The FBO Problem

It's high costs for everyone involved

BY J. MAC MCCLELLAN

IF YOU WANT TO raise the blood pressure of pilots, bring up fuel costs. If you want to put that same group into orbit, mention ramp and handling fees. There is no hotter topic among pilots. That is, unless you talk to a pilot who just landed at an airport with nobody around where what passes for an FBO is locked up, and he and his passengers can't find a restroom, much less a rental car or a way through the fence. That pilot, at the moment, isn't thinking about fuel prices.

I wouldn't say the FBO business is in crisis, but it certainly is under stress. At busy airports you find gleaming facilities with every amenity pilots and passengers could wish for. At thousands of smaller fields there isn't enough business to support much more than self-service fuel and limited hours of staffing.

We're flying in a bifurcated world of busy FBOs that must recover the high costs of their operations through high fuel prices and ramp fees, and the other half that has so little business that the cost of staying open is higher than the meager income. And pilots are caught in the middle. Without a reliable network of FBOs our airplanes are nearly worthless as traveling machines.

Until the 1980s most FBOs relied on income streams from new airplane sale maintenance, hangar rent, flight trainin airplane rental, at least some charter, a fuel sales. For all sorts of reasons those business segments evaporated leaving pretty much only fuel sales to fund the entire operation.

That's old news that we've all chewe for years. But there are other more rece developments that have added to FBO o ating costs that must be recovered from pilots who stop there.

One of the big impacts most of us se think about is the fallout of the 9/11 ter ist attacks. In the wake of that disaster every airplane and every airport becam suspect in the public's and politicians'

PHOTOGRAPHY BY ERIN BR

GOOD SENSE ENGINE OPERATIONS

BY TONY BINGELIS

We learn a little about operating our aircraft engine properly during our initial exposure to flight training. A little more is learned through experience as we build up flying hours. And, right or wrong, we "learn" even more from others during "bull sessions" and hangar discussions where spirited exchanges of opinions, experiences, and "superior" knowledge on the subject of aviating abound.

The best and most reliable advice, as always, regarding how to operate your engine sensibly is naturally obtained from the manufacturer's engine manual for the particular engine you have installed in your aircraft. It will provide you with the ultimate guidance you need.

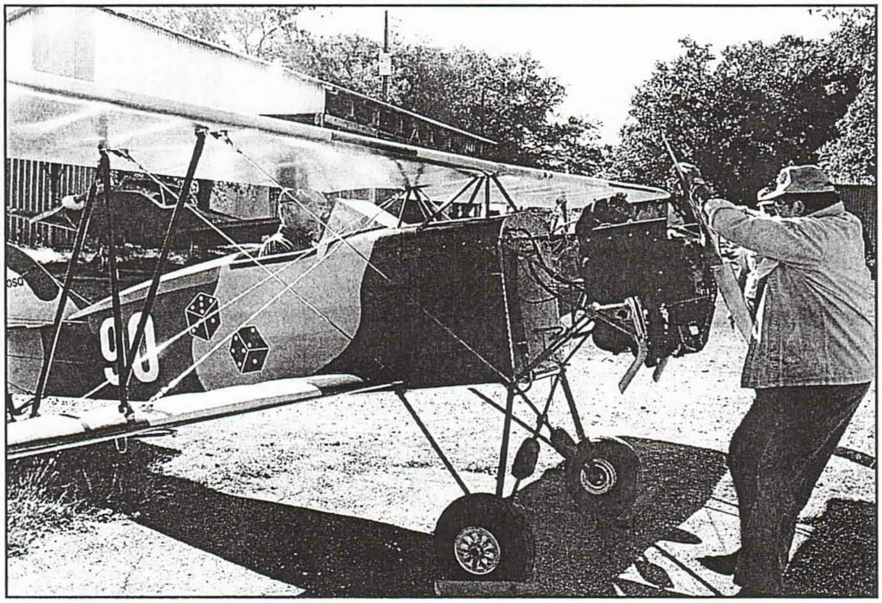
Unfortunately, such manuals seldom answer all the questions you may encounter in the day-to-day operations of your engine. I find it most interesting and encouraging to learn that the small air cooled aircraft engines most of us fly are very reliable and perform quite predictably when operated properly.

These 4-cylinder aircraft engines were first introduced many years ago and have changed very little up to the present. Among the more plentiful of these engines are the 4-cylinder Continentals (A65s, C85s, C90s, and O-200s) and the Lycomings (O-235s, O-290s, O-320s and O-360s).

They have been operated by literally thousands of owners, operators and mechanics for millions of hours under a myriad of conditions.

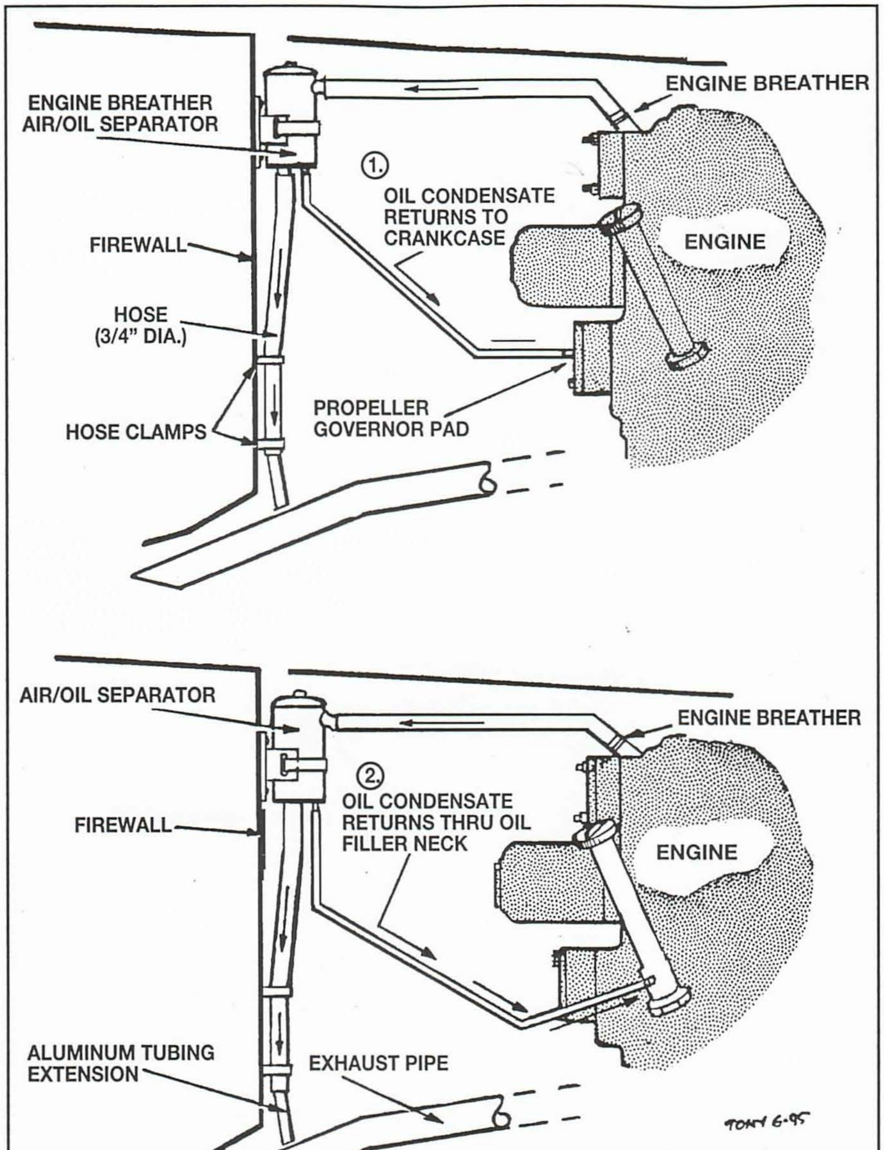
Many operational lessons have been learned and many opinions have long since been formed regarding how these engines can be operated safely and efficiently. Do the engine manufacturers, experts and "old timers" agree? Let's see what you think.

NOTE: To keep this discussion brief, I will try to confine my subjec-



Turning the prop through four or five blades before attempting to start the engine each day will give you a number of important cues as to the condition of your engine. How many can you think of? Refer to the text under "Engine Starts."

Don't blast your throttle to get the airplane rolling. Prop vortices will suck up dirt and pebbles even on paved surfaces. use minimum power to get the airplane moving...then smoothly increase power to keep it rolling.



OIL BREATHER/SEPARATOR INST'L (CRANKCASE RECOVERY OPTIONS) FIGURE 1.

tive comments and observations to the 4-cylinder air cooled carbureted engines driven by fixed pitch propellers. These are the most frequently used by homebuilders.

DON'T BABY THAT ENGINE

That's what most of them say. Surprised?

Do you really believe you are treating your engine kindly by not using full throttle for takeoff ... and habitually operate it at very low cruise rpm? If you do, you are mistaken. You will be saving a bit on fuel costs but may be setting the stage for future operational problems...and possibly increased maintenance bills.

Low power settings tend to deprive the engine of adequate cooling air and invite spark plug fouling as well as the build-up of cylinder varnish ... none of which is good for a long engine life.

Your aircraft engine, unlike an auto engine, is designed to operate under high power output conditions. This means you can operate your engine at 75% of its rated power indefinitely. At pressure altitudes above 7,000 ft. this may require full throttle to achieve and maintain. By comparison, auto engines are designed for operations within a much lower 25 to 30% range of their rated power.

Before an aircraft engine is issued its Type Certificate by the FAA, it has to be capable of operating at full throttle for many hours during a test stand endurance run. This must be successfully accomplished with its oil temperature and cylinder head temperatures maintained within their normal operating range. In view of all this, running your engine for a mere five minutes at full power during takeoff and climb will hardly faze your engine.

AS FOR OIL CHANGE FREQUENCY...

The general consensus is that oil should be changed regularly. Ordinarily this is after every 25 hours of flight for an engine not equipped with an oil filter—and 50 hours for an engine sporting an oil filter.

Like all generalities there are exceptions, aren't there? What if your airplane is flown only an hour or so once a month? Would you let the engine go for two years before changing oil? I hope not.

As bad as infrequent flight is on an engine, infrequent oil change is just as harmful...if not more so.

To remove accumulated moisture, contaminates and sludge from the oil, consider changing your oil every four months even if the recommended oil change hours aren't reached in that time.

OIL CAPACITY VS OIL LEVEL

Your engine's oil capacity may be greater than it needs to be for safe operation.

For example, most 4-cylinder Lycoming engines have an oil capacity of 8 quarts. But, did you know that the manufacturer also states that the oil level can be as low as 2 quarts and the engine would be safe to operate?

Certainly, I wouldn't advocate taking off on a long flight with such a low oil level in the engine. However, most homebuilders soon learn that the ideal oil level in their Lycoming is about 6 quarts.

If you try to maintain a full 8 quart level, the engine will quickly spew out at least one quart in short order. This equates to a higher oil consumption than necessary, doesn't it?

THE ENGINE BREATHER FUNCTION

If the belly of your aircraft is dirty with an oil slick, you can generally blame that on the copious air-oil vapors expelled through the engine crankcase breather.

It could be that an oil separator can help keep the belly of your airplane clean and, also, minimize the loss of oil while allowing the engine to breath freely.

The usual practice is to install an oil separator on the firewall and run a small oil drain line from the separator back to the engine. Some builders accomplish this by attaching the drain line to a fitting screwed into a tapped (3/8" NPT) hole in the base of the oil filler neck, or into a cover plate where a prop governor would have been installed for a constant speed prop.

A few builders don't like to reintroduce the excess breather oil residue back into the engine because the oil may still contain moisture and contaminants that have passed through a less than efficient oil separator.

Rather than returning the expelled oil to the crankcase, why not collect that small amount of oil condensate into a container which you can empty periodically ... say at every oil change (see Figure 1).

And what an ugly looking mess it is ...no wonder many builders don't want that stuff draining back into their engine.

ENGINE STARTS AND GROUND OPERATION

Quite a few pilots make a habit of turning their propeller through about 5 blades or more before starting the engine. Of course, they are careful to check that the ignition switch if OFF.

Even so, care must be taken any time you propeller is moved...even with the switch OFF because a "P" lead may have become disconnected and the hot magneto will fire when least expected under the right (wrong?) circumstances.

Anyhow, turning the prop through before starting the engine can be useful as it will:

1. Help lubricate the cylinder walls, especially if the engine has been idle for a week or so.
2. Prove that you have compression on all cylinders.
3. Give you the opportunity to inspect the condition of the propeller closely.
4. Tip you off if you have a leaky valve.
5. Verify that your impulse coupler is working.

For better cooling always try to face the aircraft into the wind especially when awaiting your turn for takeoff.

Avoid high power run-ups on the ground because the engine will not cool as well as it would in flight.

High power run-ups, if they are necessary, must be kept brief.

After any high power operation, allow your engine to idle for a minute or two before shutting it down to help dissipate excess heat.

Avoid running your engine uncowled because it is not good for the engine...the cylinders will cool unevenly and hot spots may develop.

If it is necessary to check the idle mixture, try to do it quickly, running the engine only briefly.

TAXIING

Don't blast the throttle to get your airplane rolling. Prop vortices will suck up dirt and pebbles even on paved surfaces. The consequence could be badly chipped propeller blades.

A safer procedure would be to use a minimum of power to get the airplane rolling...then smoothly increase the power to keep it moving. This technique helps reduce the ability of the propeller blades to suck up damaging particles.

Taxiing at too high an rpm is poor practice because you will be controlling your speed by riding the brakes. This is, usually, unnecessary. Even with a free swiveling nose gear, only an occasional tap of a brake pedal will be needed to keep it rolling straight.

Of course, taxiing in a crosswind may require a slightly high rpm ... but be aware of the need for what you are doing.

TAKEOFF AND CLIMB

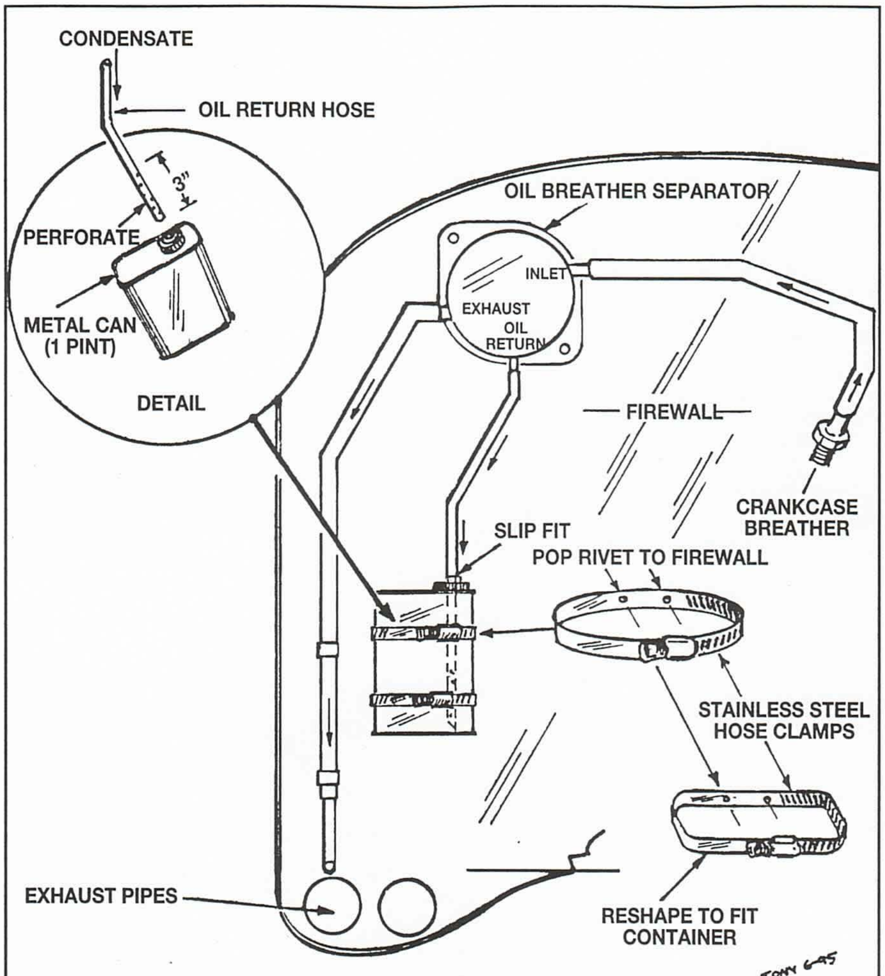
Avoid following another aircraft too closely down a dusty/dirt runway because even the best air filter won't protect your engine from ingesting a lot of crud.

Many pilots pull the power back immediately after takeoff. I consider this to be rather risky because it seems more engine failures occur during the first power reduction than at any other time.

For that matter, I see nothing wrong in NOT retarding the takeoff power until a safe altitude has been gained and that first turn in traffic is made.

Remember, we are talking about the small engined, fixed pitch jobs—not the big powerful types that are capable of shattering windows unless power and props are pulled back for climb. Actually, you should be able to climb to a reasonable cruise altitude without reducing power.

Many homebuilts, and some ultralights, will climb about 1000 fpm.



OIL BREATHER SEPARATOR (OIL CONDENSATE COLLECTOR)
(SCHEMATIC)
FIGURE 2.

Therefore, in five minutes of full throttle operation you can usually climb to 5000 feet...if you want to go that high.

My Lycoming O-320A Fuel and Power Chart indicates that with full throttle, my engine, at 8000 ft., will be producing only 76.2% of its sea level horsepower...this with 23.4" Hg and 2400 rpm, or 24.5" Hg and 2300 rpm. Therefore, I can lean aggressively even though I may be tooling along at full throttle.

For safety's sake your electric fuel pump (booster pump), if you have one, should be turned ON for takeoffs and landings.

Formation flying can be especially hard on the engine and throttle control linkage due to the frequent throttle movements from full power to idle ... especially at the hands of a pilot new to formation flying.

ON LEANING

I believe in leaning my Lycoming almost from the ground, certainly as soon as the throttle is partially retarded. Lycoming recommends "aggressive" leaning for all power settings of 75% and below.

The higher the field elevation the more useful the initial leaning effort becomes...actually it might be essential for smoothing the engine for takeoff. Naturally, you would not, ordinarily, lean the engine anytime it is putting out full rated power (2700 rpm) as detonation becomes a potential risk.

Anyway, when you come right down to it, most homebuilts flying with a fixed pitch cruise propeller will seldom develop full power for takeoff, therefore, a judicious leaning of the engine during the climb should never be a problem.

LET DOWNS

An engine can cool excessively during a let down, especially in cold weather. This could be bad as it invites lead fouling and can lead to cylinder cracking and excessive wear.

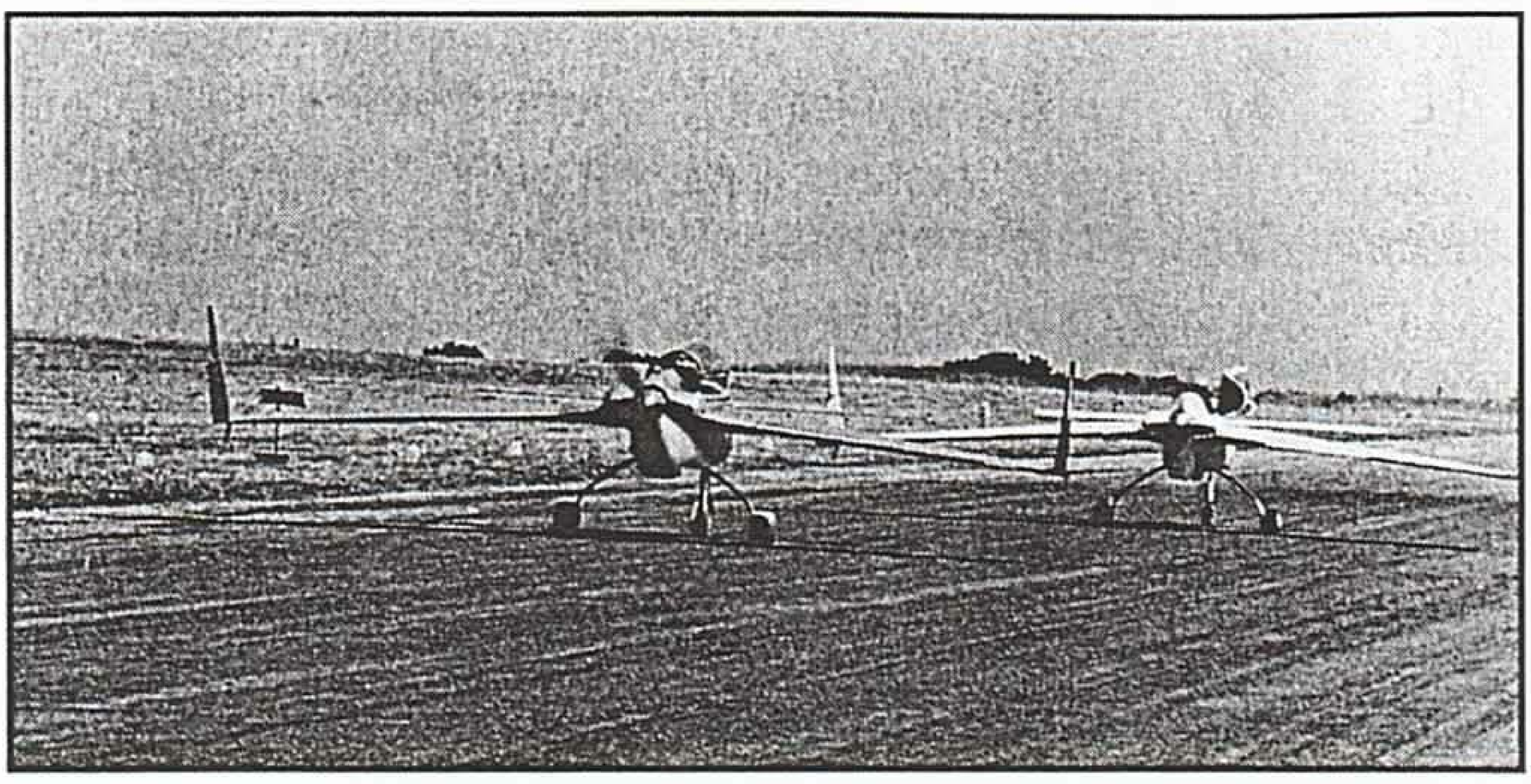
Start your let down early. By reducing your manifold pressure two or three inches from your cruise setting, or the rpm by a couple hundred, you can establish a leisurely let-down without causing the engine to cool excessively. As you lose altitude, don't forget to readjust your mixture in order to maintain smooth engine operation during the descent.

Chopping the throttle and allowing the airspeed to build up to the point where the windmilling propeller is driving the engine is bad, bad, bad. Keep your engine warm especially during cold weather operations.

USE OF CARBURETOR HEAT

The general belief is that engines equipped with pressure carburetors or fuel injectors are more or less immune from carburetor icing problems and need no carburetor heat provision.

There is no doubt however that carbureted engines are vulnerable to



Don't follow another aircraft too closely down a dusty/dirt runway because even the best air filter won't protect your engine from ultimately ingesting a lot of crud.

carburetor icing and that they must have some provision for carburetor heat.

Induction system icing problems can crop up even in the summer when humidity is high and the temperatures are ranging up to 90°F simply because the mixture chamber temperature can drop as much as 70°F from that of the inlet air.

