pound links, each over a foot long.

As brakes were applied, the plane began to slow somewhat, but it was evident that insufficient runway was left for a safe stop. At 100 knots the F-86 slammed into the barrier and decelerated to a stop with only minor damage inflicted by the barrier cable. Chalk up one save for the runway arresting gear.

We don't propose to go into the cause factors of these cited incidents. The important thing is that the barrier saved these planes from almost certain destruction.

• The pilot of an F-86F was returning to the base from an air-to-air gunnery mission. His landing was fast because he inadvertently left the emergency switch in STANDBY position. This forced an idle condition of approximately 42 per cent and the pilot found it impossible to slow the plane to normal touchdown speed.

Mobile Control observing the fast approach, instructed the pilot to "take it around." However, on advancing the throttle a compressor stall occurred and a forced landing suddenly became a reality.

The F-86 engaged the barrier at an estimated 70 knots. Only the right gear connected with the cable but in spite of this the pilot was able to maintain straight directional control and the plane was stopped without any appreciable damage.

Chalk up another on the plus side for the barrier.

• The pilot of this F-86F was No. 3 in a flight of four Sabre Jets that had just completed a routine training mission. His trouble began on the first landing attempt. He messed up the pattern and Mobile sent him around for another shot at it.

While tooling around the pattern on his second landing attempt, the pilot noticed that the throttle was not functioning properly. On final he discovered that power could not be reduced below 70 per cent rpm. This was like having the well-known tiger by the tail and from this point on the pilot was committed to land regardless of any personal desires.

The plane touched down at about the midpoint of the runway and went into the barrier at 140 knots. It was stopped in less than 500 feet with only minor damage to the fairings. After the dust settled the pilot finally cut the master fuel switch to stop the engine. Obviously, the value of the Nellis barrier is increasing.

• This one was a bit different in that it involved a T-33A, and the plane went sizzling into the barrier with the speed brakes down. Normally you'd expect the speed brakes to force the barrier cable down and below the main gear. Fortunately this didn't happen as the cable was forced downward and then snapped up again to engage just the tips of the wheel fairings. 'Twas enough though, and the plane was stopped successfully. However, the pilot was extremely lucky as normally the barrier will not engage with speed brakes down.

• In another instance, an F-86 hit the crash barrier while traveling at high speed and a successful engagement was made. In this case, however, the pilot did not get rid of the external tanks prior to barrier impact. He was lucky. The cable wrapped around the pylons instead of the landing gear, but damage was negligible.

Quick Stop Tips

There are a few things that the pilot can do to insure maximum effectiveness when engaging the barrier:

• If an emergency develops in the landing roll-out or on a takeoff run, the pilot should make every effort to strike the center of the barrier, holding the airplane on a heading as closely parallel to runway as possible.

• Excessive braking action to a point where a tire may blow out or cause the plane to swerve must not be used as this probably will result in an improper engagement of the barrier, or even in hitting the barrier sideways. Also, tests indicate that a high speed impact has a distinct advantage over a slow speed roll-in in picking up the arresting cable.

• F-84s with pylon tanks and F-86s with external tanks should be cleaned up prior to impact if at all possible, i.e., drop all stores and external tanks other than centerline tips.

• Pilots flying F-80s, T-33s, F-100s or other types with speed brakes located below the fuselage should make every effort to retract the speed brakes prior to impact, as the speed brakes will deflect the arrester cable downward and prevent engagement.

Remember, the barrier will save the day for you in an emergency. Keep the few simple steps for engagement filed away in your mind. Work *with* the barrier when the chips are down and it'll take care of you. ●

YOU need these men!

Don't wait for an accident to happen! Officers trained in all phases of accident prevention and investigation at the Flight Safety Officer Course, USC, can save commanders many headaches.

Part of the accident prevention program consists of working with AACS and operations personnel. These officers are highly trained investigators.

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Right now, highly trained Air Force officers (221 graduates to date) are available to commanders in the accident prevention field. These men can save you a lot of headaches. They are graduates from the Flight Safety Officers' Course at the University of Southern California.

This comprehensive 8-week course trains Flight Safety Officers in both accident prevention and accident investigation. Following is the course curriculum:

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Physiology	24	Demonstration of Centrifuge	3
Psychology	30	Evaluation Orientation and graduation	5
Education	28	Total Hours:	283
Public Speaking	(8)		
Writing	(4)		
Graphics	(2)		
Techniques	(14)		

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