I learned that my Continental engines were more prone to carburetor icing than are the Lycoming engines I currently fly. I suppose this is partly because the Lycoming's intake manifolds are routed through the sheltered warmth of the engine crankcase. Continental engines, on the other hand, have no similar set up.

Always apply the carburetor heat before reducing the power, otherwise, the engine won't produce enough heat to prevent carburetor icing. It really doesn't do much good trying to apply carburetor heat when the engine is idling ... there won't be much, if any.

No need to use carburetor heat for takeoff and climbs because icing at full throttle is most unlikely. As for cruise and other flight conditions, you would ordinarily leave the carburetor heat in the cold position.

If you experience a loss of power on a damp hazy summer day, suspect the formation of carburetor ice. Use full carburetor heat, or none at all, unless you have a mixture temperature gauge to help you adjust your carburetor throat mixture to above the 32°F freezing level.

ON SWITCHING FUEL TANKS

I don't know about you, but I don't look lightly on the simple matter of switching fuel tanks in flight. No, I have never

Start your let downs early. Reduce manifold pressure two or three inches from your cruise setting and rpm by a couple hundred rpm to establish a leisurely let down without subjecting the engine to excessive ("shock") cooling.

had a bad experience in this regard, nor have I ever switched to an OFF position, or an empty tank inadvertently. Yet, the reluctance remains. I also avoid walking under ladders.

If I have the option, I try to time switching tanks when passing by a suitable forced landing area or an airstrip of some sort.

Following the same line of reasoning, I always avoid switching tanks in the traffic pattern just before landing and just before takeoff ... risky practices at best.

As you switch tanks, it is a good idea to look at the selector valve to confirm the tank selected and that the selector is not incorrectly positioned between tanks...it does happen.

On switching tanks, be sure to monitor the fuel pressure gauge for a few moments, assuming, of course, your aircraft is equipped with one. It will quickly show whether or not the tank switching is successful.

FORMATION FLYING

This type of flying can be especially hard on the engine and throttle control linkage, particularly at the hands of one inexperienced in the art of formation flying.

Rapid throttle movements, from full power to idle, either on the ground or in the air, cause various parts of the engine to expand and contract at different rates with engine temperature changes. Abnormal wear takes place in the control linkage and elsewhere each time this is done because of the erratic torsional stresses and temperature stresses induced.

Incidentally, throttle chopping is a major factor in cylinder head cracking and other engine problems. The practice is equally damaging in flight regimes other than formation flying.

IN SUMMARY

These few random thoughts only touch lightly on the subject of sensible engine operations. There are many additional considerations that come into play, especially with so-called "high-performance" aircraft where the engine drives a constant speed propeller, is equipped with a fuel injector instead of a carburetor and may even be turbocharged.

As I pointed out in the beginning, when in doubt consult the engine manufacturer's engine manual for guidance.

In addition, any homebuilder who wants to operate his engine in an efficient and professional manner should obtain and study the book by Kas Thomas, entitled, Aircraft Engine Operating Guide (Belvoir Publications, Inc., 1111 E. Putnam Ave., Riverside, CT 06878). I recommend it highly. ◆

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BOOKS BY TONY

The following books by Tony Bingelis are available from the EAA Aviation Foundation, EAA Aviation Center, Box 3086, Oshkosh, WI 54903-3086, 1-800-843-3612. Major credit cards accepted.

- *Sportplane Builders* (Aircraft Construction Methods, 324 pages) #21-30140 - $21.95
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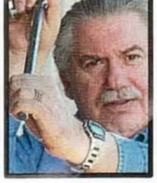


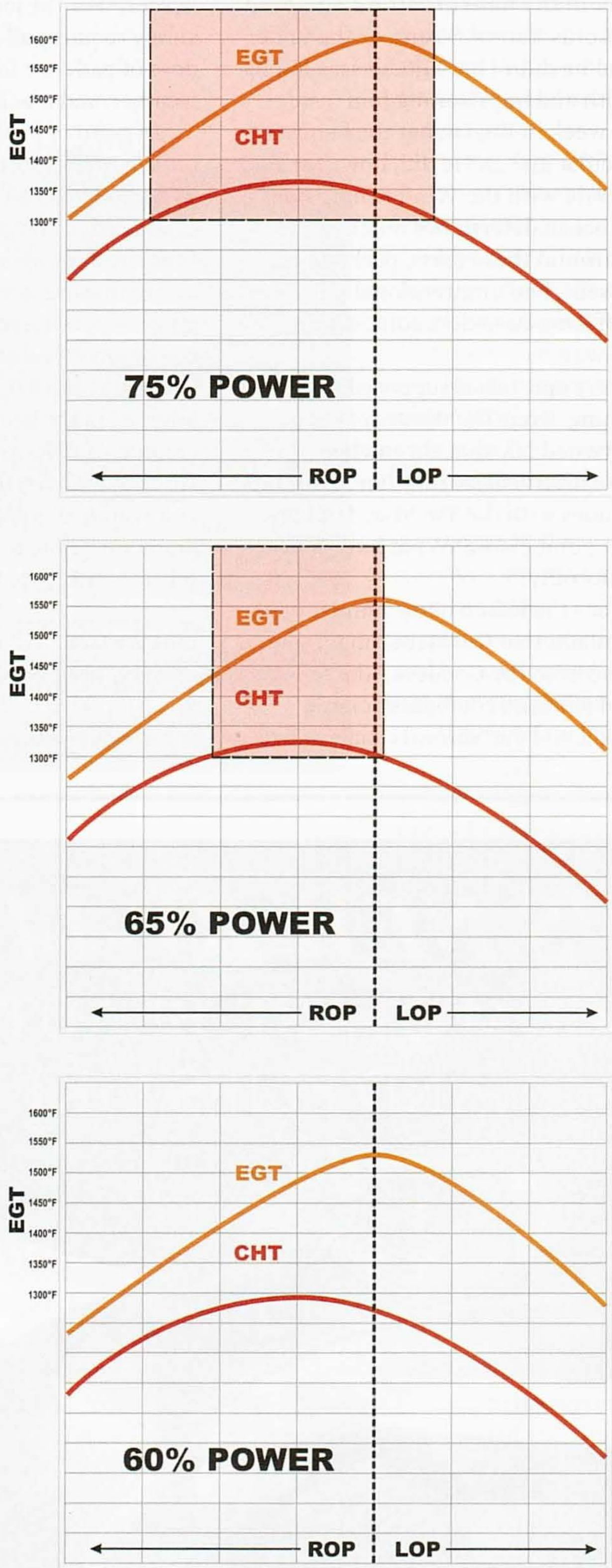


Figure 1—The lower the power, the narrower the red box becomes. Somewhere between 60 percent and 65 percent for most engines, it disappears completely.

Red Box Red Fin

How *not* to lean your engine

AT MY JULY PILGRIMAGE to EAA AirV Oshkosh, I had the opportunity to s to thousands of pilots and aircraft o on a wide variety of subjects, rangin from reliability-centered maintenan to TBO busting to corrosion, and to c duct a half-dozen informal hour-lon Q&A sessions addressing whatever m nance-related issues were on their m In those sessions, I received more qu tions about one topic than all others combined: leaning.

Some of the questions focused on old wives' tales about lean-of-peak (LOP) operation:

Q: Won't operating LOP hurt my engin burn my exhaust valves, etc.?

A: It's a lot easier to damage your eng ROP, much less likely LOP.

Q: Can my carbureted engine be oper- ated LOP?

A: Most can. Using carb heat helps. O way to know is to try it. You can't hurt a thing by experimenting with LOP operat

Q: Can my injected engine be operate LOP without GAMIjectors?

A: Some can, some can't. Only way to know is to try it. You can't hurt anything experimenting with LOP operation.

Q: Can my engine be operated LOP w out an engine monitor?

A: Sure. I operated LOP for a decade before I installed my engine monitor. No think it's really important to install an en monitor, but that's true regardless of whe you run ROP or LOP.

Q: I've experimented with LOP, but I f that my EGTs are much higher when I ru LOP than when I run ROP.

A: That's true. Why does that concern you? High EGTs are not damaging to you engine. It's high CHTs that are damaging

ILLUSTRATIONS COURTESY MIKE

your engine. And LOP operation almost always results in lower CHTs. Other questions focused on "the right way to lean" and sought cookbook answers:

Q: How many degrees LOP should I operate my engine?

A: That depends on many variables: power setting, altitude, temperature, etc. The answer might be anywhere from 0°F LOP and 100°F LOP.

Q: How many degrees LOP do you operate your own airplane?

A: I don't have a clue. I never use EGT as a leaning reference, so I don't know how many degrees LOP I operate. All I know is that it varies all over the place depending on various conditions, and it's not a particularly interesting number so I don't worry about it.

The problem with questions like this is that they are based on the misconception that there's a "right way" to lean an engine. In fact, there are lots of different right ways to lean an engine, and I employ them all from time to time.

In my turbocharged Cessna T310R I mostly climb very ROP, but occasionally I climb LOP when it's appropriate. I mostly cruise LOP, but it varies from slightly LOP to profoundly LOP depending on cruise altitude, OAT, and whether my objective is speed or fuel economy. I have thousands of hours flying Cessna 182s, and most of that time was spent neither ROP or LOP but rather right at peak EGT (and at appropriately reduced power). When I fly a Super Cub, I lean to the onset of engine roughness, and I haven't a clue whether I'm ROP or LOP. All of these ways of leaning are right ways.

The key to leaning is not doing it *the* right way because there are so many different right ways to lean. Rather, the important thing is to avoid doing it the wrong way by avoiding situations that are potentially damaging or abusive to the engine.

THE RED BOX

My friends George Braly, John Deakin, and Walter Atkinson of Advanced Pilot Seminars fame developed an important conceptual tool for conveying this idea. They call it the red box because it's generally depicted as a red-tinted rectangle superimposed over a graph of various engine landmark parameters (EGT, CHT, ICP, HP, BSFC) plotted as mixture is varied from full-rich to extremely LOP. The red box depicts the range of mixture settings that result in excessive internal cylinder pressures (ICP) and therefore should be avoided. Mixture settings outside of the red box—whether on the rich side or the lean side—are all fair game.

The width of the red box varies with power (see Figure 1). The lower the power, the narrower the red box becomes.

At sufficiently low power (generally somewhere between 60 percent and 65 percent for most engines), the red box disappears completely, and you can run the engine at any mixture you like without abusing anything.

One practical problem with the red box concept is that it's based on limiting internal cylinder pressure (ICP), but unfortunately we don't have an ICP gauge in our cockpits. It sure would be nice if we did, because it would make leaning pretty much a no-brainer. In the GAMI test cell in Ada, Oklahoma, they instrument ICP by installing special tricked-out spark plugs that contain pressure transducers capable of measuring instantaneous combustion chamber pressure. Sadly, we don't have these in our aircraft because the transducers are god-awful expensive and the tricked-out spark plugs aren't certified.

In the absence of an ICP gauge, the best proxy for ICP we have in the cockpit is CHT. The good news is that the ICP and CHT curves have the same shape and peak at the same mixture. The bad news is that CHT is affected not only by ICP but also by several other factors that don't vary with mixture (notably OAT, IAS, density altitude, and cooling system efficiency).

Figure 1 depicts the red box as encompassing all mixtures that result in CHTs above 400°F, and that's probably appropriate for most legacy aircraft when the OAT is at standard temperature (ISA) or greater. But if the OAT is colder than ISA or if the aircraft has a particularly efficient cooling system design (e.g., Cessna Corvalis, Cirrus SR22, Diamond DA40), the maximum acceptable CHT is lower and the red box needs to be wider.

Another problem with the red box concept is that it suggests that all mixture settings inside the red box are equally bad. That's obviously not true; the higher the ICP (and CHT), the more abusive the mixture. For this reason, I think it's useful to think of the red box has having a purple zone in the center depicting the mixtures that are ultra-abusive and to be avoided at all costs, and a yellow cautionary zone around the edges depicting a cautionary buffer zone to be avoided when possible for maximum engine TLC. (See Figure 2.)

THE RED FIN

Perhaps an even more useful variant of the red box concept is one that has been popularized in the Cirrus community by my friend Gordon Feingold, but is relatively unknown in non-Cirrus circles. (See Figure 3.) It is called "the red fin" and emphasizes that the width of the red box varies dramatically with power, and disappears altogether when power is reduced sufficiently.

Like the red box, the red fin depicts mixture settings that are abusive to the engine. Settings outside the red fin—whether ROP or LOP—are fair game. Figure 4 depicts the three most useful

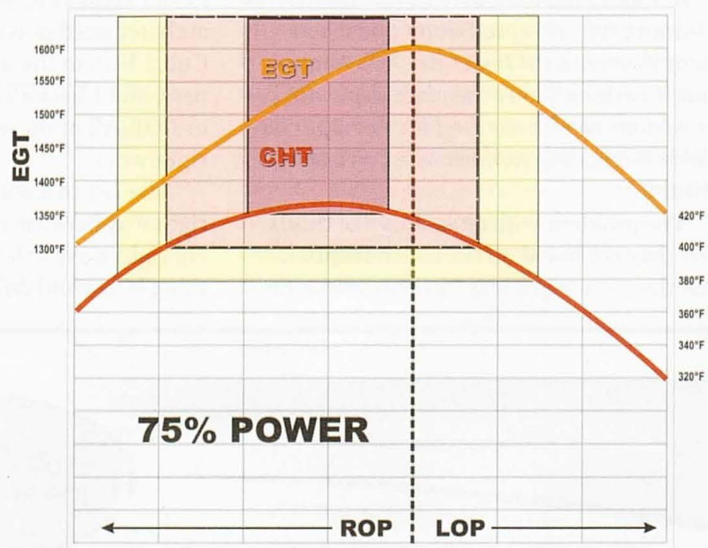


Figure 2—Modified red box chart, depicting a cautionary buffer zone in yellow and a highly abusive zone in purple.

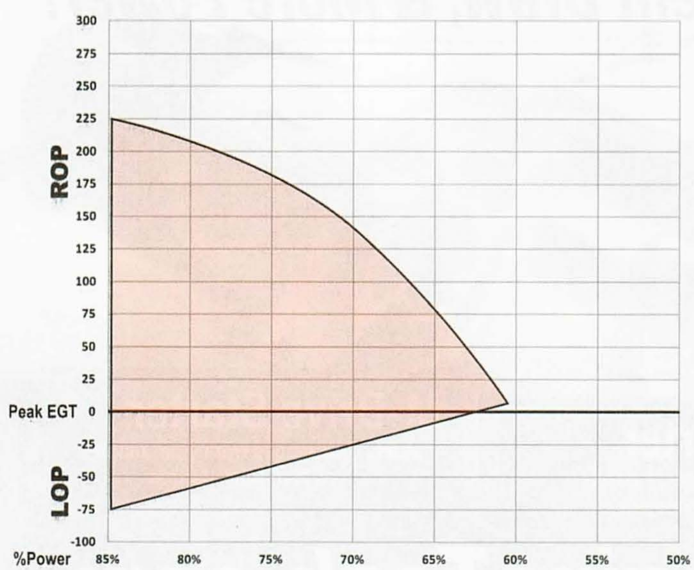


Figure 3—The red fin is an alternative depiction of the red box concept and emphasizes that the width of the red box varies dramatically with power.

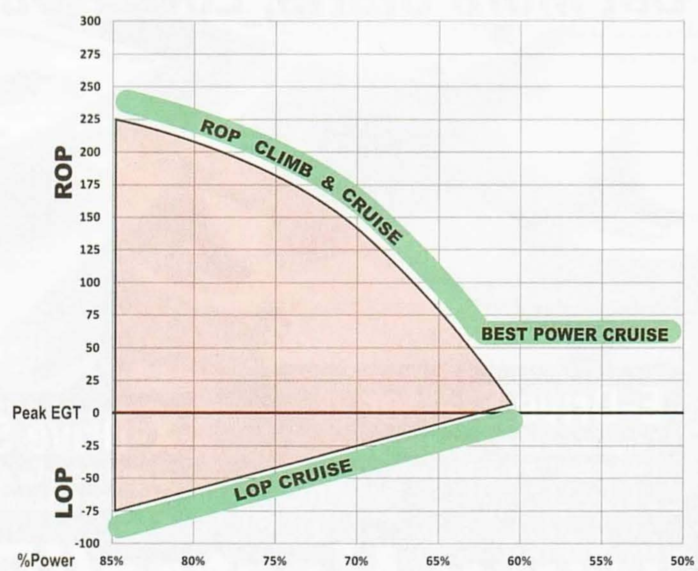


Figure 4—The three most useful outside-the-red-fin zones for climb and cruise.

ILLUSTRATIONS COURTESY MIKE BUSCH

outside-the-red-fin zones for climb and cruise. ROP mixtures are above the fin, and LOP mixtures are below it. At low power settings where the fin disappears, best-power mixture occurs at roughly 75°F ROP.

As with the red box, the red fin suggests that all mixtures inside the fin are equally abusive, but that's obviously not true. Figure 5 shows a modified red fin chart with a purple zone depicting ultra-abusive mixtures, and a yellow cautionary buffer zone to be avoided when feasible.

FLYING THE FIN

Figure 6 on Page 30 illustrates how we can use the red fin concept as a guide to mixture management throughout all phases of flight. It depicts one method of managing the mixture, but certainly not the only method. (Remember, any mixture that lies outside the red fin is fair game.) It also assumes a normally aspirated engine with a conventional non-altitude-compensating fuel system. (Turbocharged engines and engines with an altitude-compensating system are a bit simpler to manage because you don't need to adjust the mixture during climbs and descents.)

The flight starts when takeoff power is applied at full-rich mixture (which is typically at least 250°F ROP for most properly adjusted engines). We remain at wide-open throttle and let Mother Nature take care of reducing manifold pressure (MP) as we climb. With most engines, this results in a mixture that gets progressively

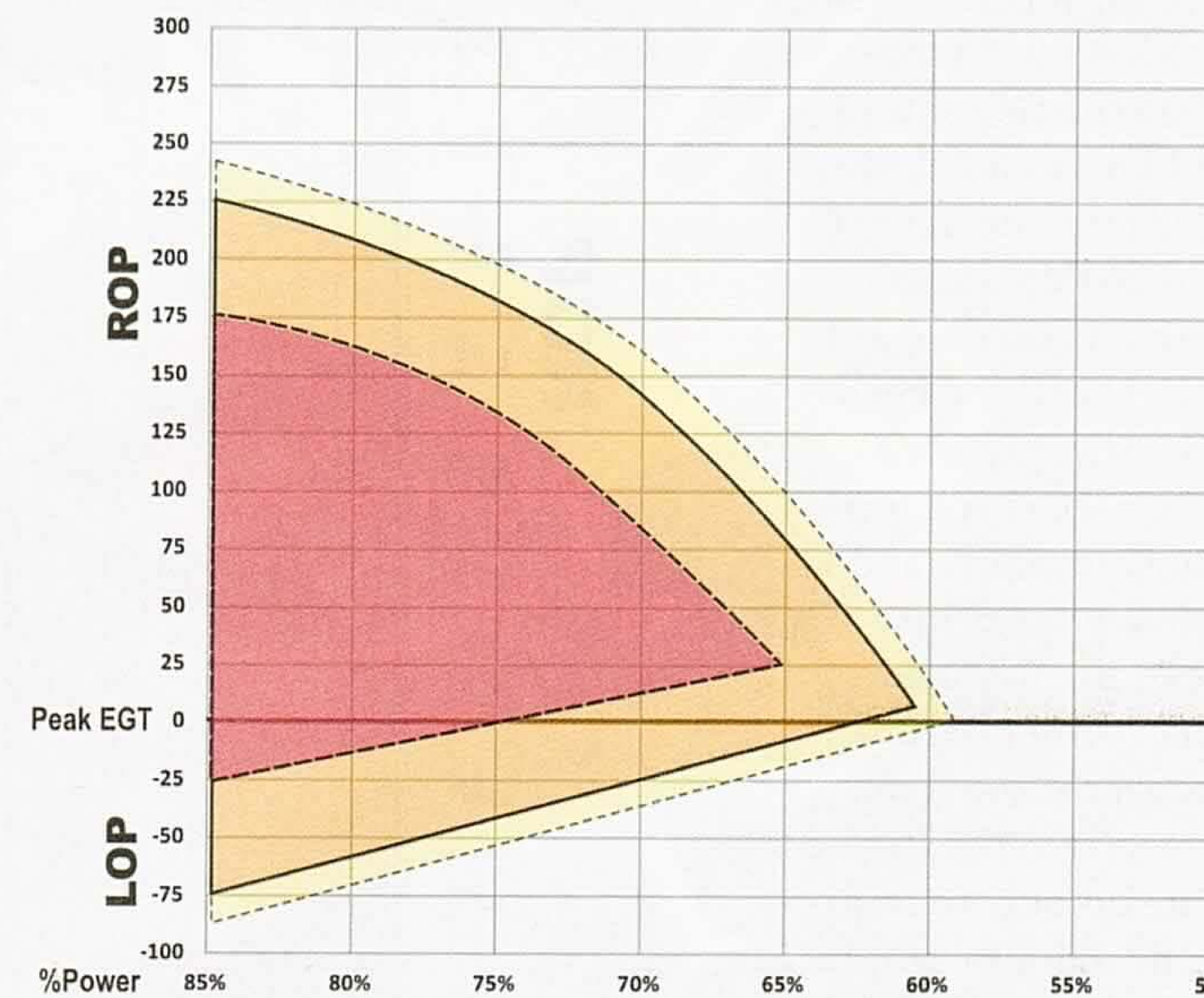


Figure 5—Modified red fin chart, depicting a cautionary buffer zone in yellow and a highly abusive zone in purple.

richer with increasing altitude and decreasing MP, so from time to time we lean the mixture manually to keep it "in the zone" on the rich side of the red fin. (In my turbocharged airplane, I don't need to do this because MP doesn't decrease as I climb so there's no need to touch the mixture.)

When we reach top-of-climb, level off, and commence the cruise phase of the flight, we perform a big mixture pull to transition from ROP to LOP. This should be done quickly to minimize the amount of time spent inside the red fin (and especially the ultra-abusive purple zone). About two or three seconds is about right for the BMP. Note that we lose a bit of power as we transition from ROP to LOP; that's normal and expected, and will be reflected by a small loss of airspeed.

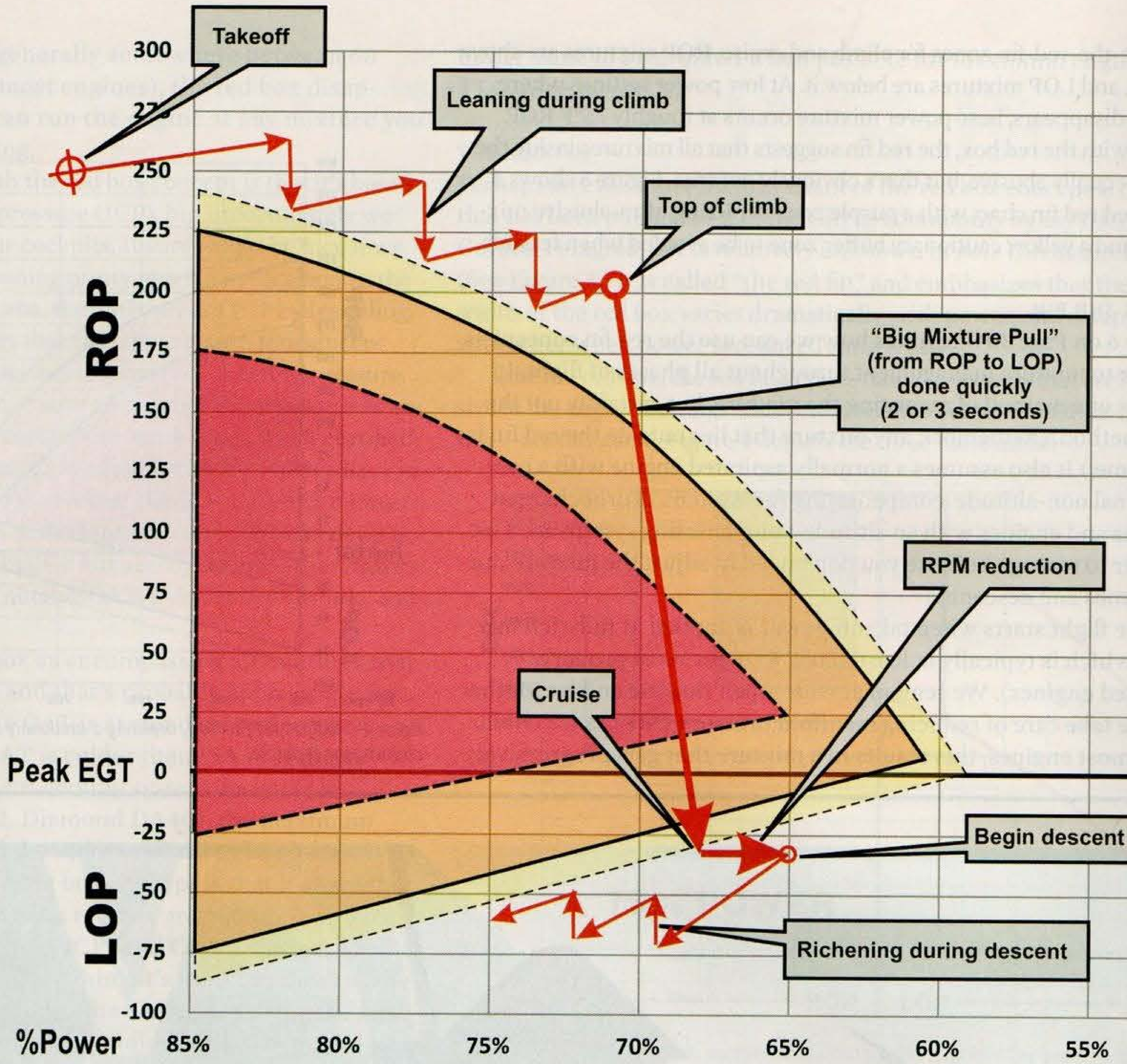


Figure 6—One way of managing the mixture during a flight with reference to the
This assumes a normally aspirated engine with a conventional non-altitude-compensating fue

I recommend *not* using the lean-find mode of your engine monitor when doing this, because it requires you to lean very slowly in order to locate peak EGT. That results in spending a considerable amount time inside the red fin (and the dreaded purple zone), which is exactly what you *don't* want to do. If you feel compelled to locate peak EGT, it's much better to perform a quick BMP to get into the LOP zone below the fin, and then slowly richen to locate peak EGT from the lean side.

Personally, I don't care about locating peak EGT, so I skip this step altogether. I just do a quick BMP to a known-safe LOP fuel flow—or until I hear and feel a small power loss that tells me I'm safely LOP below the fin—then fine-tune the mixture using either CHT or my fuel totalizer as a primary reference.

As we begin the descent phase, we remain LOP below the fin. Because MP increases with decreasing altitude, the mixture becomes leaner, so from time to time we richen the mixture to prevent it from getting so lean that the engine starts running rough. If we forget to richen, no problem: The engine will remind us. (Once again, I can skip this step in my turbocharged airplane because MP remains constant during the descent.)

Because our airplanes aren't equipped with ICP gauges, the red box and red fin can provide only approximate guidance. Without ICP information, we can't know the box or fin boundaries precisely. B conceptual guidelines, they're close enough. If we keep them in mind and make a conscious effort to stay out o red zone (and especially out of the pu zone) for more than a few seconds at time, we will be rewarded with maxi engine longevity and reliability, and r mum maintenance expense. *EAA*

Mike Busch, EAA 740170, was the 2008 National Av Maintenance Technician of the Year and has been a for 44 years, logging more than 7,000 hours. He's a A&P/IA. E-mail him at *mike.busch@savvyaviator.co* Mike also hosts free monthly online presentations a of EAA's webinar series on the first Wednesday of ea month. For a schedule visit *www.EAA.org/webinars.*

ILLUSTRATION COURTESY MIKE

HOMEBUILTS FLYING IFR

WHAT IT TAKES TO FLY YOUR E-AB IN THE SYSTEM, AND IN THE CLOUDS

BY STEIN BRUCH

Light IFR and heavy IFR—those two terms are frequently used when people ask me the most common question I hear, "What equipment do I need in my homebuilt aircraft to fly 'heavy' or 'light' IFR?"

First, I think most can agree that the FAA generally doesn't separate IFR into various or distinct levels of gravity. You are either in the system and filed, or you are not. Either way, the equipment required should be similar, if not the same. Separately, how you use your aircraft and the equipment will probably drive your decisions beyond the basics, but it won't change the practical requirements.

ILLUSTRATION BY GARY COX

THIS TOPIC USUALLY RESULTS in strong emotions, opinions, and long-winded debates at air shows and in online forums. While technically it can be a complex topic, it's actually very simple. We do know one thing for sure: If you ask the FAA a question, it will answer. The problem is, if you ask 50 different agency employees, you're likely to get 50 different answers, and many times those answers are just opinions disguised as facts.

So, big picture, what should you have? What really makes sense, both legally and functionally, if you intend to use your homebuilt for IFR flight, or even night VFR?

In its simplest form, the IFR requirements for our homebuilt aircraft are spelled out in the Federal Aviation Regulations (FARs) and, by proxy, in your aircraft's operating limitations. It can be easy to get caught up in a bunch of circular arguments relating to additional publications (like Part 43, advisory circulars, the *Aeronautical Information Manual,* service bulletins, etc.), but reality is often different than theory. There is a difference between what you must have and what you should have.

Instead of reprinting the entirety of 91.205 that details the list of items, let's just agree that you need all the instrumentation installed for day and night VFR, along with additional items to make your plane practical and legal for IFR use.

With that in mind let's break this down into the various sections of functionality. Please remember I'm referencing mainly operation in the United States. There are a myriad of various different laws and policies in other countries regarding IFR operation as it relates to instrumentation.

FLIGHT INSTRUMENTS

Obviously you want and need a way to keep the shiny side of the aircraft facing up, which means you need an attitude indicator of some sort. For many decades, this has been a spinning mass of metal enclosed in an instrument with the sky and ground displayed on it, powered by vacuum or electricity. The other five instruments that make up the standard six-pack are also needed and required (altimeter, airspeed indicator, magnetic compass, heading indicator, vertical speed indicator).

While still available in their familiar form, it's currently cheaper to purchase a number of fully solid-state digital indicators or EFISs (electronic flight instrument system) than it is to buy a set of traditional round instruments of decent quality. There are a number of options in the market, ranging from about $1,700 to $100,000. These units don't necessarily need to meet a technical standard order (TSO) or be certified, but they do need to meet the specs and pass a 24-month inspection/certification, just as they would in a standard certified aircraft.

While some folks still maintain that "round is better" (I won't argue that here), I will submit that a plethora of modern additions to the EFIS are extremely useful at reducing pilot workload and increasing situational awareness.

Since the majority of builders will be going with EFIS, you may notice that many companies offer a dual AHRS (attitude and heading reference system)—which in plain speak is a box of electronic gyros, to drive the displays. That is an excellent option for simple redundancy, but our take is that sometimes two identical AHRS boxes in the same system can be dangerous without proper thought or failure analysis during installation. If they are identical units, it is more likely that a software bug or problem will develop, which, unlike a simple hardware failure, could affect an entire system.

That means for practical purposes you should have an independent instrument of a different manufacture, technology, or model. This is the approach taken by the large transport category and many military aircraft with the set of standby instruments along with the main displays. These instruments are both for redundancy and safety. There are a number of options on the market for these devices, priced in the $1,700 to $3,500 range, that are nicely sized and often contain their own backup battery sources.

PHOTOGRAPHY BY **JIM KOEPNICK**

If you are worried that you've never flown behind any of the new gadgets and you won't be able to learn them, don't worry! Though some of the early systems did have somewhat complicated menu structures and could be cluttered, the manufacturers have spent a lot of time making the new systems quite easy to use and very intuitive. Another huge benefit of the modern EFIS is its ability to interface with many other systems in your plane. When connected, the EFIS will talk to your engine instruments, autopilot, radio, GPS, ELT, even things like a carbon monoxide detector or pitot tube. I point this out not because of the cool factor, but to make the argument that it does reduce pilot workload and increase situational awareness.

I'm also of the opinion that for practical IFR usage the new "smartphone or tablet" quasi-EFISs, which use separate wireless AHRS, are not a good option. For VFR use, backup use, or novelty, they are neat, but not something I'd yet be able to recommend in an IFR environment. Practically speaking, you should have at least one good quality EFIS (or collection of traditional flight instruments of good quality), along with a good standby or backup instrument of some sort. If you choose dual AHRS, I'd still strongly recommend a backup attitude source of some sort.

It's also important to ensure that whatever you choose has been installed in such a way that a simple electrical failure will not torpedo the entire system. This means having something like a backup battery, standby alternator, or other source of energy to power the main device in the event of a simple alternator or battery failure.

THE MANUFACTURERS HAVE SPENT A LOT OF TIME MAKING THE NEW SYSTEMS QUITE EASY TO USE AND VERY INTUITIVE.

NAVIGATION

The simplest paraphrasing of the rules state that you must have installed equipment appropriate to the navigation and flight that you will be performing. For the very basic, a VHF nav/comm would suffice if your IFR flight was limited to VOR or ILS navigation or approaches.

The reality is that, while this will suffice at the most basic level, IFR GPS navigation is becoming standard, which the FAA is striving to implement as part of its NextGen air transportation system. In the past, the primary means of precision approaches was the ILS, but WAAS GPS approaches now outnumber those by a good margin, and continue to be implemented at a fast pace. Due to this, many folks are choosing to include a WAAS GPS in their homebuilts.

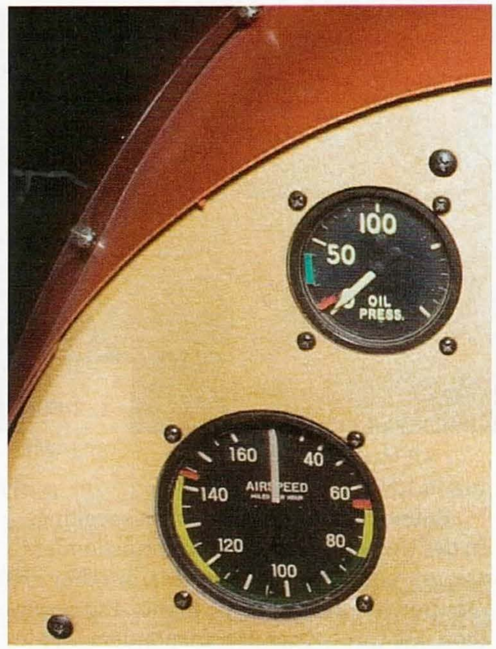
There is a whole series of details relating to the TSOs of such devices, and it is my opinion that a WAAS GPS used for precision IFR work must be certified. Without getting into too much detail, it's important to briefly look at TSO-C145a and TSO-C146a. Older non-WAAS units are certified to TSO-C129 and are typically for en route and nonprecision work. The 145/146 units are primarily used for WAAS GPS navigation.

There is an important distinction between 145 and 146. TSO 145 is basically the GPS unit, and when combined with a certified (or equivalent) FMS type system, it can be a fully functional and legal solution. Aside from that combination, the 146 units (such as the Garmin GTN or GNS, or the Avidyne IFD) are recommended, and about the only solutions readily available to homebuilders. These boxes are fully certified as stand-alone navigators, and the 145 boxes are not. Simply installing a 145-certified GPS with a noncertified EFIS (without extensive documentation, testing, or certification) will not suffice as an IFR legal replacement for the 146 boxes, no matter what the EFIS vendor states on a website or in an advertisement.

A good, certified WAAS GPS is not technically required, but functionally will make your IFR flights much easier and give you many more options. To fully take advantage of these magic boxes, they still must have appropriate indicators to display course deviation, HSI, etc. This can be accomplished through most EFISs, certified or not (except for certain countries that require the indicators to be certified or separate).

TRANSPONDERS AND RADIOS

At the core of flying are the terms aviate, navigate, and communicate. In regards to rules for homebuilts, the first two are



open to more debate than the last one. Communication is simple. You need an appropriate comm radio in the airplane to be IFR legal. In fact, two radios make life much easier, so I always recommend a second comm radio as an excellent addition to your IFR equipment list.

There are minute details that can be discussed and countries with other requirements, but most radios made here in the past 10-15 years are perfectly legal from a frequency spacing perspective, while many radios made more than 20 years ago are not. If you find a deal on a "360-channel VHF comm" from a buddy or online, it's nothing more than a boat anchor. Good radios are more than nice to have, and they are required.

PHOTOGRAPHY BY **JIM KOEPNICK**

The new electronic flight bag applications for smartphones or tablets can be reserved for their own article. They are of tremendous value and offer tons of useful additions to the cockpit of any aircraft, VFR or IFR. For the cost of just a few paper charts, you can have all of the charts (IFR, sectional, world aeronautical charts, etc.) on your tablet, all current, and within arm's reach. Certainly these aren't any sort of requirement, but they are an incredible use of money.

Last but not least is ADS-B and other situational awareness products. Having XM or ADS-B weather data certainly isn't required, but will give you things like cloud data, temperatures, winds aloft, freezing levels, radar data, METARs, terminal area forecasts, NOTAMs, temporary flight restrictions, SIGMETs, AIRMETs, and other data at near real-time intervals, making for a much more comfortable and safe flight.

Communicating is more than speaking. In the United States, airspace transponders are not required in all instances, but they are required in most IFR-type flights. Currently there are three types of transponders: Mode A (transponder code reporting only), Mode A/C (Mode A with pressure altitude reporting), and Mode S (similar to Mode C, but includes additional information about your aircraft in its reporting). Some countries do require Mode S, but currently the United States does not, and Mode C will suffice in most locations. Transponders are another area where I recommend using certified equipment that carries a TSO.

Regardless of whether it's remotely installed or mounted in the radio stack panel, aircraft transponders still must pass the same biennial transponder check and certification as everything else. Along with this, there is often some argument (from shops doing the test and agency folks as well) about whether the altimeter or encoder needs to be certified. At this time in the United States, if your altimeter and encoder meet the specifications and pass the pitot/static or transponder checks, they are fine, whether they are TSO'd or not. This has been the case for decades.

SOME ARE LEGAL "MUST-HAVES," BUT OTHERS ARE SAFETY AND FUNCTIONAL "SHOULD-HAVES."

OTHER EQUIPMENT

In addition to the items previously discussed, there are a few ancillary items of which some are legal "must-haves," but others are safety and functional "should-haves."

The "must-have" category includes an ELT if your airplane has more than one seat. In the United States you can still legally use a newer 406 MHz ELT, though, contrary to some information, it is not required at this time. You can also use the cheaper non-406 ELTs, but it should be noted that only the newer ELT will trigger the satellites and notify someone. The newer 406s also have the advantage of being many times more accurate than the older units. An alternative is to use a 243 unit plus a personal locater beacon (PLB), which would give you the accuracy benefits of the 406 ELTs.

Compasses are technically required, though in some installations, in some regions, with some inspectors, you will be credited for a compass through use of a secondary compass in an EFIS. This is still one of those areas in which policy interpretation is exactly that, and is not universal between various agency personnel or locations.

An autopilot isn't identified as a legal "must-have," but is one I include in a list for comfortable IFR flight. Prices range from $1,700 to $6,500 when purchased in conjunction with a good EFIS, making them so reasonable now for homebuilders that there is no reason not to at least install a basic two-axis autopilot. There are many options for autopilots, but well-integrated units will fly coupled approaches, holds, climbs, descents, and almost every other function that you'd use in a typical IFR flight.

THE LIST

To recap, the items I feel you should have in your homebuilt for IFR flight are:

- Primary gyro-based attitude indicator or instrument (EFIS or equivalent)
- Primary flight instruments, likely an EFIS
- Secondary attitude indicator or instrument
- Backup power source if using an EFIS or other electrically powered units
- Certified WAAS GPS
- Certified transponder
- Autopilot, two-axis preferred
- ELT, new 406 MHz or old 243 MHz plus PLB
- Compass
- Weather and traffic system
- Backup or portable comm
- GPS

Obviously the aforementioned list is open to interpretation and opinion. Some of it is just a gray area, and several different opinions and answers will be correct. As I said from the start, "must-haves" and "should-haves" are two entirely different things. As a builder or owner of a homebuilt, you have access to a ton of equipment that is not only available at a good price point, but oftentimes offers superior functionality to what is available in the certified world. *EAA*

Stein Bruch, EAA Lifetime 643063, is president and CEO of SteinAir Inc.

Formation Flight Safety

BY CHARLIE PRECOURT, EAA BOARD OF DIRECTORS, SAFETY COMMITTEE CHAIRMAN

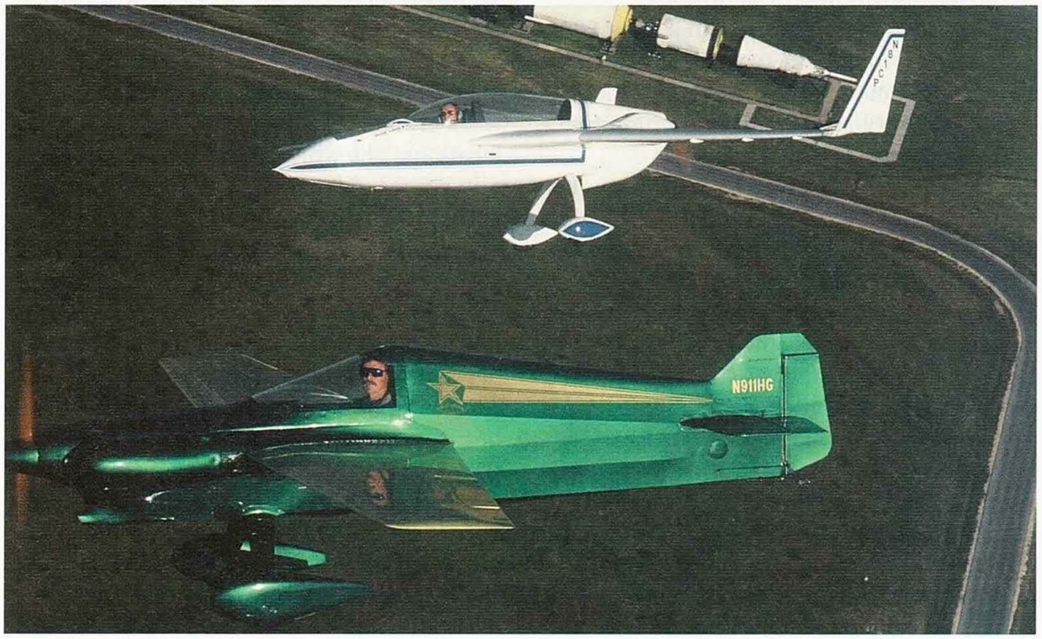
WITH AIRVENTURE APPROACHING, many of us are practicing our formation flying skills in preparation for our annual trek to Oshkosh. Formation ranks up there among the most enjoyable flying we do, but it demands greater preparation, training, and some unique safety measures. The simplest rule we all follow is "don't hit the other guy!" Unfortunately just recently a midair collision occurred between a vintage warbird Hawker Sea Fury and a Cessna 210. Both aircraft were en route to Eagles Nest Airport from Half Moon Bay Airport near San Francisco. It is too early to know a lot of detail, including whether or not the flight was a planned formation, but the National Transportation Safety Board reported the midair collision occurred when the pilot of the Sea Fury pulled up to the left side of the Cessna 210. The 210 crashed into the bay, killing the pilot, while the Sea Fury managed to make it to Eagles Nest.

This is an all too sobering reminder of what can go wrong when airplanes operate close together. If you're contemplating formation flying for the first time, be sure to find someone with good experience to give you the proper training. You don't need a CFI for that, but the individual who instructs formation should have a commanding knowledge of formation flight and experience in the types of aircraft involved. One of the best sources I've seen for formation training was written by the Formation and Safety Team (FAST) at *www.FlyFast.org* where you can find a comprehensive guide to this type of flying.

You might think the most challenging part of flying formation is mastering a stable position on the wing, but I've found that flying well as the formation leader is far more challenging. The leader has to plan, think, and maneuver for two (or more) aircraft. A good leader will make the job of flying the wing position much easier. When I've conducted formation training with students in both aircraft, I can readily determine from the wing position whether it is the student or instructor on the controls in the lead aircraft. The experienced lead provides a predictable stable platform. Turns, changes in power, climbs and descents, and configuration changes all require the leader to plan well ahead so the wingman is ready for the change and can respond promptly to maintain position. For example, when I begin a turn as leader, I roll in smoothly, with initially a low-roll rate but steadily increase it to a normal-roll rate for the aircraft, to get to the desired bank angle. Common mistakes are to roll too quickly, surprising the wingman, or to roll too slowly, causing the wingman to "stutter" his roll inputs in anticipation of the normal roll rate that the lead never gets to. Finding the right balance takes a lot of thinking ahead, and practice.

An extremely important concept for both the lead and wingman is what we call situation awareness (SA). Many failures in formation flying can be attributed to one or more pilots in the flight having lost SA, leading to confusion and errors in the cockpit. FAST defines SA as "the continuous observation of current conditions and, along with the integration of previous knowledge, the ability to quickly form a coherent mental picture to anticipate future needs and direct future actions. Strong SA allows the formation pilot to absorb information from several different sources near simultaneously, such as the aircraft engine and navigation instruments, radio chatter, traffic analysis, etc., and anticipate what actions are needed over time."

In many regards, flying a general aviation aircraft in formation can be much more challenging than flying the military jets. Propeller aircraft have a narrower operating speed range, slower response to power changes, and often slower roll rates, all of



PHOTOGRAPHY COURTESY OF **CHARLIE PRECOURT** which make the job of the leader even more challenging. This is most challenging if the aircraft in the flight are not all the same type. A technique I've used during preflight is to place the formation aircraft side by side on the ramp in the relative position desired for close-aboard formation in flight. Typically, this puts the number two aircraft on about a 30 to 45 degree bearing line behind the lead with at least 3-foot spacing of the wingtips. Use this arrangement to select sight-line references from the pilot seats that you can later use in flight, with the one minor adjustment that you will step down lower, vertically, by 3 feet or so, which of course can't be pre-arranged on the ramp. The wingman steps down vertically from the lead to provide separation margins (enhanced collision avoidance!) for turns performed by the leader into the direction of the wing aircraft.

There are several specific collision risk factors that must be taken into account in formation flight. These include maintaining sight, proper monitoring of the wingman's position by the leader, appropriate lateral and vertical spacing, overtake speeds during maneuvering rejoins and position changes, consideration of wingtip vortices, and prop wash. Each of these should play a significant role in the way you plan, brief, and execute a formation flight. An absolute must for every formation flight is to have a "lost sight" plan. My favorite is easy to remember: If either aircraft loses sight with the other, call it immediately on the radio. If the other also responds "lost sight," you must immediately execute the lost sight plan. The simplest is to use altitude separation. Lead (aircraft No. 1) is an odd-numbered position and goes to an odd altitude in thousands. The wingman (No. 2) goes to an even-numbered altitude. Neither crosses the altitude where the other was last seen to achieve this. In other words the lead chooses to climb or descend to an odd altitude based on whether the last wingman position was below or above the leader. Once safely established at dissimilar altitudes, radioing each other's relative position over ground references can get you back together.

Every successful formation flight is created during the briefing. The pilots of each aircraft must discuss each phase of flight from engine start through post-flight engine shutdown in great detail. Expected position of each aircraft for each phase of flight must be well-understood, and the protocols for use of the radios must be unambiguous. A plan also must be established for abnormal and emergency procedures. My general rule of thumb is anytime a wingman aircraft experiences an emergency, that aircraft is offered the lead position and the other aircraft takes the wing position to offer support and coordination with ATC as needed by the emergency aircraft. The support another aircraft can provide in an emergency is one of the most beneficial aspects of formation flying. If the preflight briefing is thought out and executed well, formation flying can be a significant enhancement to overall flight safety. Fly safely out there! EAA

Formation Flight Safety

Part 3

BY CHARLIE PRECOURT, SAFETY COMMITTEE CHAIRMAN, EAA BOARD OF DIRECTORS

I'VE ALWAYS CONSIDERED formation flying one of the most enjoyable types of flying we can do. Formation fundamentals strengthen your overall flying abilities, but also require some unique training to perform correctly and safely. To re-emphasize some important points from our first two articles, don't take up formation without some good instruction. Your instructor doesn't have to be a CFI. In fact it is more important the instructor be well experienced in formation and in the type of aircraft you want to learn than be a CFI. The best CFIs in the world can't teach you to be safe in formation unless they have formation experience.

The FAA doesn't provide any requirements for teaching or testing for these skills through the normal certificates and ratings, so we have to rely on experience within the pilot community. A great reference is *The Formation Pilot's Knowledge Guide* published by FAST, the Formation and Safety Team. (Visit *www.SportAviation.org* for a PDF.) I highly recommend it!

Another key point discussed in Part 1 is the challenge of flying the lead position. It is important to learn to perform on the wing to a high degree of proficiency before attempting to learn lead, as these positions are two entirely different skills and should be approached in building block fashion. One way you'll know when you're ready to start learning lead is when you can recognize the mistakes the leader is making while you're on the wing!

To continue from Part 2 with more on the finer points of flying the wing position, I was thinking about the student errors that make me uncomfortable when I'm teaching a pilot to fly on the wing. For close-in formation, our correct position relative to the leader is determined by a number of things. One is it places you close enough that you could penetrate IMC together without losing sight. Another is the proper position allows maneuvering through turns safely, while the inverse is true: Being out of position can increase the risk of collision.

Inevitably, when a pilot is first learning to fly close formation, there will be lots of deviations from the proper position, but I become most uncomfortable when the wingman drifts high on the leader. There are a couple of reasons for this. First, as you drift higher, the leader is moving more toward your aircraft underside where it gets harder to see. Worse, if the leader initiates a turn into you while you are out of position high, lead will appear to be going under you. To match his turn you need to bank away, which will cause you to instantly lose sight altogether, so you're now stuck, even though you're only a few feet away. Very uncomfortable, and a big no-no. As a rule of thumb, I don't want to ever see the entire upper surface of the leader's wing (low-wing

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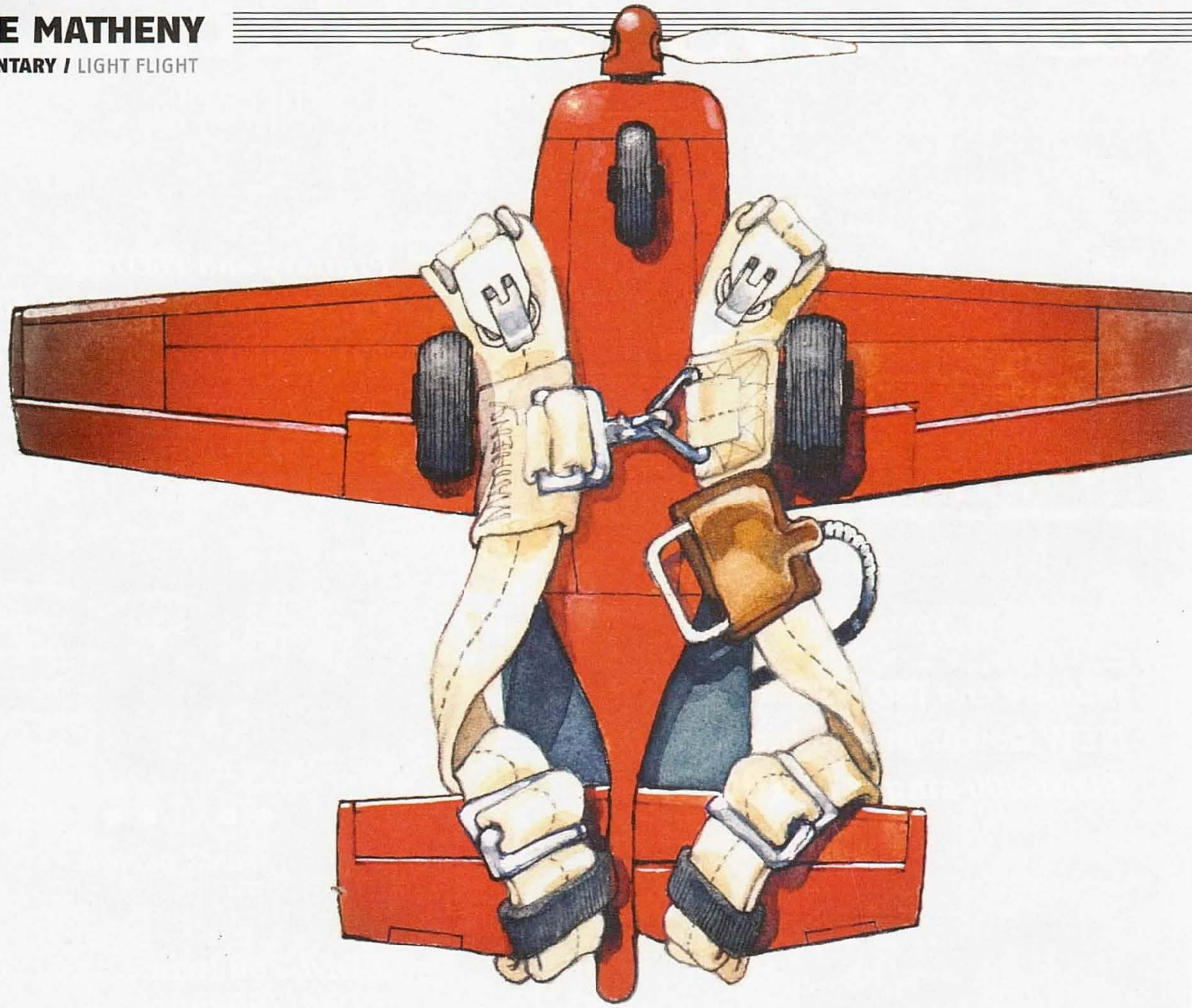
PHOTOGRAPHY COURTESY OF CHARLIE PRECOURT aircraft), and I make corrections immediately to avoid that happening. If the leader is in a high-wing aircraft, being out of position high is even worse, as the leader also loses sight of you! To avoid getting high on the leader, some wingmen of formation demonstration teams will fly with the pitch trim "preloaded" nose down, requiring them to hold constant back pressure to stay level. With this trim setting, any drift high can be corrected quickly by just relaxing back pressure. This is not a technique I have used personally, just never adopted it, but I know many have. The point is to avoid getting high on lead.

Another common student error I see during turns in close formation occurs when the leader turns away from the wingman. When the lead's turn away from you makes you see his aircraft's belly, it gives the impression that you're low. Instinctively the first correction the student makes is to pitch up to correct. The problem is students often correct in pitch without initiating bank, so they end up drifting wide. At this point they have traded the low position error for a wide position error, necessitating two sizable corrections. Instead, when the lead turns away from me, I make sure that I match his bank and roll rate as a priority, and then correct the vertical error with pitch. Ideally you can do both axes together, but if you trend out of position low as lead turns away, be sure to get the bank error fixed pronto. In doing so, I don't have to correct two errors (vertical then lateral), as I never get wide. I maintain proper lateral by keeping up in roll, and then gradually fix the pitch.

Another maneuver to master on the wing is the rejoin. Rejoins return us to close formation from more distant positions, and they can be done straight ahead or turning. Practice turning rejoins by positioning about 800 feet in trail of the leader. Lead initiates a 30-degree bank turn, and the wingman follows and accelerates 5-10 knots. This is another place where being high on lead makes me uncomfortable. Wing should descend enough that lead appears above the horizon (three to four finger-widths held at arm's length is a good rule of thumb). At this point your higher speed gives you a bigger turn radius, which will move you toward lead. You strive to fly along a 30-45 degree bearing line aft of the leader. You can estimate that by flying your aircraft to keep lead near the front lower quarter panel of your windscreen. From that starting point, if you increase bank, lead will move aft in your view; if you decrease bank, lead will move forward. So "driving up lead's wing line" is controlled by varying bank angle. As you get closer you can start to reduce speed to match lead's and slide into position. Your safety escape route is provided by staying below lead, and if you find closure rates are too high for comfort, you roll out your bank and pass behind and below lead, overshooting to the outside of the turn until the speeds are matched. Mastering the turning rejoin will be a great confidence builder for more complex formation skills to come later. Fly safely out there! EAA

DAVE MATHENY

COMMENTARY / LIGHT FLIGHT



When Airplanes Wear Parachutes

The case for and against having a whole-aircraft recovery parachute

I GO WAY BACK WITH parachutes—*way* back: A few years before I was born, my dad, as a young Army Air Corps lieutenant, bailed out of a Stearman when he ran out of fuel one black night over Alabama. Once safely down, he still couldn't see anything, so he wrapped himself in the canopy and went to sleep. In the morning he found his way to a farmhouse. I don't know what happened to the Stearman; I only heard him tell the story once, and then it was only to make the point that he was young and foolish and should have checked the fuel level himself before takeoff rather than leaving it to somebody else. That seems like a good rule in any case.

Growing up on Air Force bases, I thought that everybody in airplanes wore parachutes: pilot, crew, passengers, everybody. By the time I was old enough to realize that, no, some people flew without any parachute in the airplane at all, in ing airline passengers, I wondered wh gloomy, self-destructive spirit possess them to do such an irrational thing. A years passed, first one and then anoth I knew ejected from a disabled aircra lived. One man had gotten into a dogf with a MiG-15 in his F-86 over North The MiG disintegrated, and the F-86 ingested debris and flamed out. He st for the nearby Pacific Ocean and pun out over water, and was later picked helicopter. A nephew of mine, a Mari

ILLUSTRATION BY DAV

pilot, was engaged in an air-combat exercise in an A-4 some 70 miles off the coast of South Carolina when his oil pressure went to zero. A pair of F/A-18s formed up on his wing to escort him to shore, but then told him he was trailing 40 feet of flame from his tailpipe; he and his back-seater ejected and were picked up by helicopter. He's now a captain with Delta. I have made 14 parachute jumps, meaning that I've trusted my life to a parachute just that many times. Welcome to my world.

NOT A TOUGH SELL

I have a long history with BRS, the whole-aircraft parachute recovery system, so I'll lay my cards on the table: When I was first drawn to ultralight flying, in 1981, it happened that Boris Popov, who was just then in the process of developing the BRS, was also the dealer who sold me my first aircraft. I was anxious to buy a unit and mounted one of the very first ones on my first aircraft. We became good friends; he was best man at my wedding in 1986. I helped with small activities around the shop in the early days, firing early BRS drogue guns and stuffing parachutes back in their containers for more test firings (you really don't have to be that careful about the repack when the canopy is just going to be yanked out in another firing in a couple of minutes). Later, I flew the camera ship for some early test deployments and saw the canopy stream out behind and fill—an utterly beautiful sight—then watched as the pilot cut away from it and resumed normal flight. I also watched a test deployment where, because of a malfunction, the pilot had to ride the deployed canopy down to the ground (he hit power lines but emerged unscathed). I have always had a BRS mounted on every ultralight I have owned. I even bought $200 worth of BRS stock back in 1988; if this article were to somehow double the cash value of my stock, I might be able to add cheese to a hamburger at a fast-food place, but probably not.

I am not a salesman for BRS. I am just a big advocate of having some kind of backup parachute system. In any case, BRS is not the only player in the game these days. Second Chantz, the manufacturer of a similar system, appeared and disappeared in the 1980s but has since returned to the market. And a European manufacturer, Magnum Ballistic Parachutes, also offers such a system. I won't try to compare and contrast the different systems. I am strongly biased toward having some kind of whole-aircraft backup parachute aboard, whatever is being flown. Even parachutists wear a reserve parachute. But I will try to lay out the arguments pro and con as squarely as I can so that pilots can decide for themselves which way is best.

OUT OF THE FEVER SWAMP

Discussions about whether whole-aircraft parachute systems are a good idea is a perennial in aviation, but I was particularly drawn to a recent blog post by this magazine's editor-in-chief, J. Mac McClellan. He looked at the experience that Cirrus aircraft had with insurance because it was selling new airplanes with a type of BRS installed. He observed that in the beginning, "The underwriters—and actually most of us in general aviation—expected Cirrus airplanes to be raining down under the chute, but nobody knew how much damage the event would cause or how much it would cost to fix the airplane. Because of the chute, underwriters just didn't know how to price Cirrus hull coverage." Now, after about 15 years of sales of these airplanes, "more than 95 people are alive because Cirrus pilots deployed the Cirrus Airframe Parachute System (CAPS), and the number of deployments is increasing." And insurers, he wrote, "didn't need to worry. Cirrus pilots did have accidents for all of the conventional reasons, but they just weren't using the chute." Pilots were not firing the system for less-than-catastrophic failures.

The comments section inevitably became a discussion of the relative merits of having such a device installed in an aircraft. The comments were largely polite and well-reasoned, which is not an everyday occurrence on the Internet. (As anyone who has read comment boxes knows, they usually turn into a fever swamp within a few exchanges. But EAAers are a better-natured bunch, more inclined to use reason than insult.)

Rather than simply listing arguments for and arguments against, I'm just going to lay out the *anti*-arguments as they are usually given—not necessarily as they were phrased in the comments section—and then discuss each one.

"I have thousands of hours in everything from sailplanes and crop dusters to airliners, and have never needed one of these systems." I believe this might actually be the most compelling argument, although it's not based on reason. To have decades of experience and knowledge and yet reject the idea of a backup parachute is the Godzilla of anti-parachute-system opinions, stomping Tokyo and New York, breathing fire on

I am strongly biased toward having some kind of whole-aircraft backup parachute aboard, whatever is being flown. Even parachutists wear a reserve parachute.

fleeing hordes of terrified little counter-arguments squeaking out their objections. *Me have experience. You little fearful things. Shut up now, stop worry, fly plane.* But the same argument can be made for never wearing a seat belt and shoulder harness in a car. I, personally, have always worn them and have never, ever in all these years been thrown against them. Never. Which would make me an idiot for having buckled up all those tens of thousands of times, except for the highway traffic fatality statistics.

One ultralight expert whose knowledge I admire, a dealer in the Midwest, has been building, repairing, and selling parts for ultralights for more than 30 years. He just shrugs off the idea of the BRS, saying things like, "I've got one I pulled off a trade-in. It's just taking up space in my shop. I'll sell it to you if you really want one." Another man, writing in the comments section, said he had 25,000 hours: "I have had several low (below 200 feet) engine failures and other incidences due to striking objects, including complete loss of rudders, brakes, etc. ... To me it's just a continuation of the eroding of pilots' skills and competencies, and professionalism...it is even more ridiculous, and an admission of incompetence to think that a BRS should be an essential requirement... Let's try and make some difference between ourselves and monkeys."

"They weigh a lot and cost a bundle." True. And certainly some of that added weight could be used for fuel, passengers, or anything else that will probably be used on most flights, as opposed to a system that is very unlikely to be needed. And parachute systems are indeed costly. For example, Second Chantz's lowest-price system, intended to be used in an aircraft with a gross weight of no more than 550 pounds, costs about $3,000, and you will still have to install it yourself, and probably will have to modify your aircraft to make it fit. The 1,050-pound system is a little over $4,000. And the costs don't stop with the installation. All of the systems will need a periodic repack and replacement or overhaul of the rocket, or whatever serves to deploy the parachute, as often as five years in some cases, 10 years in others. Depending on size and whether the deploying device needs to be replaced, the cost can range above $2,000.

The counter-argument on cost is that *everything* in aviation is expensive—I have always tried to console myself with that thought. But—paying a lot of money for something you will probably never need? That galls. So let's ask: How often is that system needed? According to Wikipedia's article about Cirrus, "As of 11 June 2014, the CAPS has been activated 59 times, 46 successfully with 95 survivors and 1 fatality in equipped aircraft. No fatalities have occurred when the parachute was deployed within the certified speed and altitude parameters." BRS claims a total of more than 300 lives saved since it first came on the market in 1982. In BRS reckoning, one deployment saving two lives counts as two saves.

"But are these really 'saves,' and not just cases of some ninny pulling the handle unnecessarily?" A lot are unquestionably saves. Some years back, in an effort to prove that BRS deployments were unnecessary, a man posted on an Internet forum a long list of BRS deployments that he had pulled off the company's website. By including only those in which the handle had been pulled after merely losing the engine, and leaving out any in which there had been a structural failure or catastrophic loss of control, he managed to make it look as if a long procession of weaklings had bleated, "Oh, save me!" and buried their faces in their hands when they lost power. But a reading of the actual circumstances behind deployments shows that a large percentage are cases where the parachute was the only option.

By a striking coincidence, I know two pilots who have used a BRS in true emergencies. One was flying a hang glider in Wisconsin and had a structural failure: A wing spar broke in the middle—not something you would be likely to catch on a preflight inspection—and he fired the unit.

The other was a man in Texas who was flying a homebuilt biplane when the elevator linkage failed, sending him into a vertical dive, so he pulled the handle. Both pilots walked away from what would have otherwise almost certainly been fatal accidents.

"You might pull the handle instead of just landing the airplane." I have some experience in this matter. In the early 1980s, flying with unreliable two-stroke engines and powertrains, I made a total of 24 forced landings. Maybe not a Guinness World Record—not when there were so many paleo-ultralight-fliers out there who could just about count on every flight to end with a seized engine or the scream of the engine over-revving when a belt drive lost its cogs—but enough to be able to speak with some authority on what one actual pilot might do in the event of losing the engine. In none of those did I ever even consider pulling the BRS. The aircraft turned into a glider, and a glider is a flyable aircraft, and I glided down to a landing.

One commenter wrote that he'd had three engine failures in 24 years of flying and had never chosen to use the BRS. "Two of the engine failures were at night and one in daylight at about 50 to 100 feet and 100 mph just after liftoff," he wrote.

Not everybody who has the option turns to the parachute. A Vietnam-era fighter pilot I know lost both engines in an F-4 to flak and chose to glide it right on down to a forced landing on a long, smooth beach. He just had a horror of ejecting, he said, and preferred to take his chances with the landing, and it turned out just fine. I don't think I would have done that, but I wasn't the one in the cockpit. I think we need to trust pilots to make their own decisions.

Another commenter wrote: "I would suspect that in the majority of cases a pilot will feel that he can make a reasonably safe off-airport landing somewhere. So, rather than deploy the parachute that is what he decides (and prefers) to do. Might work out for him and the airplane or it might not."

To have decades of experience and knowledge and yet reject the idea of a backup parachute is the Godzilla of anti-parachute-system opinions, stomping Tokyo and New York, breathing fire on fleeing hordes of terrified little counter-arguments squeaking out their objections.

"You will never need a backup parachute if you exercise common sense and maintain your aircraft to the highest standard." It is unquestionably true that you can be painfully strict about such things as never flying in bad weather, and keeping a sharp lookout for other aircraft, and maintain your aircraft religiously, and avoid voluntary flight maneuvers that might result in disaster. But it's impossible to eliminate every chance of getting into a situation where one will need a backup device. Even if we cross off as avoidable such things as inadvertent flight into instrument conditions by VFR-only pilots, we still have the unavoidable, as in the case of the man cited above whose wing spar failed in the middle, where it is not normally inspected before flight. Loss of control and midair collisions are also always possible.

"If you have one of these systems, you might take chances you would not otherwise take." No argument here. Embarrassing though it is to admit, I did once actually consider, for about 1.2 seconds, rolling my Quicksilver GT400. I thought something like, "Well, I have the BRS if anything goes wrong." But I rejected that idea before it was even properly out of the gate. (My only excuse is that it was a beautiful day, and I had been doing some steep turns and stalls and was feeling like Sky King. Plus, I have rolled some other aircraft, although they were designed to take that kind of thing.) Probably the GT can be rolled, but I don't know that for sure. And although I could probably complete the maneuver without trouble, it would have been crossing a very clear line, one that there is no need to cross. The system is there as a backup for bailing me out of situations I can't control, not for ones I deliberately get myself into. It is completely up to me to decide not to do stupid stuff. Could some other Sky King install a parachute system and then give into temptation to do something stupid? Yes. Of course. It's up to the pilot. But then, so many things are up to the pilot.

"To a man with a hammer in his hand, everything looks like a nail." Meaning that pulling the handle can be seen as the solution to any problem. However, although this saying sounds profound, it doesn't stand up to the slightest examination. I have walked around with a hammer in my hand many hundreds of times and have never been tempted to hit anything with it other than what I originally intended to hit. (I *have* used a pair of heavy gooseneck pliers to hit a nail, but that was only because I was too lazy to go get a hammer; nor was I then tempted to go around crushing things with my mighty goosenecks because everything looked like it needed a good squeeze.)

Well, I have tried to be fair with presenting opposing points of view, but it doesn't feel like I have succeeded. I plan to go on flying with a BRS mounted whenever the aircraft I fly is capable of having one fitted to it, and I plan never to have to use it. For all that I regard an inflated canopy as beautiful, I have seen what happens when an aircraft has had to ride a deployed parachute all the way to the ground—in that one case, he tangled with power lines—so I will only pull that handle in the event of something extreme. That's the only reason it's there. EAA

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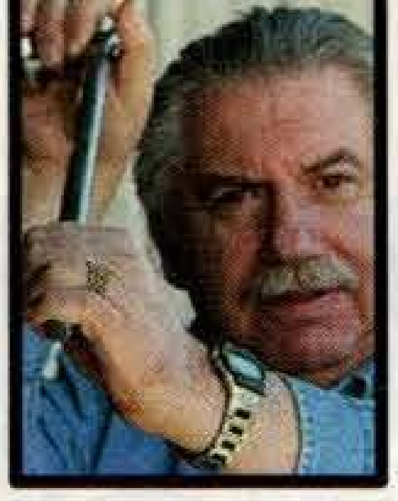


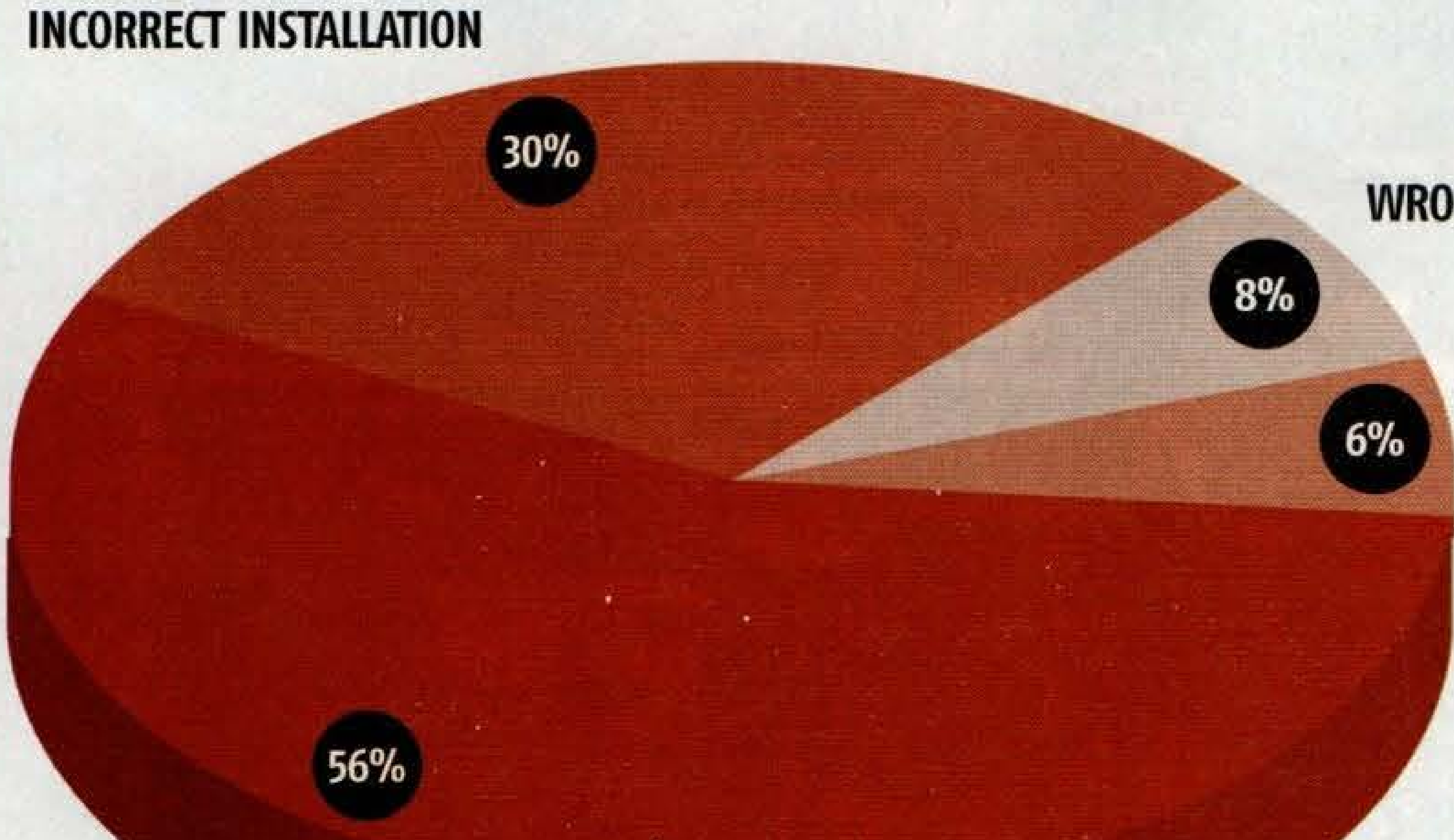
MIKE BUSCH
COMMENTARY / SAVVY AVIATOR

Human Error

"To err is human..." but when humans make mistakes working on aircraft, bad things can happen

DURING THE CENTURY SINCE the Wright brothers first flew, the predominant perpetrator in aircraft accidents has shifted dramatically from machine to human. Today human error is responsible for about 90 percent of aircraft accidents and incidents.

It's not that people have become more careless, forgetful, inattentive, or reckless. It's that aircraft and aircraft components have become much more reliable. As component failures become fewer and fewer, human failures represent an ever-increasing percentage.



Most maintenance errors are errors of omission.

Most of the efforts of the aviatior research community have focused o errors committed by pilots. This is a priate, since 75 to 80 percent of seri aviation accidents are due to pilot er Yet roughly one-eighth of accidents are still caused by maintenance erro and many of those are serious, some times fatal.

In the wake of the 1988 explosive decompression of Aloha Flight 243 a the 2000 fatal stab-trim-jackscrew c of Alaska Flight 261, there has been increased focus on maintenance erro by the airlines. But in my view, not n enough attention has been given to m tenance errors in general aviation, w the incidence of maintenance-induce failures is more prevalent.

KINDS OF MAINTENANCE ERRORS

Maintenance errors can be divided i two broad classes: (1) introduction o problem that was not there before th maintenance began (or what I call a "maintenance-induced failure" or M and (2) failure to detect a pre-existin problem during maintenance inspect

Errors of omission seem to be the common kinds of maintenance error analysis of 122 maintenance errors

ILLUSTRATION BY CHR

detected by a major airline over a three-year period revealed that 56 percent were omissions, 30 percent were incorrect installation, 8 percent were wrong parts installed, and 6 percent were other things.

My experience in general aviation suggests that we suffer the same kinds of MIFs as the airlines do, and that the majority are errors of omission. This includes things like fasteners left uninstalled or improperly torqued, caps and inspection plates left loose or missing, hoses and electrical harnesses left disconnected, and so forth.

THE REASSEMBLY PROBLEM

Most maintenance errors occur not when taking something apart, but when putting that something back together. There's a good reason for this. Consider a bolt onto which eight nuts have been assembled, each one labeled with a unique letter A through H.

Assume that the task at hand is to disassemble the nuts from the bolt, clean them, and then reassemble them in the original order. There is really only one way to take this assembly apart, but there are 40,320 different ways in which it could be put back together—and 40,319 of them are wrong!

This simplistic example illustrates the fact that the task of disassembly usually constrains you to one particular sequence, with each succeeding step being prompted by the last. You don't require much guidance, because the disassembly procedure is usually obvious. In contrast, correct reassembly usually requires knowledge—either in your memory or in the form of written instructions.

Human memory being as imperfect as it is, reassembly based on memory is inevitably error-prone. Reassembly based on written guidance (such as a checklist or maintenance manual instructions) is far more reliable, but people doing a hands-on grease-under-the-fingernails job tend to be reluctant to consult written instructions. Watch any A&P work on an aircraft—including yours truly—and note how rarely he consults the manual or any other form of written guidance.

Reassembly-by-memory is probably adequate for a task that one does every day. But some maintenance tasks aren't like this, and we all know—especially if we're pilots—just how easily

s only one way to take this assembly apart, but more than 40,000 ways to put it back together—all but one n wrong.

n forget the details of a task after a relatively short period of time. o make matters worse, improper nbly is not always obvious on later ction. The absence of washers, ings, fasteners, seals, O-rings, caps, cation, and the like are often con- d after reassembly. Thus, embly by memory often creates the rtunity for double jeopardy: an ased probability of forgetting thing important during reassem- nd a decreased probability of ting the error once the job is done.

MISTAKES, AND VIOLATIONS

es to perform a task as planned mmonly termed slips, lapses, or fumbles. "Slips" occur when trying to do the right thing but s it up somehow. Slips can be d by omitting some necessary , performing some necessary in a clumsy fashion, performing unwanted action, or carrying out ht actions in the wrong order. lips most often occur when doing by memory—often well-practiced hat are done frequently in an atic fashion.

istakes" are higher-level failures d by an error in the plan itself. are usually caused by lack of edge and occur most commonly performing tasks that are not ery often. Often mistakes are d by trying to do something by ry that should have been looked he manual. Forgetting to torque a cylinder hold-down nut is a slip; torquing it to the wrong torque value is a mistake.

"Violations" are deviations from standard practices, rules, regulations, or standards. While slips and mistakes are unintentional, violations are usually deliberate. They often involve cutting corners in order to take the path of least resistance and can become part of one's habit pattern.

In a recent post to the AOPA Opinion Leaders blog, I wrote about an incident in which the pilot of a Cessna 340 launched into IMC on the first flight after maintenance, only to discover that his airspeed indicator, altimeter, and VSI stopped working as the aircraft climbed through 3,000 feet while in the clag. The cause of the problem turned out to be the failure of an avionics technician to reconnect a static line that had been disconnected to facilitate access to some panel-mounted avionics. The technician's failure to reconnect the static line was an inadvertent slip: He simply forgot. On the other hand, his failure to perform a static system leak check after opening the static system was a (presumably deliberate) violation of FAR 91.411(a)(2). Because of the violation, the slip went undetected and jeopardized safety of flight.

DISTRACTIONS

Distractions can play a big part in errors of omission. A common scenario is that a technician installs some fasteners finger-tight, then gets a phone call or goes on lunch break and forgets to finish the job by torquing the fasteners. I have personally seen some of the best, most experienced A&P/IAs I know fall victim to such seemingly rookie mistakes—not to mention me—so I know that they can happen to anyone. I also know of several fatal accidents and countless less-serious incidents and precautionary landings (not to mention pissed-off aircraft owners) caused by such omissions. Unfortunately, they're a fact of life.

Just as pilots need a "sterile cockpit" during high workload phases of flight, maintenance and avionics technicians need a distraction-free workplace when performing safety-critical tasks. Unfortunately it has been my observation that the typical piston GA shop is a distraction-rich environment. Phone calls come in. Customers drop by unexpectedly. UPS and FedEx drivers deliver anxiously awaited parts. The Snap-on tool truck stops by. The shop's FAA principal maintenance inspector pays an unexpected visit. The roach coach arrives with lunch.

Distractions seem to be less of a problem in the big repair stations where there's usually a full-time parts manager to deal with deliveries, a customer service manager to handle customer visits and phone calls, and sometimes even a compliance manager to interface with the FAA. But in the smaller shops that owners of piston GA usually use, employees usually wear multiple hats and must deal with these distractions as they come. That can lead to mistakes.

Big maintenance, repair, and overhaul (MRO) facilities aren't immune to distractions either. Often such shops have multi-shift operations, and that creates its own issues. Whenever a task is handed off from one technician to another at shift change, there's always the potential that something will be lost in the shuffle.

QUALITY ASSURANCE

I've visited quite a few GA aircraft and engine factories over the years—the Beech, Cessna, Cirrus, Continental, Hartzell, and Lycoming factories come to mind—and watched how they build our flying machines and their powerplants. One of the fundamental work rules I've observed at all these facilities is that there must always be at least two sets of eyes that look at every step of the process: the technician that performs the work, and an inspector who verifies that the work has been done properly. Often there are three sets of eyes: two technicians who work as a team and check one another's work, and then an inspector who rechecks the work. (Although as we've seen, even careful post-reassembly inspection cannot always detect errors and omissions made during reassembly.)

Large repair stations that work on turbine aircraft—such as the big Wichita Citation Service Center that I've visited a few times—typically have similar rules, where designated inspectors are required to check the work of each technician and sign it off. But the smaller shops where most piston GA maintenance is done seldom can afford the luxury of having dedicated inspectors on staff. One technician will sometimes ask another to check a particularly critical or complex task, but most maintenance is checked by just one set of eyes belonging to the person who did the work, and most scheduled inspections are done by just one IA. Fewer sets of eyes inevitably means that more slips, mistakes, violations, and discrepancies escape detection.

THE OWNER AS FINAL INSPECTOR

Aircraft owners and pilots need to understand that maintenance errors create a significant hazard, and act accordingly. The most likely time for an aircraft to suffer a mechanical problem is on the first flight after maintenance. Prudence demands a post-maintenance test flight every time the aircraft comes out of the shop. The test flight should be done in VMC, without passengers, and in a place where the pilot can easily put the airplane back on the ground if something isn't right.

Prudence demands a post-maintenance test flight every time the aircraft comes out of the shop. The test flight should be done in VMC, without passengers, and in a place where the pilot can easily put the airplane back on the ground if something isn't right.

Prior to the test flight, the owner or pilot should conduct an extraordinarily thorough preflight. Make sure that all inspection plates and fairings are installed and secure, all cowling fasteners are tight, and all fuel and oil caps installed. Check that all flight controls and trim systems are free throughout their full range of motion and operating in the correct direction. Check that all instruments and avionics systems are functioning properly. Perform a ground test of the autopilot. Run up the engine thoroughly, then shut down and check for leaks. Be sure you don't smell fuel or anything burning.

In short, be thoroughly skeptical any time an aircraft comes out of maintenance. Your preflight and test flight are the last line of defense against maintenance errors. *EAA*

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Staying Sharp

Flying proficiency and building

BY BUDD DAVISSON

THE STORY IS AN OLD AND TOO-FAMILIAR ONE. A builder, let's call him Bill, spends five years laboring on his [insert name of common homebuilt here]. It is an award winner in every detail. As a builder, he is in the top few percentile in terms of capabilities. As a pilot, he's average/typical: 225 hours of total time, mostly in Cessnas, spread out over the last 15 years with none during the five years the airplane was being built. He knows his piloting skills are probably rusty, so as soon as he has the airworthiness certificate, he rushes out to the airport and gets a flight review. He spends two hours in a rental 172, shoots 10 landings, and his CFI proclaims him airworthy. In a Cessna. So, he is now legal again, but is he actually prepared to test his own airplane?

THERE IS ALWAYS A FIRST FLIGHT

Common sense says Bill is definitely not prepared to fly his newly completed airplane. However, the degree of the mismatch between his skills/proficiency and the airplane in question depends on the airplane to be flown. If it's a Pitts, he's not even in the ballpark. If it's a Pietenpol, he might have a chance, assuming he's tailwheel current. But, his C-172 flight review didn't do that. If it's an RV-6A, the tail wheel is no factor, but the control feel (light and quick) and performance become worries. Bill wouldn't be the first to have a tragic first flight, and he probably won't be the last. All of which is so unnecessary.

First, let it be known that personally I am nervous when builders do their own first flights unless they are very current, very proficient pilots who have recent experience in aircraft similar to what they've just built. Unfortunately, that profile doesn't fit many

ILLUSTRATION BY **BRANDON JACOBS**

builders. Plus, if a pilot/builder who has five years of his/her life tied up in the project has a problem on the flight, there's the possibility that the pilot will make decisions with the builder part of the brain rather than the pilot part.

On page 68 in this issue, I have an article in which, as an old-school instructor, I make a case for re-inserting the "basics" back into one's flying skill package. However, what we're talking about on this page isn't flying technique so much as it is proficiency. Let's face it, when it's a sunny Saturday and building fever has taken over our brains, we know that, if we go flying, we'll walk back into the shop and nothing about the project will have moved ahead. Visual progress always spurs a project on, so we often find our urge to build overpowering our urge to fly. Then, when we come to the end of the project, a number of months or years will have passed since we've flown. This is where EAA's Flight Advisor program can be brought to bear.

FLIGHT ADVISORS CAN BE IMPORTANT

Decades ago, EAA began to address first-flight difficulties by formally recruiting highly experienced homebuilt pilots who know specific airplanes well and are willing to share their expertise. They advise the soon-to-be-homebuilt pilots on the best course of action to be taken to fly their airplane. Where the tech counselors look for glitches in the hardware, the flight advisor checks out the software between the builder's ears and helps him or her make the right decisions concerning the first flight.

NEW REGULATIONS EASE THE FIRST FLIGHT BURDENS

The last decade has seen some incredibly important changes in the FAA's attitude toward test flying homebuilt aircraft and getting transition training for them. These have been in three phases, each better than the last.

» **Allowing CFIs to charge for training in an experimental amateur-built aircraft.** In the past, it was impossible for an instructor to charge for doing anything in a homebuilt aircraft. Then the FAA allowed them to charge when giving training for transition into the exact type of homebuilt being used as a trainer. So, a CFI could charge an RV builder for training given in an RV.

» **Letter of deviation authority (LODA).** This expands the program and allows commercial flight training to be given in an airplane that approximates the characteristics of the homebuilt to be flown, for example training for a Thorp in an RV. This makes it easier to get training for aircraft that have no factory support.

» **Additional Pilot Program.** This is a really big change in that a new homebuilt pilot can now bring along a pilot who is more experienced. The "required crew" limitation, which essentially required all test flights to be flown solo, was removed. This is an important change because the newbie pilot can now have someone on board to not only watch over the pilot's flying but also to help in the case of a problem. More than half of first-flight accidents involve pilot error, so this one change has and will drastically lower first-flight accidents.

NOTHING CAN SUBSTITUTE FOR RECENT PROFICIENCY

While the above changes in the regulations do a lot toward easing first-flight fears, if pilots haven't flown in a long time, the amount of rust that has built up cannot be removed in a short period of time. Removing a lot of rust and getting pilots ready to fly an airplane that may be different than anything they have flown can be a long, sometimes arduous task. So, homebuilders have two choices: One is to make an effort to slow the growth of rust by flying more often while building. That way the transition CFI isn't trying to make a diamond out of a lump of coal. Or, accept the fact that their new beauty will languish for a period of time until they soak up enough training and are absolutely ready to fly it. If they're using the Additional Pilot Program, they don't have to be as sharp because they can lean on the pilot who is experienced in the type to do the more serious flying. This, of course, assumes it's a two-place airplane, which many homebuilts are not. If flying a single-place homebuilt, even if it already has the test time flown off by a pro, the newbie E-AB pilot's skills have to be approaching razor sharpness. The two approaches, fly-while-you-build and fly-after-you-build, require some discussion.

I am nervous when builders do their own first flights unless they are very current, very proficient pilots who have recent experience in aircraft similar to what they've just built. Unfortunately, that profile doesn't fit many builders. Plus, if a pilot/builder who has five years of his/her life tied up in the project has a problem on the flight, there's the possibility that the pilot will make decisions with the builder part of the brain rather than the pilot part.

MAKING FLYING PART OF THE PROJECT

When the builder is whittling on a part, the airplane is in the act of improving while the builder is, at the same time, in the act of deteriorating as a pilot. So, there are two projects in the room at the same time: The airplane and the pilot. The successful builder develops a level of self-discipline, a "project mindset," viewing each part as if it is the entire project. Build the airplane one part at a time so the completion of a part is a milepost on the road to completion. Flight proficiency can be easily built into that kind of thought pattern, if the builder so desires.

A single flight while building, even if it's just a hamburger run, can be inserted into the building schedule once a month or every six weeks just as if it is a component of the airplane. Builders have to approach these flights as if they are airframe parts where they apply their own definition of craftsmanship. They should be conscious of how well they keep the ball centered, how consistent their airspeed control is, how close they came to landing on their chosen spot on the runway. They should criticize their performance in the air just as they criticize their performance on the bench. In so doing, when it comes to transitioning to the new airplane, their instincts and basic piloting skills will be intact and they'll enjoy the new airplane just that much more.

PUTTING OFF RUST REMOVAL UNTIL THE END

There is something to be said about the continuity required while building an airplane. Interruptions and distractions are to be avoided. So, breaking stride to trundle out to the airport to fly can irritating to some builders but not to others. Some builders put the heads down and mentally become hermits, focusing on the task at hand and surfacing only to eat and commute to work. Others like a break as a way to recharge their batteries. By the way, an extreme case of "taking a break" was a friend who was restoring a Waco ca biplane (an enormous task) and saw building a Bearhawk as a way taking a break! If flying proficiency is sacrificed for building progress, builders have to look at the transition from builder to pilot as they're learning to fly again.

Flying is one of the most perishable skills most of us possess, and although the rate at which i deteriorates depends on the indvidual, a hiatus of a few years pu most of us right back to the beginning. Or close to it. So, when we get back in the cockpit, we need be willing to accept the fact that we may find huge gaps in both o actual skills and our judgement. The CFI charged with knocking the rust off can't make any assumptions about how much o our skill is left. The instructor ha to do more than simply get us to the point where we can get up a down without breaking anythin

This re-entry into the third dimension should include a little of everything that it took to get our certificate in the first place. Crosswinds and bad days need to be challenged. Strange runways explored. Emergency procedures practiced. The rudimentary stick-and-rudder basics need to be made instinctive again. When all of this has been accomplished in a "normal" airplane, the flight advisor, spo CFI, or qualified additional pilot can take us by the hand and lead us into the new world our homebuilt represents. There are no short cut

NEVER LOSE SIGHT OF WHAT IS IMPORTANT

We can never forget that aviation is one of the most unforgiving environments in existence. Our ability to survive lies almost entirel in our own hands. Not only in our ability to manipulate the controls but in our mental capacity to perform correctly even in emergency situations. It is important that we recognize that both of those skills come together only when we've made the effort to make ourselves better pilots. Building the perfect airplane is a waste, possibly a dangerous one, if we don't make the same effort with our skills. *EAA*

Budd Davisson is an aeronautical engineer, has flown more than 300 different types, and h published four books and more than 4,000 articles. He is editor-in-chief of *Flight Journal* magazine and a flight instructor primarily in Pitts/tailwheel aircraft. Visit him on *www.AirBum.com.*

FORMATION FLYING, INC.

Last year the FAA established a new requirement for non-aerobatic formation flight in waivered airspace at airshows. Any pilot now wishing to participate in such activities must possess a valid industry formation training and evaluation credential acceptable to the FAA. Two organizations, FAST and ICAS, have received FAA approval to issue non-aerobatic formation cards. FAST, however, is for warbirds only and ICAS' emphasis is on the professional airshow pilot. That left a large group of competent formation flyers who like to support their local airshows with formation flybys without an agency to issue cards.

That situation is about to change. Stu McCurdy, who led the 25-ship formation at Oshkosh '97 for Van's Aircraft 25th Anniversary, has been searching for alternatives to resolve the problem. Discussions with EAA, FAST, FAA and formation groups around the country, led to forming a corporation dedicated to formation flying. The corporation, called Formation Flying, Inc., will parallel FAST, use similar formation manuals, videos, evaluation guides and forms, appoint a limited number of formation check pilots around the country, evaluate formation knowledge and proficiency skills, issue formation cards and maintain the requisite database. EAA will become a signatory organization to this corporation and assist in certain administrative requirements. This corporation will go a long way todard standardizing formation flying across the country. Once formed, with procedures and documents in place, the corporation will seek FAA's acceptance of its credentials for flying non-aerobatic formation in waivered airspace.

Stu McCurdy now needs to hear from formation flying groups around the country who would like to become members of and support this corporation. If you or your formation group would like to be in on the ground floor of this developing corporation, send your name, address, telephone number, e-mail address, name of the formation, number and types of aircraft and a summary of formation experience to: Stu McCurdy, 3509 Gattis School Road, Round Rock, TX 78664.

Lancair

flying *new* types

IT'S ALL ABOUT THE BASICS

BY BUDD DAVISSON

AVIATION *has a problem.*

This time it's not money. It's not politics. It's not regulations. What it is, is an overall, insidious degradation of basic flying skills.

IT HAS BEEN HAPPENING FOR A LONG TIME, *and it's hurting sport aviation.*

HOW DO I KNOW THAT? Because over the course of nearly 8,000 hours' dual given, I've been checking out pilots to fly all manner of sport aircraft, Cubs to Pitts to Midget Mustangs to whatever is out there. Almost all of my "students" are certificated pilots seeking to make the leap from "normal" general aviation aircraft to those "sport" type aircraft that camp under the EAA banner. And, almost regardless of these pilots' flying background, their basic flying skills are such that some sport aviation airplanes will present a larger challenge than they'd have to meet within the general aviation population. That's not necessarily because their instruction is subpar. It's just that a Katana, 172, or anything similar isn't going to prepare a pilot for many of the aircraft that are the basis of sport aviation.

WHY SPECIALIZED TRAINING?

For the purposes of this discussion we're defining "sport aircraft" as those which fall under the EAA umbrella: homebuilt and vintage, which has the subcategories of antique, classic, and contemporary. And the question being asked is, if "normal" flight training isn't adequate by itself to fly some sport aircraft, and the basic skills of many pilots have eroded, is flight training available to prepare pilots to safely fly those birds that fall into each of these categories? The answer is yes. And no.

For some of the homebuilts, the RVs for instance, there are specialty instructors available who do their training in RVs. For aircraft like Stardusters and Thorps, this usually isn't the case. For classics like Cubs, Champs, and their ilk, yes, there are those who do that kind of training. For the antiques, say a Waco QDC or Pitcairn, you'll have to dig to find a qualified instructor. For the contemporaries, most of which are similar to modern aircraft, you would think adequate training would be available, but in some instances, that may not be the case.

One of the strongest arguments for specialized training for sport aircraft is that "normal" FAA-blessed flight schools don't offer that kind of training. That's not their purpose. In fact, it could be argued that, while the pilots coming out of those schools are safe to fly modern aircraft similar to those they trained in, they are babes in the woods when it comes to some types of sport aircraft. This is because modern certified aircraft, especially trainers, are known quantities: The FAA certification process makes them that way. When a pilot climbs into a Cessna/Piper/Beech/Diamond/Cirrus, although each has its own idiosyncrasies, within certain limits they still fly essentially the same. More than that, their designs are such that pilots' basic skills can be weak, and they'll still be safe because the airplane will try to take care of them. However, homebuilts, antiques, the classics, and even some of the older contemporaries are different breeds. Even a flight instructor with 1,000 hours in something like a Katana or Cirrus is unlikely to have the skill set to safely fly something like an RV (even a nose-wheel version), Cub, or Staggerwing. And a tailwheel endorsement won't make up the difference.

THE PROBLEM IS OFTEN THE BASICS, NOT THE HARDWARE

The laws of physics don't change for anyone. Not for Burt Rutan, Beechcraft, or NASA. However, aircraft to aircraft the interpretations of those laws do change, and the handling characteristics can vary wildly. At the same time, however, the very basic, rudimentary piloting skills involved in flying still apply, regardless of the airplane. In some cases, that's where the problem lies. It is very difficult, for instance, to teach the need for rudders in controlling adverse yaw or P-factor in aircraft where the engineers have designed most of those effects out of the aircraft in favor of ease of handling.

In the vast majority of sport aviation-type aircraft there has been little or no attempt to eliminate any of the aerodynamic gotchas that every propeller-driven airplane includes. It is the rare vintage or homebuilt airplane, for instance, for which the aerodynamics have been dumbed down to minimize such things as adverse yaw or P-factor. It is an eye-opening experience for someone with only Cessna or Katana flight time to do nothing more than make a turn in an Aeronca Chief (the king of adverse yaw), or perform a full-power climb-out in a Pitts and try to keep the ball centered. Basic skills are required across the board regardless of airplane type, but the newer and more "normal" the aircraft, the less that is so. And it shows.

O, WHAT IS MISSING?

xcuse me if I indulge in a purely personal observation, but in looking back over undreds, maybe thousands, of past students, almost all of whom were certifi-ated pilots, I can easily see a distinct commonality of those skill nuances that ney're missing. For some pilots, all of the areas listed below are weak, while nost pilots are weak in at least a few of them. It is true that only a few of these kill lapses are truly troublesome in flying general aviation aircraft, but in some port aircraft, they can cause serious heartburn.

Don't Truly Understand What the Rudder Is for. This is a super-common problem evidenced by pilots holding rudder or aileron while established in a turn or while climbing/gliding with the ball well off-center, thereby compromising efficiency and directional control.

Looking at the Nose Without Actually Seeing It. This is another way of saying their attitude control is approximate, rather than precise, because they don't see the small changes in the nose's position relative to the horizon so speed control becomes a continuously moving game of tag.

General Lack of Precision. For many pilots, everything that is quantifiable, from pattern altitude to approach speed, is approximate with no effort at holding exact numbers. This is a mindset, a general outlook, and not a skill. It affects every aspect of flying.

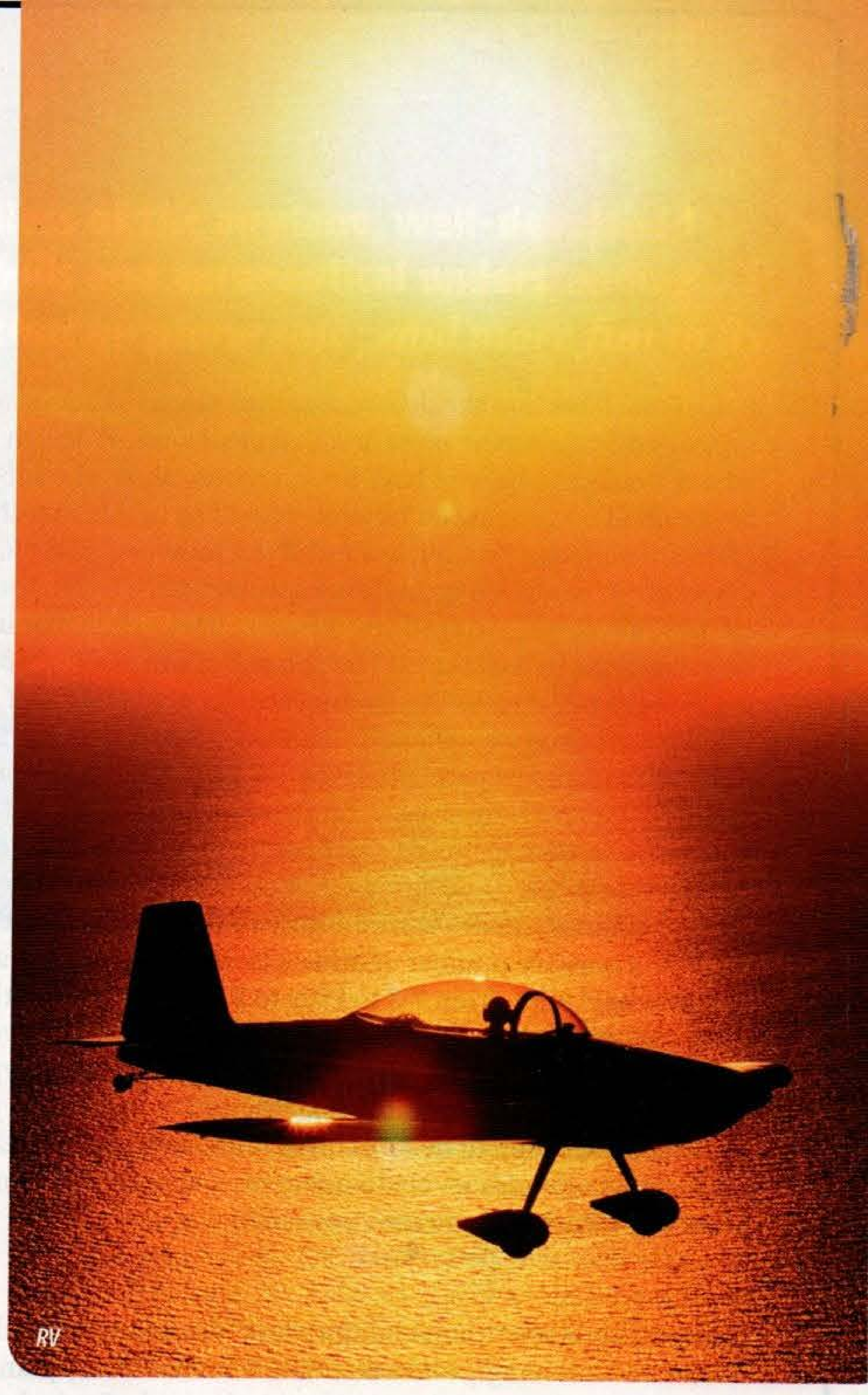
A General Lack of Aerodynamic Understanding. Such things as the buildup of drag with increased lift of any kind for any reason is not part of some pilot's thought patterns. There is also often a lack of understanding of the speed/g relationships that can breed unsafe situations at either the high, or low, speed ranges. So many aerodynamic basics aren't truly understood.

A Lack of "Feel" for the Airplane. Too often an airplane is viewed as a mechanical device, rather than being an art form that uses nothing more than invisible air to add a third dimension to our lives. If an airplane is seen and treated only as a machine, the pilot will never experience the wonderful feeling of being one with flight. They'll simply be a lever puller. A button pusher.

Limited Planning Ahead. The old platitude that says "Never let your airplane go anywhere your brain didn't arrive at first" is at the core of aviation safety. To get where you're going, you need to visualize where that is and what it takes to get there. It makes no difference whether it is over the horizon or on the other end of final approach.

Total Dependence on the Engine for Approach. You can always count on your dog, but the same can't be said of your airplane's engine. Yet, pilots will habitually set up a long, power-on approach knowing that if the engine fails, they are in deep guano. Pilots who don't do enough power-off landings (assuming they can be done in their airplane) to have developed the judgement this kind of landing engenders will be nothing more than passengers when the engine actually quits. And they do quit!

No Overall Sense of Awareness. There is an entire world outside of the cockpit. Yet, some pilots act as if their world is defined by their instrument panel. A continual scan of the world outside, from behind one wingtip to behind the other catching the panel on the way and noting as many details as practical, makes pilots aware of their place and progress.



RV

'NORMAL' VS. SPORT AVIATION

Exactly what differentiates "normal" general aviation airplanes from sport-oriented types, and why do I say the basics are more important in the sport arena? That's difficult to answer concisely because the world of the sport airplane is not only huge but different airplanes in different parts of that world will have differing levels of "differentness." In addition, those differences may affect different parts of the pilot's skill package at differing times. Is that different enough for you? So, we'll divide and conquer by wading through the various EAA classi-fications (homebuilt, vintage, etc.), pointing out the differences to be expected and the types of training that may be needed.

Basic skills are required across the board regardless of airplane type, but the newer and more "normal" the aircraft, the less that is so. *And it shows.*

FIRST: ABOUT THOSE PESKY TAILWHEELS

Before we delve into the different categories and aircraft types, let's spend a few minutes discussing the most dreaded of all aircraft design features: the tailwheel. Books can be, and have been, written about the subject, but they can all be summed up in a few quick sentences. The first is that there is a huge amount of misinformation floating around about tailwheels. In fact, no one viewed tailwheel airplanes as being anything special until early in the 1950s because almost *all* prior airplanes had the little wheel in back. Then manufacturers saw the nose wheel as a way to sell the "If you can drive, you can fly" concept. It is worth noting that the majority of the landing accidents in tailwheel aircraft can be traced back to a crooked or drifting touchdown, which sets a series of events in action that are then poorly handled. If the CG is on the line of travel and there is no crosswind, there is no reason for the taildragger to turn. This, however, comes back to basic airmanship. It's difficult to make a square, no-drift touchdown if the pilot lacks the coordination to fly a clean approach.

Yes, taildraggers do require a little more training but it's well worth the effort because a massive number of otherwise unavailable aircraft become available to the tailwheel pilot, from J-3 to Pitts to P-51. Fortunately, there are a number of flight schools that specialize in tailwheel training. However, make sure you go to one that will give you a well-rounded experience on all types of runways in all kinds of conditions. The experience should be more than just what is needed to get you safe enough to fly on calm or wind-on-the-nose days. A few extra hours in challenging winds on challenging runways are well worth the time and money. It's the best insurance you can buy.

HOMEBUILTS

As soon as you say "homebuilt airplane" some people quake in their boots, but others nod knowingly and ask, "Which homebuilt airplane?" The latter are those who understand that the world of homebuilt airplanes is at least as wide and varied as the general aviation community itself. Maybe more so. They range from super slow (Pietenpols) to super fast (Glasair III). The big difference between homebuilts and others is that there is no guarantee how any one of them will compare to civilian airplanes because they weren't designed to the same specification template, FAR Part 23.

Something that can be said about many of the newer generation homebuilts (RVs, GlaStars, Lancairs, Bearhawks, Zeniths, etc.) is that their designers, being professionals, do pay homage to the FAR standards in making their designs suitable for public consumption. However, most include a strong flavoring that adds just a little "bite" (read that as "fun") to the recipe. Few homebuilts can be considered our granddad's Buick Roadmaster, which can easily be said of many general aviation airplanes. Many homebuilts can be seen as Corvettes (or Ferraris), and it's this sports car attitude that can come as a surprise to some folks.

Any RV, for instance, is a superb handling airplane, but its quicker (delightfully so!) control response and much smaller size will initially challenge a Piper or Cessna pilot. It'll take only a few training flights with an experienced instructor for any strangeness to disappear. However, without that training the possibility of over-controlling at a critical juncture exists. And there's no excuse not to get that kind of training because the new homebuilt rules allow giving training in non-certified aircraft. Plus, almost all major kit manufacturers can hook a builder up with an instructor or two who specialize in their airplane. The best training of this type, however, doesn't focus only on the way to fly that particular airplane. Hopefully, the check pilots make the flights a form of flight review in which the pilot's basic skills are sharpened and then applied to the airplane in question.

'EQUIVALENT TRAINERS'

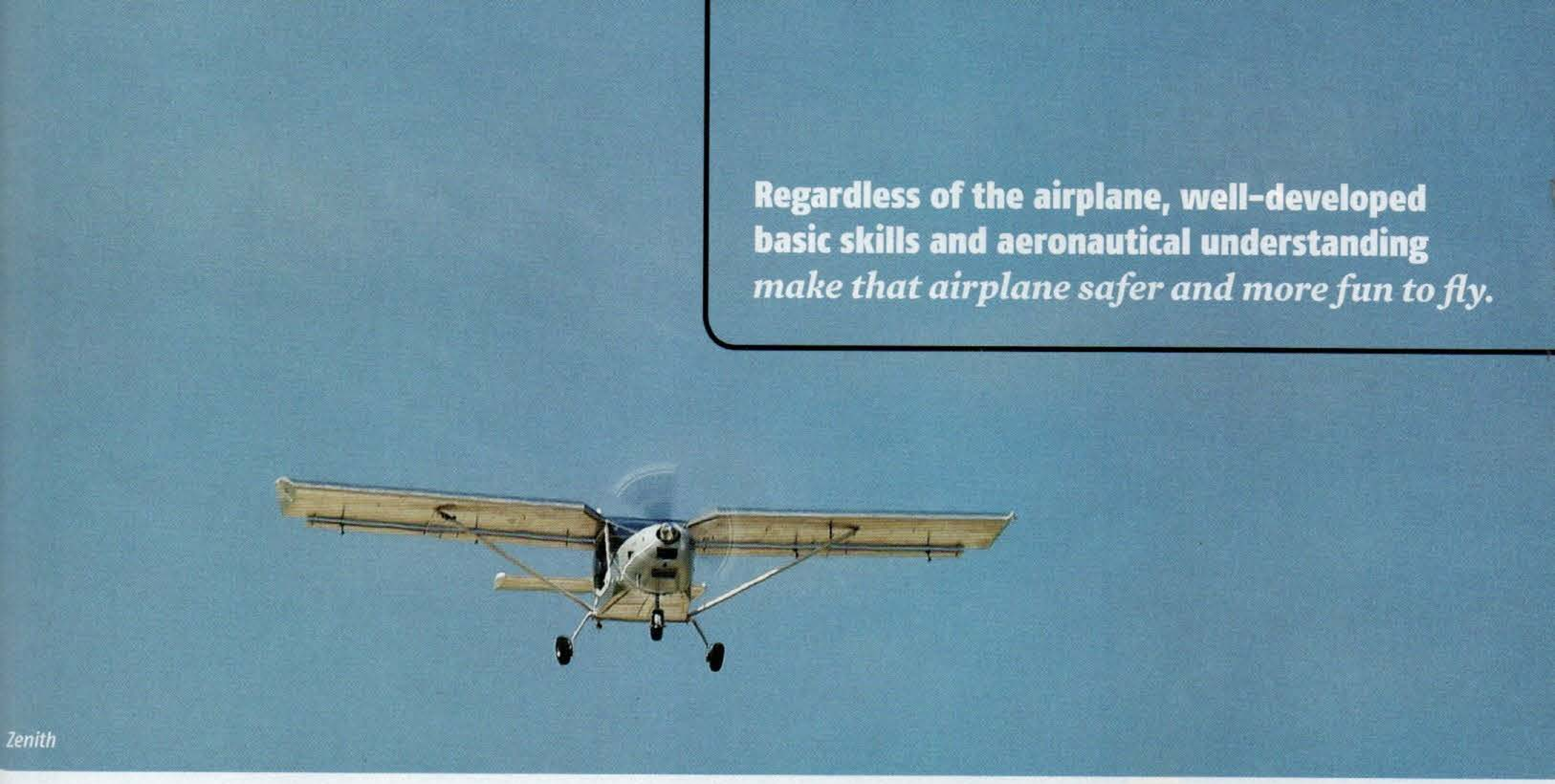
For the less numerous homebuilt designs for which there is no factory training support, there are civilian aircraft that can give a similar experience, and a good instructor can translate what the student is seeing in the trainer to what they can expect in their own airplane.

The old Grumman AA-1 Yankee series of aircraft handle very much like RVs, Thorps, and most of the other quicker monoplanes. They are responsive and nearly duplicate the steeper-than-average power-off glide slope of the homebuilts. Unfortunately, it's hard to find a training school actually using them.

At the opposite end of the performance curve are the low and slow designs like the Pietenpol/Baby Ace, etc. The good news here is that Cubs, Champs, and even Citabrias, which are operated by any number of flight schools nationwide, will give the new slow-motion homebuilt pilot a good basis to build on.

For fast-moving taildraggers, the two-place Pitts Specials are readily available just about everywhere in the country for meeting that oft-feared moment when they have to be landed. This is another of those old wives' tales. Airplanes like Midget Mustangs, Pitts, Skybolts, Stardusters, etc. are not the terrorizing experience the homebuilt pundits say they are. They do, however, absolutely demand training, and the two-place Pitts, combined with the right instructor, is the perfect trainer. It gives ground-handling experience as well as acclimating a pilot to a lack of visibility over the nose and, when compared to most homebuilts, produces a pilot that is over-trained. Come close to being able to land a Pitts and the other types are easy. At the same time, the basics of aviating will become abundantly clear to the newbie because the S-2 Pitts is anything but subtle in pointing out a pilot's shortcomings.

Bearhawk



Regardless of the airplane, well-developed basic skills and aeronautical understanding *make that airplane safer and more fun to fly.*

Zenith

INTAGE

'hen talking about vintage aircraft (antique, classics, and contemporary), we're ctually talking about everything from the dawn of aeronautical time to what mounts to yesterday (1970). During that 60 years, certification standards hanged dramatically, and more importantly, the market's idea of what is accept- ble changed. For that reason, while there is little difference between a ontemporary aircraft of 1970 (think C-172) and today's aircraft, comparing a 20s antique aircraft to a 1960s contemporary is a study in aeronautical prog- ss. While the basic skills apply across the entire spectrum, the further back to antiquity we go, the more noticeable the absence of basic skills will become d the more likely a detailed checkout will be required.

NTIQUE – DECEMBER 17, 1903, THROUGH AUGUST 31, 1945

nere are actually at least four generations of "antique" aircraft, and the handling each is different. The aircraft of the "teens," like a Jenny, have handling that can ly be described as leisurely and rudimentary. During that time, the concepts we l take for granted, like ailerons, powerplants, and overall control balance, were nder development, and there is a gross difference between a 1910 Curtiss, a 1917 urtiss Jenny, and a 1920 anything. Little about their stability and control require- ents will be recognized by a modern-trained pilot. 1920s aircraft, on the other nd, would be more familiar, although still very demanding of stick and rudder ills. 1930s aircraft show the thought and development that makes them still able in today's world, and they include newborns like the Luscombe, Cub, ylorcraft, and Ercoupe that survived World War II to become postwar classics.

LASSIC – SEPTEMBER 1, 1945, THROUGH DECEMBER 31, 1955

ne decade right after WWII saw the continuation of some prewar designs, but e 1946-48 over-production of new light aircraft designs (C-120/140, PA-16/17, vift, Champ, etc., most of which took years to sell) form the basis for much of on-homebuilt sport aviation today. The classics, through the 1950s Tri-Pacers d C-170s, outnumber just about any other segment of the sport aircraft popu- tion, although RVs may now outnumber them.

The new postwar designs all feature improvements in handling and design finements, but they still demand that basic stick and rudder flight skills be plied. Keeping the ball centered in the interest of improved controllability and safety asks that the pilot knows when, and how, to use the rudder. Then there is that tailwheel thing, which calls upon those same feet to handle two-directional control in variable conditions. The tailwheel classics (120/140, PA-16/17, C-170, etc.) are far from being difficult to land but encourage a pilot to pay attention in the touchdown phase of the landing. The basics apply. The nosewheel classics (Ercoupe, Tri Pacer, etc.) will let the pilot survive less-than-wonderful touchdowns but would still reward the pilot for good basic skills in the air.

CONTEMPORARY – JANUARY 1, 1956, THROUGH DECEMBER 31, 1970

The contemporaries bridge the gap between old and new. This group includes C-172s, Cherokees, Bonanzas, and so many others that are still stage center on the general aviation scene. In only a few instances do they present challenges that modern pilots can't handle with their present skills with a detailed checkout. Also, most of the marques are represented by type clubs in through which specialized instructors are readily available.

THE BOTTOM LINE IS 'BASICS'

Regardless of the airplane, well-developed basic skills and aeronautical understanding make that airplane safer and more fun to fly. The next time you're in the air, be your own toughest critic and see exactly what you're doing right and what you're doing wrong. Just that little bit of introspection will make you a better, safer pilot. And it's free! *EAA*

Budd Davisson is an aeronautical engineer, has flown more than 300 different types, and has published four books and more than 4,000 articles. He is editor-in-chief of *Flight Journal* magazine and a flight instructor primarily in Pitts/tailwheel aircraft. Visit him on *www.AirBum.com*.

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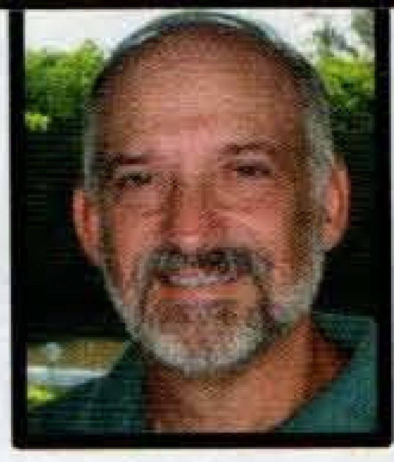


What's So Dangerous About That?

The unknown hazards we carry onboard

BY ROBERT N. ROSSIER

MOST PEOPLE GIVE PRECIOUS little thought to the potential hazards of common products we find and use in our homes, garages, and basements. But as pilots we need to give these things some thought, especially when it comes to what we carry onboard our aircraft. What might be a mere mishap in an earthbound setting could easily spell disaster in the air. And sometimes it's the things we least suspect that pose the greatest danger.

HOUSEHOLD PRODUCTS

Most pilots have an acute awareness of hazardous materials that pose a threat when carried aboard aircraft. Among the many substances we concern ourselves with are products such as motor oil, bleach, brake fluid, propane tanks, oil-based paints, spray paint, charcoal lighter fluid, paint thinner, alcohol, butane lighters, cleaning supplies, and batteries. While the average person off the street might wonder what's so dangerous about these items, the answer is clear in the numerous reports that have been collected over the years regarding issues that have occurred in flight. Noxious fumes from solvents, lubricants, and fuels are one problem; chemical burns are yet another. Just imagine what we mig be splashed in should we make an otherw survivable off-field landing. And then ther the long-term issue of what the corrosive effects to the airframe, various mechanism or wiring might be if a spill is not properly cleaned up.

MEDICAL EQUIPMENT

Whether we fly commercially or bring fa ily and friends on trips with us, one haza we might not recognize comes in the for of certain medical equipment. Certainly, we must take precautions whenever oxy gen bottles are carried aboard, but other items can be of concern as well. These days, portable oxygen concentrators are common for those suffering from variou breathing conditions, and the safety of these devices for use on aircraft has been called into question. For commercial operations, FAR 135.91 — *Oxygen and Portable Oxygen Concentrators for Medical Use by Passengers* — lays out a strict set of criteria and operational guidelines that those of us flying under Part 91 should at least consider for our safety as well.

BATTERIES AND CONSUMER ELECTRONICS

One recurrent theme in air safety over the years has revolved around batteries. Generally, the types of batteries we are concerned with are of the automotive lead-acid variety, with their highly corrosive liquid electrolytes that can cause severe burns when spilled. Those are bad news, but they aren't the only batteries we need to worry about. Even some of the most innocuous batteries can present a hazard. Years ago I read about an incident that occurred when a person loading a bag into an aircraft noticed it was beginning to smolder. On closer inspection it was found that a 9-volt transistor battery had been packed in the bag, and the two terminals had shorted out across the metal zipper. The shorted battery quickly heated up, and the surrounding materials were approaching ignition temperature. Had the developing issue not been noticed on the ground, it might have become a serious problem in the air.

What might be a mere mishap in an earthbound setting could easily spell disaster in the air. And sometimes it's the things we least suspect that pose the greatest danger.

Similar occurrences have been documented with other high-energy battery-powered items such as the high-powered lights used by scuba divers. As it turns out, the heat generated when these devices are left on can be enough to ignite a blaze. More modern dive lights typically use LED (light-emitting diode) technology that generates a fraction of the heat of older incandescent devices, but the power source is still there, and still potent.

These days, due to their high-energy density, lithium-ion batteries are favored for everything from wheelchairs and toys to electronic entertainment and cellphones. But they don't enjoy a perfect safety record.

Back in April, a woman from Wisconsin claimed that her Fitbit Flex 2 fitness tracker exploded on her wrist, leaving bits of melted plastic for doctors to pick out of the second-degree burns the incident caused. Fortunately, she wasn't on an airplane. But consider the Australian woman on a commercial flight from Beijing to Melbourne who got a shocking surprise when the headphones she was wearing suddenly and inexplicably began to sizzle and burn. She tore them off and tried desperately to stomp out the blaze. A fast-acting flight attendant found a bucket of water in which to douse the defective headgear. Imagine the chaos that could cause in a four-seat aircraft. And while these incidents appear to be isolated, there have been numerous instances of so-called hoverboards that have spontaneously combusted. Most carriers no longer allow them to be shipped by air, and that should be a warning to us all. And then there are the Samsung Galaxy Note 7 cellphones that have been banned from commercial flights due to their fiery personalities.

The common thread running through all these incidents seems to be the lithium-ion batteries that power the devices. The organic (meaning carbon-based) electrolyte inside lithium-ion batteries is typically quite volatile and flammable. An internal electrical short, whether it's caused by external damage or a manufacturing defect, can result in rapid overheating, a pressure build-up as gases are produced inside the battery, and eventual explosion and/or ignition of the fluid vapors. With millions of these devices being produced, even an extremely low rate of manufacturing defects can spell occasional disaster.

IMAGINING THE WORST

If our concern is over the flammability of materials in the cockpit, we might think the regulations have our back. The FAA is pretty cautious when it comes to the materials that can be used in the cabin of an aircraft and requires fabrics to meet "flame-resistant" criteria. So maybe we take solace in the FARs and feel like we have some measure of protection. But how about the items we bring aboard? How about the cellphone that was stashed in a duffel bag and thrown in the baggage area behind the passenger seats?

The issue surrounding how we might extinguish a fire in the cockpit was driven home to me one day when a fellow pilot accidentally made a partial discharge of a chemical fire extinguisher in our yearly ground school classroom. This was a pretty big room — huge when compared to an aircraft cockpit — yet the products of that extinguisher made it impossible to breathe. Eyes stinging and choking breath, we had to evacuate the room. Now imagine trying to extinguish a burning duffle bag in the back of the airplane. This probably isn't going to end well. In fact, my attitude is that chemical extinguishers should be considered only for dealing with fires while on the ground. In the air, the only viable option might be a halon extinguisher. Or a parachute.

OTHER ELECTRONICS ISSUES

With the multitude of electronics in our daily lives, we might ponder their safe use in an aircraft. One area of concern is the potential for portable electronic devices (PEDs) to interfere with navigation and communication systems in the cockpit. Operations under FAR Part 135 and 121 prohibit the use of PEDs with certain exceptions such as pacemakers and hearing aids, and those of us flying under Part 91 might want to consider the potential risk to our operating safety as well. The regulations do permit the use of specified PEDs and other devices that the operator of the aircraft has determined will not interfere with the safe operation of that aircraft — at least from the navigation and communication perspective. How we power those devices and the risks they pose is another matter entirely — and perhaps one worthy of consideration.

The dangers associated with hazardous materials may not be a problem on every flight, but they do come up from time to time. If we pay close attention to what we bring on board our aircraft, we can likely avoid the worst case scenario. *EAA*

Robert N. Rossier, EAA 472091, has been flying for more than 30 years and has worked as a flight instructor, commercial pilot, chief pilot, and FAA flight check airman.

MEDICAL REFORM

IS REAL

BASICMED RULE PUBLISHED IN JANUARY, TO TAKE EFFECT IN MAY

YEARS OF EFFORT BY EAA AND AOPA

culminated in January when the FAA published its updated regulations, known as BasicMed, which will implement the aeromedical reform law passed last July. The regulations will take effect on May 1, 2017. Because it is final, the rule was not released for a typical public comment period. The FAA also published an advisory circular, AC 68-1, describing the rule's implementation.

The details of the rule are laid out in the sidebars, but what it boils down to is this: As long as you've had an FAA medical within the last 10 years, you can fly recreationally using a valid driver's license in lieu of a medical certificate. To stay legal, you'll need to take a free online medical education course every two years, and see any state-licensed doctor every four years. That doctor will have to run through and sign a checklist that you'll keep in your logbook until your next visit is due.

"This is the moment we've been waiting for, as the provisions of aeromedical reform become something that pilots can now use," said Jack J. Pelton, EAA CEO and chairman. "EAA and AOPA worked to make this a reality through legislation in July, and since then the most common question from our members has been, 'When will the rule come out?' We now have the text and will work to educate members, pilots, and physicians about the specifics in the regulations."

During EAA AirVenture Oshkosh 2016, Sen. James Inhofe (R-Oklahoma), the author of the Pilot's Bill of Rights 2 legislation that evolved into the aeromedical reform law we have today, praised EAA's advocacy efforts. "I am grateful for the strong and consistent voice of EAA members who shared why third-class medical reform is necessary," he said. "I want to thank Jack Pelton, CEO and chairman of the Experimental Aircraft Association, and his team for their leadership and support from the beginning and all their work to educate my colleagues in Congress on issues that affect pilots."

WHAT AND WHERE CAN I FLY?

- Aircraft not more than 6,000 pounds max takeoff weight.
- No more than five passengers.
- For recreation, not for compensation or hire, though flight instruction is allowed.
- Within the United States, at less than 250 knots and at or below 18,000 feet MSL, VFR or IFR, day or night.

WHAT DO I HAVE TO DO?

- Hold a valid U.S. driver's license.
- Carry your driver's license with you when you fly.
- Have a medical certificate issued by the FAA at any point after July 15, 2006.
- Answer questions on the Comprehensive Medical Examination Checklist (CMEC).
- See any state-licensed physician once every four years, and have him or her complete the CMEC.
- Complete a free online medical course every two years.

TIMELINE

MARCH 2012
EAA and AOPA petition the FAA to give pilots who fly recreationally the option of getting a third-class medical or, instead, participating in a recurrent online education program that will teach them how to self-assess their fitness to fly.

JUNE 2012
The FAA opens the petition for public comment for three months, through mid-September 2012.

DECEMBER 2013
Rep. Todd Rokita (R-Indiana) introduces the General Aviation Pilot Protection Act (GAPPA), which includes third-class medical certification reform language. A companion measure was subsequently introduced in the Senate.

AUGUST 2014
FAA Administrator Michael Huerta announces at EAA AirVenture Oshkosh that more than 16,000 comments were received regarding the EAA/AOPA petition and a rule would be released for public comment by fall 2014.

FEBRUARY 2015
Sen. Jim Inhofe (R-Oklahoma) in
duces the Pilot's Bill of Rights 2
U.S. Senate, which includes thi
medical reform language simila
previous GAPPA bill and more e
sive than that requested in the 2
EAA/AOPA petition for exempti

JUNE 2015
Sen. Joe Manchin (D-West Virginia) and Sen. John Boozman (R-Arkansas) offer a third-class medical certification reform amendment to a Senate transportation bill.

JULY 2015
At AirVenture, Huerta announces that the EAA/AOPA petition is still awaiting final action from the Department of Transportation to advance to the rulemaking process. EAA also fires back at the Air Line Pilots Association (ALPA) regarding a letter opposing aeromedical reform, which ALPA sent to all senators.

SEPTEMBER 2015
The Pilot's Bill of Rights 2 gains a Senate supermajority, surpassing 60 Senate co-sponsors.

DECEMBER 2015
The U.S. Senate passes the Pilot's Bill of Rights 2 on a bipartisan vote after extensive negotiation with Commerce, Science, and Transportation Committee members and Senate leaders over third-class medical certification reform. The bill is sent to the House.

FEBRUARY 2016
House Transportation and Infrastructure Committee Chairman Bill Shuster (R-Pennsylvania) introduces the House version of an FAA reauthorization bill that includes medical reform language similar to that contained in GAPPA. The bill passes out of committee but never makes it to a floor vote.

APRIL 2016
Inhofe includes Pilot's Bill of Rights 2 provisions in the Senate's FAA reauthorization bill, which passes the Senate 95-3.

JULY 2016
With FAA authorization set to ex
the House and Senate agree to a
14-month authorization extensio
with some broadly agreed-to poli
implementation, including medic
reforms contained within the Pilo
Bill of Rights 2.

JULY 11, 2016
The House passes the FAA extension and medical reform.

JULY 13, 2016
The Senate passes the FAA extension and medical reform.

JULY 15, 2016
President Obama signs the FAA Extension, Safety, and Security Act of 2016, making medical reform law.

JANUARY 10, 2017
The FAA publishes its final rule, announcing changes to Medical Certification of Small Aircraft Pilots, known as BasicMed.

MAY 1, 2017
BasicMed to go into effect.

EAA GETS IT DONE

SIMPLICITY

Thanks to third-class medical reform, many pilots who have held a valid medical certificate in the past 10 years will never have to see an AME or hassle with FAA paperwork again.

SAVINGS

By removing the need for constant medical and special issuance renewals, third-class medical reform saves pilots significant time and expense.

SAFETY

Third-class medical reform will allow pilots to treat underlying medical conditions with their personal physicians and continue to fly the type of aircraft in which they are most experienced.

ADVOCACY

EAA could not have pushed medical reform through Congress without your continued support. Thousands of EAA man hours and ongoing relationship building went into getting this done. Your membership, and our community, makes a difference.

THE COMPREHENSIVE MEDICAL EXAMINATION CHECKLIST (CMEC)

The CMEC will have two parts: questions to be answered by the pilot in advance of the exam and a list of items for your doctor, any state-licensed physician, to include in the examination. The questions will include basic identifying information like name and address, date of birth, a short medical history and list of current medications, and information about whether you've ever had an FAA medical certificate denied, suspended, or revoked.

The list of items for the doctor to cover in the examination are now part of the third-class medical exam and are typical to those found in any routine physical. These items include:

- Head, face, neck, scalp
- Nose, sinuses, mouth, throat
- Ears and eardrums
- Eyes
- Lungs and chest
- Heart
- Vascular system
- Abdomen and viscera
- Anus
- Skin
- Genitourinary system
- Upper and lower extremities
- Spine, other musculoskeletal
- Body marks, scars, tattoos
- Lymphatics
- Neurologic
- Psychiatric
- General systemic
- Hearing
- Vision
- Blood pressure and pulse

And anything else the physician in his or her medical judgment considers necessary. The doctor will have to indicate that he or she has made the necessary checks, and both the pilot and doctor will need to sign the form. Then you put the form in a safe place and get back to flying.

Additionally, many EAA members have reached out to share their enthusiasm. Steve Engelking, EAA 244968, of Longmont, Colorado, wrote, "Thank you so much to Jim Inhofe for getting this through Congress and passed into law. Three cheers for this heroic effort!"

Stewart Barnes, EAA 761379, of Anchorage, Alaska, is also celebrating BasicMed, calling it "Simpler, cheaper, more efficient." He went on to say that, "The FAA third-class and [special issuance] never did anything to make me safer, healthier, or a better pilot. It had zero value yet it cost me money and my doctor's time to jump through the hoops. Not anymore!"

January's publication finalized the highly anticipated measure that was signed into law in July of 2016 as part of an FAA funding bill. That was the ultimate success of a long effort by EAA and AOPA to bring significant aeromedical reform to pilots flying recreationally and eliminate the time and expense burdens on those holding third-class medical certificates.

The law guaranteed that pilots who held a valid third-class medical certificate during the period after July 15, 2006, will be eligible to fly under the new rules. New pilots and pilots whose most recent medical expired prior to July 15, 2006, will be required to get a one-time third-class exam from an FAA-designated aviation medical examiner.

The FAA was required to implement the law within 180 days of its signing, a deadline that it met with one day to spare. Despite the release of the regulations as a final rule, EAA is reviewing the language carefully to ensure it fully reflects the language and intent of the law.

Aeromedical reform has been a top advocacy priority of EAA members for a number of years, and led to EAA and AOPA initially petitioning the FAA for changes in the third-class medical certification process. The goal was to reduce the unnecessary regulatory and expense barriers that pushed aviators out of recreational flying and kept prospective pilots from entering the aviation community.

EAA has updated its online FAQs and will continue to update them to provide the latest information on aeromedical reform. EAA is also working with its aeromedical and legal advisory councils to provide resources that will help members and their personal doctors understand the provisions of the new regulations. EAA

Formation Flight Safety

Part 2

BY CHARLIE PRECOURT, SAFETY COMMITTEE CHAIRMAN, EAA BOARD OF DIRECTORS

WE KICKED OFF OUR Formation Flight Safety series last month with a focus on the challenges of the lead position, as well as situational awareness and key collision risk factors. Flying well as a formation leader can be more challenging than flying the wing, and it's important to emphasize that you shouldn't try to tackle the lead position until you have mastered flying on the wing. Even if it's easier than leading, flying wing is still a new skill.

I can still remember my first formation training flight, back in the fall of 1977 (how time flies!). I remember it because I was surprised by my instructor's demonstration of the wing position. We briefed a basic two-ship formation skills mission, with me flying wing. We performed an interval takeoff with about five seconds of spacing behind the lead aircraft, and my instructor demonstrated the takeoff and join-up straight ahead. But it was his technique of flying in close formation ("fingertip" in Air Force lingo) that really surprised me. He was jockeying the throttle back and forth constantly, plus and minus an inch at a pretty high frequency (maybe two cycles per second!), and the same was true with the control stick. He was "stirring" it constantly. Since we were in the old T-37, side-by-side, jet trainer, I had a perfect view of his inputs and resulting position. But what I couldn't figure out was how his inputs were affecting our position on the leader.

I later discovered that I couldn't figure it out because those inputs were not having much if *any* effect on his position! "Inside" some of those stirring motions were a few inputs that mattered; I just couldn't see which ones they were! After all, the leader was not moving his throttle, and was only moving the stick when he needed to initiate a roll or pitch maneuver. So we probably didn't need to be moving the controls so vigorously! Bottom line, if you're flying the wing well, you'll be making smooth deliberate inputs to maintain position. My instructor was what is known as a "high gain" pilot, one who is constantly moving things, even if the movements don't really matter. His input in one direction was immediately canceled by an input in the other direction—the net result was zero change.

Having said that, flying the wing position does indeed involve making constant corrections back to the "perfect" position relative to lead. But the corrections you make should be small and timely. This requires an ability to anticipate. If you wait too long to make a correction, you will end up farther out of position, necessitating a large correction, which takes longer to have effect, which means another correction will follow, and before long you're oscillating in large variations around the desired position. To learn to anticipate corrections, and get ahead of them, you need good reference points on the lead aircraft that allow you to "triangulate" your correct position, both laterally and fore-aft. The three legs of the triangle are:

- Your view up the "wing line" toward your leader's head.
- The leader's fuselage line from his cockpit back toward his tail.
- Your view directly abeam, at his tail.

On the ground prior to flight (as we discussed last month) set the two aircraft on the ramp in a desired close formation position. From your wing aircraft cockpit position, look up the wing line of the lead aircraft and find something on the fuselage or cockpit directly behind an item on the wing. For example, does the wingtip light superimpose the canopy leading edge? If so, remember that; it creates your "wing-line" reference. Then look abeam at the tail of the lead aircraft, where are you relative to the rudder hinge, for example. These are your "null" (good) references. All corrections in flight with the stick and throttle are meant to return you to this position. We're looking for our two aircraft to have wingtips about 3 feet apart laterally, and a wingman "stagger" aft of the lead about 30-45 degrees; in other words our cockpit is that angular amount from a perfect side-by-side line.

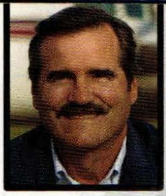
So on my first formation flight, the instructor gave me the aircraft after his "demonstration," and I had no idea how to make the required corrections. I ended up in that proverbial "yo-yo" adding too much power and overshooting, then pulling off too much and getting behind, banking into lead and getting too close, then banking away too much and getting too far away. Eventually, though, I discovered a very interesting relationship in the "triangulation" necessary for the correct position, one that you can explore with a simple exercise. The objective of the exercise is for you to learn to recognize when a power change is required to correct back to position versus a bank angle change. Believe it or not these two inputs, power and bank, are very closely coupled in achieving that perfect, stable wing position.

Start out with your instructor stabilizing your aircraft in the proper wing position in wing-level flight on the leader. Then make a very slight bank angle input away from the leader (2-3 degrees of heading change). What you will notice first is an apparent lag behind the leader. If you are not closely monitoring your "triangulation reference," it will appear that you are drifting behind. Your instinct will be to add power. In fact, what has happened is you have increased your lateral spacing on lead, because of the heading change. Since you are on a 30-45 degree staggered wing-line reference, any move outward along this line also appears to be a move aft. Your intuition is to add power. But all you really need to do is bank back into the leader, and you will come right back up the wing line to the original correct position. Perform this exercise until you instinctively know that you are wide and need to bank toward lead, or that you are truly aft and need to add power. Until you master this "perception" issue, you inevitably find yourself in the power yo-yo moving back and forth about the desired position in large oscillations.

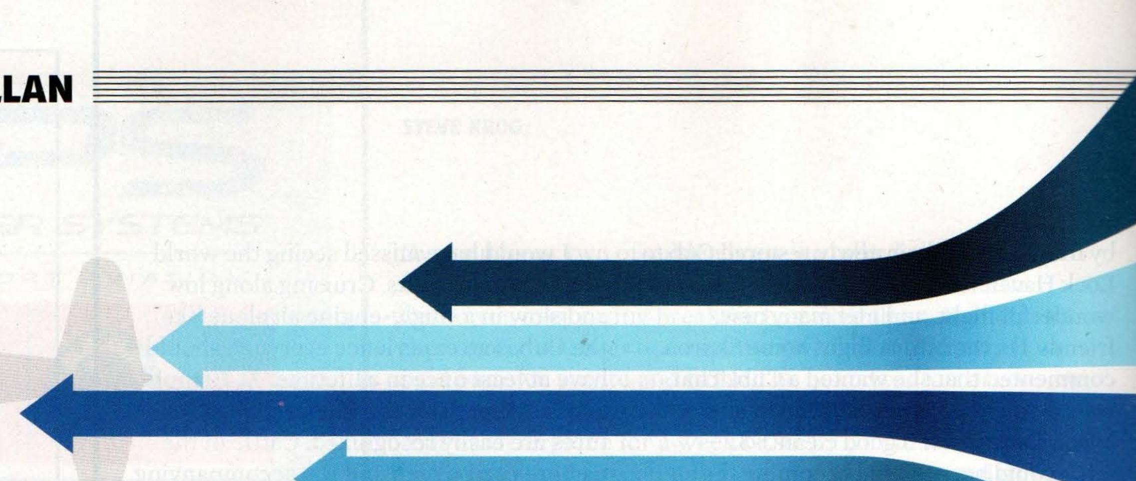
Another common error for pilots learning to fly formation in the close position is their over-fixation on the triangulation references. If you look at only those two reference lines we defined, you miss the big picture. Once you get comfortable, those references will become second nature, and you'll be looking at the whole lead aircraft and seeing movements in relative position at the inch level instead of the foot level. In other words, see the big picture of where you are relative to lead, and make the correct correction (power or bank) immediately, when it's a matter of a few inches instead of a few feet.

Once you have mastered this concept, then other positions take on the same relative demand. If you want to do a cross-under to move from the right side of leader to the left, reduce power slightly, step back to get to a place where your nose clears leader's tail, then add power to stabilize. Then add a small bank change to the left to move laterally across to the left side. Then once on the left side, add power to move forward to the wingtip position. This maneuver uses all the principles I discussed above.

Spend some time on the basics above and you'll get really comfortable with relative positioning on your leader. Once your corrections are instinctive, you're ready to move to more advanced maneuvers like rejoins and trail formations. A topic for next month! Fly safely out there. EAA



J. MAC MCCLELLAN
COMMENTARY / LEFT SEAT



Traffic Pattern Tactics

What's allowed near a runway, and what works best

BY J. MAC MCCLELLAN

SOME SAFETY EXPERTS have recently recommended that pilots consider flying a steady turn from downwind to final in the traffic pattern. The theory is that a constant turn is easier to fly than a squared-off downwind to base followed by another squared base to final turn.

That's not a new idea. In fact, it's old. But for many pilots the traffic pattern is a rectangle around the runway, and any deviation from that three- or four-leg pattern is probably illegal, or at least unsafe. That's not true.

Jeff Skiles took on the traffic pattern in his Contrails column in the March issue. Clearly Jeff is in the big majority that backs the rectangular pattern most of us think of as "standard." But I think the issue is not as standardized as one may think.

First, let's consider the rules that require us to fly a standard, or any, traffic pattern: There aren't any.

Under FAR 91, the rules that govern overall flight operations, there is no definition of what a traffic pattern is, or any requirement to fly a traffic pattern when approaching an airport to land.

The only FAR that comes close to requiring a traffic pattern is 91.126 that says pilots approaching to land at an airport without an operating control tower must make all turns in the vicinity of the airport to the left. If the markings on the airport — segmented circle and such — indicate a right traffic pattern, all turns must be made to the right.

The rule doesn't say we must fly a downwind, or base, or any other component of a traffic pattern. The rule doesn't even say we have to turn at all when approaching to land so straight-in approaches from any distance are legal. Even more confusing, the rule uses the word "vicinity" of the airport without defining what that means. Is "vicinity" the 4-nm radius around an airport under which we must establish radio contact if there is an operating control tower? I don't think so. Is "vicinity" a mile, or half mile, or maybe a few hundred yards? It depends, I guess.

The FAR Part 91 rules do, however, give right of way to an airplane on final approach to land over other airplanes in the area and airplanes waiting to take off. If two airplanes are approaching at the same time, the lower altitude airplane has right of way over the higher altitude airplane. That's pretty much it for regulatory traffic pattern flying.

What we think of as the standard traffic pattern is described in the *Aeronautical Information Manual (AIM)*. For pilots as old as me that's the book we used to call the *Airman's Information Manual*.

The *AIM* is not strictly a regulatory document, but it does describe what the FAA believes are best practices. You can't be busted for not following a recommendation in the *AIM*, but if you ignore its advice and come to grief, your defense will be more difficult, at least.

I'll be the first to say we need traffic patterns at both towered and nontowered airports. The most obvious reason for traffic patterns is to standardize traffic flow making it more likely we will see and avoid other traffic. The other reason is the traffic pattern helps us orient ourselves and prepare for a safe landing.

In the *AIM* is the description and diagrams of the standard pattern with entry, downwind, base, final, upwind, crosswind, and departure legs. It's all very tidy on the page with nice square turns from one leg to another. Altitudes for the traffic pattern are proscribed by the airport operator, but the distance of the downwind from the runway, for example, is not.

One thing that always makes me chuckle when looking at the standard traffic pattern is the recommended entry leg onto the downwind. So, according to the chart in the *AIM*, how do you join the left downwind leg when approaching the airport? Turn right. So, to fly the recommended pattern we break the only pattern rule, which is to make all turns to the left. Just one more example of why using words like all, never, always, and other exclusives is so problematic.

All of that aside, I'll be the first to say we need traffic patterns at both towered and nontowered airports. The most obvious reason for traffic patterns is to standardize traffic flow making it more likely we will see and avoid other traffic. The other reason is the traffic pattern helps us orient ourselves and prepare for a safe landing.

At towered airports we need a traffic pattern, and pilots need to know what it is, because that's how controllers issue instructions. When a controller tells you to "report the left downwind" for the active runway, you need to know what that means. No matter what the FARs say about the requirement for flying a traffic pattern, an instruction from a controller is a requirement unless some emergency situation demands that we deviate from that instruction.

TRAFFIC PATTERN AS KEY

The military emphasizes the standard traffic pattern less and "key" positions more. I think that makes sense.

In military flying parlance the "key" positions, such as high key or low key, help to standardize an approach and landing, particularly in high-performance airplanes.

The key position is a location over or near the airport at which the pilot knows he should be at a specific altitude and airspeed, and configuration in terms of flaps and landing gear.

By flying to the key position at the specified altitude and airspeed, a pilot can know with very good precision what power setting, flap setting, bank angle in the turn, and so on will put the airplane on final approach at the proper altitude, speed, and configuration.

It's the same for civilian pilots, especially pilots just learning to fly, or transitioning to a new type. If we just wandered onto final approach from some random distance from the airport, judging when to slow down, when to extend flaps, and what power setting to use would all be difficult, at least until you had hundreds or more likely thousands of hours of experience in that airplane.

But by entering a downwind leg our situation looks familiar. We quickly learn what power setting is going to yield the target airspeeds for base leg to arrive on the desired glide path and airspeed for final. Instructors or pilots checking you out in a new type know and can recommend the power setting and configurations that work from downwind, while that would be very hard to do if every approach was a random run to final.

The other common military flying technique I like and think works well is the overhead break, which calls for the pilot to fly directly over the runway and then "break" into a turn to downwind and continuing the turn onto final.

When approaching a nontowered airport — particularly one I'm not familiar with — I find that flying directly over the runway works great. Overhead you can look for markings and the windsock on the airport. You can see traffic in all directions. And other airplanes are most likely to be below you taking off or landing, and others on a downwind or upwind pattern leg are crossing in front of you. When you announce on UNICOM that you are overhead the runway, everybody on the frequency knows where to look.

DRAGGING IT IN

I learned to fly more than 45 years ago at a tiny airport east of Cleveland — Concord Airpark — where the single runway is barely more than 2,000 feet long and there are trees all around and a big hump in the middle of the strip. Because the runway was short and the trees were tall, the airplanes there were nearly all basic singles. A Bonanza was an exotic machine, and its pilot who took on the challenge was clearly an ace to be admired.

The mantra at Concord and thousands of other small airports around the country back then was to always be in a position to make the runway if the engine quit suddenly while flying the pattern. That meant that you stayed close on downwind, turned a short final, and usually had to employ some slipping on short final to get rid of the extra altitude you carried just in case.

For whatever reason, we don't seem to have the same fear of engines quitting that dominated years ago. And in my Cessna 140 I did have the engine quit a few times in the pattern during the winter. You couldn't get that light-wing-loaded Cessna down in the dense air of winter with power anything above idle. But at idle the carburetor and induction tubes hanging down in the cold below the barely warm Continental C85 engine would simply stop providing a useful fuel mixture, even with carb heat on, and the engine would quit.

I learned to blip the power every 15 or 20 seconds on those cold days to keep the engine turning. Better still I learned that duct tape over about half the cowling cooling air inlets, and two other openings just below the prop hub, kept the engine warm enough to run virtually every time.

Any pilot who strayed too far away from the runway, out of engine-out glide distance, was "dragging it in." In those days dragging it in was a mark of poor airmanship and much scorn from the local experts who gathered at the airport routinely to critique all approaches and landings.

Today we call dragging it in a stabilized approach. Traffic patterns at airports with even modest amounts of activity stretch out over miles making it unlikely any pilot who loses power suddenly while in the pattern can glide to the runway. But except for old-timers — who now have to be older than me to have earned the title — I don't hear a lot of concern about the size of a traffic pattern or even much worry about an engine quitting.

What's happened is that a stabilized approach in larger airplanes at a distance from the runway is essential for safety. A pilot rolling onto a quarter-mile final in a jet would be drummed out of the corps. So at airports with a mix of traffic the pattern must expand to accommodate heavier and faster airplanes that require a stabilized final approach at least for the last 1,000 feet or more of descent to landing.

So sometimes at some airports we will all be dragging it in, no matter what we fly. But when you have the airport to yourself, I still think staying close enough to make the runway if you suddenly lose power makes sense.

SQUARE TURN?

Back to the original question — would a curved more or less steady turn from downwind to final approach be safer? I believe the answer is yes. When you make square turns you have to level the wings, and that means you need to lower the nose or add power to maintain airspeed. When a pilot is distracted by traffic or wind or whatever the record shows we don't always do that, and a stall and spin is the too-often tragic result.

For all the reasons I discussed, and more, we don't always have control of how we fly the traffic pattern. Making a continuous turn to final in a low-wing airplane blocks your view of other traffic that may already be on final. That means there is no simple solution to the stall-spin loss of control in the pattern. All we can do is work on our basic airmanship, fly turning patterns when we can, and be ready for whatever surprises the traffic pattern may hold. *EAA*

J. Mac McClellan, EAA 747337, has been a pilot for more than 40 years, holds an ATP certificate, and owns a Beechcraft Baron.

The FBO Problem

It's high costs for everyone involved

BY J. MAC MCCLELLAN

IF YOU WANT TO raise the blood pressure of pilots, bring up fuel costs. If you want to put that same group into orbit, mention ramp and handling fees. There is no hotter topic among pilots. That is, unless you talk to a pilot who just landed at an airport with nobody around where what passes for an FBO is locked up, and he and his passengers can't find a restroom, much less a rental car or a way through the fence. That pilot, at the moment, isn't thinking about fuel prices.

I wouldn't say the FBO business is in crisis, but it certainly is under stress. At busy airports you find gleaming facilities with every amenity pilots and passengers could wish for. At thousands of smaller fields there isn't enough business to support much more than self-service fuel and limited hours of staffing.

We're flying in a bifurcated world of busy FBOs that must recover the high costs of their operations through high fuel prices and ramp fees, and the other half that has so little business that the cost of staying open is higher than the meager income. And pilots are caught in the middle. Without a reliable network of FBOs our airplanes are nearly worthless as traveling machines.

Until the 1980s most FBOs relied on income streams from new airplane sale maintenance, hangar rent, flight trainin airplane rental, at least some charter, a fuel sales. For all sorts of reasons those business segments evaporated leaving pretty much only fuel sales to fund the entire operation.

That's old news that we've all chewe for years. But there are other more rece developments that have added to FBO o ating costs that must be recovered from pilots who stop there.

One of the big impacts most of us se think about is the fallout of the 9/11 ter ist attacks. In the wake of that disaster every airplane and every airport becam suspect in the public's and politicians'

PHOTOGRAPHY BY ERIN BR

It didn't matter that the terrible damage was done by "heavy" airline jets; after the attack every airplane of any size was lumped into the threat category.

At airports with airline service, the reaction was immediate and uniform. Control of ramp access and identification of everyone on the airport side became a requirement. Fences were made more robust, gates more secure, and requirements for tracking all personnel on the "airside" more stringent.

Even at airports without scheduled airline service the rules for fencing and access and identification all increased if that facility wanted to receive government funding.

I was based at White Plains, New York, at the time, and we airplane owners all had to go through a TSA identification and screening process just to get to our airplanes. As I remember it, there were three different rounds of photos, fingerprints, and biometric data identification processes we submitted to as new and "improved" techniques were introduced.

While most of us general aviation airplane owners believe the security measures enforced after the attack were all an overreaction, that doesn't matter. The security forces – and more importantly the public – believe our airplanes can be a threat, and we're not going to win that argument.

Guess who got to pick up the costs of enforcing the new security procedures for GA? The FBO, that's who. The line crew and the rest of the staff had to go through identification procedures, control access to the ramp, and often escort, or at least observe, pilots and passengers as they come and go to their airplanes.

The result is higher costs for the FBO with no added income. And the security apparatus has created a huge inconvenience for pilots because the airport becomes essentially unusable when the FBO is closed. I was talking the other day to a crew who forgot to call the FBO to ask for "late staffing" for their after-hours landing to drop passengers. Taxiing to the ramp, no problem. But they couldn't get through the fence. They could see their cars parked on the other side, but with the FBO closed, they had no route through the fence, and it's tall and topped with barbed wire.

Finally an airport maintenance guy came by in a pickup and agreed to ferry the people around to their cars. But he couldn't use the gate at the FBO because it wasn't authorized, or locked shut, or something, so he had to drive to a far corner of the airport to a gate he was authorized to use. It took several trips to drive the passengers to their cars that were mere yards away on the other side of the fence.

We're flying in a bifurcated world of busy FBOs that must recover the high costs of their operations through high fuel prices and ramp fees, and the other half that has so little business that the cost of staying open is higher than the meager income. And pilots are caught in the middle. Without a reliable network of FBOs our airplanes are nearly worthless as traveling machines.

The FBO would have kept staff at the facility — for a hefty but probably still unprofitable fee — if the pilots had remembered to call. But my point is that the cone of security that has dropped over our airports costs us all, and the best an FBO can do is pass on the costs to break even.

The other development that has helped blow up the fuel sales income stream for many FBOs is the large and continuous improvement in jet engine efficiency. Years ago you couldn't fly a business jet very far without needing to take on fuel. But more recent designs are not only much more efficient, but they also have higher maximum landing weights, so pilots can carry fuel on multistop hops, which is convenient and often cost saving but deprives FBOs along the way of income.

Another cost-driving issue is rising expectations for what is an acceptable level of amenities at an FBO. Airport authorities who grant leases to FBO operators want, and often demand, a stylish, modern, roomy, and even plush facility. After all, the FBO is the first impression passengers will have of a city when they arrive, and nobody wants to yield any prestige to a city or state next door or across the country. And if there is more than one FBO on the field, they all have to compete to impress pilots and passengers with their service and accommodations. It's really easy to see where the high costs come from, and you get one guess who gets to pay.

While I'm listing cost burdens on many busy airport FBOs, it's also worth mentioning private fuel farms. Some airports, over the years, gave permission for locally based airplane owners to install their own fuel facility. That's great for the operator, but there goes one more source of income for the FBO leaving the visiting pilot — or one not big enough to have his own fuel farm — to pick up the tab for fuel sales income the FBO lost out on.

My memory is too foggy to recall exactly when the first ramp fees were introduced, but it was in response to the cost impacts I've listed, plus more. With costs piling up and pilots being able to "tanker" more fuel, FBOs decided a ramp fee was the only way to recover the costs. If you buy a minimum number of gallons based on your airplane size, the fee is waived. We've all worked the numbers, and if you buy the minimum fuel at the big FBO, the cost difference between that fuel bill and the lower cost small airport nearby is about equal to the ramp fee. No surprise there.

At first, only the biggest FBOs at the largest airports charged ramp fees. Now fees are the norm at even modest FBOs at not very busy airports. There are a few busy FBOs that have managed to continue without handling fees, but the number is dwindling. And with or without ramp fees the fuel prices at the big FBOs have to be higher than the smaller airport no matter what to cover costs.

It would seem that competition would bring down FBO fuel prices and ramp fees, but not always. The problem is traffic volume. The operating costs of an FBO are not going to be cut in half just because there is another FBO on the field. If there isn't sufficient traffic, the income from each FBO goes down while the costs remain the same. And if one FBO really excels in getting the big majority of the traffic, the other loses money and goes out of business, anyway.

In my experience the small FBO has posted a name and phone number to call if you have problems. And friendly people have always been there to help me, give me a lift to a restaurant or motel, open the hangar door, and whatever else I asked. These are people like us who love airplanes and want to be around them and to help fellow pilots. Theirs is a labor of love, but it still has to pay the rent and put food on the table, and I worry that there isn't enough flying to assure that can go on forever.

Having said all of that, and understanding and even sympathizing with the challenges of the FBO business, I do believe some FBO fees and charges border on gouging. Having spent most of my career living and flying in the New York City area I like to think I'm immune to sticker shock. But when I encounter a $400-plus ramp fee for a King Air at a modest-sized airport in the middle of the country, I sure think that's chutzpah if not actual gouging.

The problem is I have no way of knowing what requirements and cost burdens the airport authority has put on that FBO. The FBO has a beautiful new building that it may have been required to build, and who knows what the airport is charging for the lease. But the FAA can find out. One of the requirements of FBOs and other businesses on airports receiving federal funds is that they charge fair prices that can be justified based on operating costs. And that's oversight I hope the FAA is taking seriously.

The other half of the FBO problem is a hundreds, even thousands of airports in smaller communities there simply isn't enough traffic to support more than minimum services. The cost of running a small FBO isn't high compared to the busy airports, but when the top line of income is tiny, any cost can be too much.

The great salvation for small FBOs and GA airplane owners who use them has been self-service fuel. But in my experience the credit card readers on the self-serve pumps are finicky and not terribly reliable. Maybe it's because the card reader device is often exposed to the weather or the dollar volumes being charged are much higher than at a car gas station, but I've frequently had problems getting the system to operate.

But in my experienc the small FBO has posted a name and phone number to call if you have problems. And friendly people have always been there to help me, give me a lift t a restaurant or motel, open the hangar door, and whatever else I asked. These are people like us who love air planes and want to be around them and to help fellow pilots. Theirs is a labor of love, but it still has to pay the rent and put food o the table, and I worry that there isn't enoug flying to assure that can go on forever.

Whether it is a glossy and swank FBO at a busy airport or a modest downhome operatio in the country, we need them all. FBOs have been hit with repeated high-cost body blows over the past 20 and 30 years, and I admire those who remain. They have found various avenues to deliver the service we need and expect at the many kinds of airports that mak this country's aviation system the best in the world. So the next time I launch into a tirade about FBOs I'm going to pause to remember where I would be without them. *EAA*

J. Mac McClellan, EAA 747337, has been a pilot for more than 40 years, holds an ATP certificate, and owns a Beechcraft Baron.

Retractable Gear Article Comments

The following was taken from a letter to me from James Foster (IL)

I was disappointed by the comments regarding J. D. Newman. There is no place for repeating hearsay and conjecture in an article weighing the merits of RG systems (if anywhere). Unsubstantiated statements that undermine the entrepreneurs in our sport do all of us a disservice. We should encourage new designs and then let the market decide if the developer correctly interpreted its desires.

Lets work toward elevating the science, and art of the canard pusher designs. Criticism is fine, but keep it constructive and fair.

Fly Canards

EZ Retractable Main Gear, Another View

In the January issue David Orr's article, EZ Retracts, contained statements that stimulated reply from a CSA member and a non-member. The member's comments are printed in the article on the left. The other letter presents J.D.Newman of Infinity Aerospace views of the situation.

Mr. Newman's very detailed letter stated, "I hope and believe there is space for this letter to be published in its entirety, or it will lose it's informative value and purpose." He further offered to pay to have the 3 page double-sided letter placed in the newsletter.

Among other things, the letter refutes: the reason for the law suit against the Long-EZ owner, time period of the agreement, reason for the crash, negative statement that his retract system is not insurable or held in low esteem by the insurance investigator, safety concerns, and offers history of his company and an update on Infinity progress.

Past newsletter policy has been to make extended articles available to the membership. To obtain such articles members have been directed to send a SASE and request the desired information. It has also been policy to not accept any paid material for publishing.

In light of that policy, and not wishing to paraphrase Mr. Newman's information, I have decided to make the letter available through the usual extended article method.

Long-EZ For Sale

O-320 Long-EZ, low time.
Call Estol Harp (412) 482-2555

I SCREWED UP

Looking isn't the same as seeing

BY BUDD DAVISSON

SHOW ME A BUILDER who has never made a mistake, and I'll show you a builder who has never actually built anything. Mistakes are part of life, and in any situation, be it mechanical or social, the very first thing to say or do when something goes wrong is to admit right up front that you really screwed that up. This brings the situation to a close, ready to be worked upon. The second thing is asking how you can fix it. While saying those things to ourselves, we need to do so while asking ourselves what we learned from that mistake. In this Shop Talk I'm doing all three. This is a mea culpa and a discourse on mistakes rolled into one.

The email that prompted all of this came from Todd Tracy, EAA 1272355, of Pompano Beach, Florida. It read, "The June 2019 article Shop Talk 'Confessions of a Knot Nerd' has incorrect photos for Steps 2, 3, 4 and 5!" and he goes on to explain what is wrong. Nice catch, Todd. Thanks! And you're right.

When I received that email, I thought, "What the ...?" and immediately grabbed some rope. Giving it little to no thought, I tied the taut-line hitch as I have done hundreds, maybe thousands, of times in my life. Another "What the ...?" The knot came out just the way Todd described it and the way I thought it should be. So, what did I do in the photos? This is where, when we're building stuff, whether it's the Station 4.1 Fuselage Framus or taking a photo of a knot, we need to actually *see* the part, not just look at it.

There's a profound difference between seeing and looking. The latter means our eyes are the only organ involved while the former has our brain conducting the exercise, not just our eyes. The result is that, when seeing, we're actually analyzing what our eyes are looking at and drawing useful data from the image. When I was shooting those photos, I was doing a lot of looking and very little seeing. I was, as we so often do, seeing what I wanted to see. I was thinking more about exposure, framing, etc. than what the picture said.

What I was looking at and not seeing was that between step one and step two, I must have turned the rope over or something because I misidentified which line was going from the ground to the airplane. The one that's on the left in the first photo is on the right in the second one. Another "What the ...?" I was tying the knot around the wrong piece of rope and going the wrong direction! Fundamentally, the series of half-hitches go around the main rope and put it in a slight bind, and the harder you pull on it, the tighter it gets. I looked at it with my eyes, but my brain was somewhere else and didn't see the mistake.

There's a profound difference between seeing and looking. The latter means our eyes are the only organ involved while the former has our brain conducting the exercise, not just our eyes.

That's a pretty basic mistake. How could I not have seen that? I didn't see it the same way a close friend and highly experienced airplane builder didn't when I walked into his shop and found a mistake. He was building a 450-hp replica of a 1930s racer. I immediately pointed out a deep nick, almost through the tubing, in the stabilizer spar from a cut-off saw. It was obvious to me because I was "seeing" but invisible to him because he was so close to it that he was always "looking" and saw only what he expected to see. We all do that. Every one of us. That's why an extra set of eyes going over our work is always needed. It's the same way that our spouses do a better job

Radio Antennas

Dave Black (VA) - In addition to being a Velocity builder I hold Commercial and Amateur Radio licenses. To speed up the building process I had my wings with internal Nav and Com antennas built for me. I *assumed* the antennas were fine until I tested them.

Antennas are as important to radio receivers as propellers are to engines. There is a fair amount of "black magic" in antenna design but the idea is to radiate as much signal as possible. Fortunately that is easy to test. The general health of an antenna may be determined by checking its *Standing Wave Ratio* (SWR) across the frequency band. SWR is the ratio of maximum voltage to minimum voltage on the transmission line, and indicates what portion of the signal is reflecting back instead of radiating. If no signal is reflected back, you have a perfect SWR of 1:1. As an antenna works more poorly, more signal bounces back without radiating and the measured SWR increases. An SWR of 2:1 is often considered the acceptable maximum. It is important to note that a high SWR adversely affects receive just as it affects transmit functions.

I checked my antennas with an SWR analyzer. The results made me sick. I discovered my nav antennas have an SWR ranging from a low of 2:1 to 4:1. My com antennas range from nearly 1:1 to over 8:1, higher than my meter will read! At 8:1 SWR nearly 2/3 of all power reflects right back to damage the transmitter. Not good. If I was grading these antennas, the navs would get D+ while the coms would get D-.

The SWR vs frequency plot for each of my nav and com antennas shows the SWR changes a lot with change in frequency. (see plots on next page) The curves have sharp bottoms and the traces go into the stratosphere! My built in antennas were not even correctly tuned for their band. As installed, my nav antennas would work well only above 116 Mhz. The coms would work acceptably below 122 Mhz, rendering most of the com band useless.

Much better antennas are available. The Sportcraft 008 com antenna is an inexpensive commercially available antenna designed for composite aircraft. Its plot lies relatively flat across the whole com band, never reaching as high as 2:1. This is how an SWR curve should look. That antenna gets an A.

I opened up my winglets to see if I could salvage the installation. It was impractical to fix the many installation errors: failure to use Baluns for matching co-ax to antennas, locating the antenna near a carbon-fiber lay-up, routing co-ax directly along an antenna element, use of cheap co-ax with solid center conductor and open weave braid, antennas cut to wrong length, and failure to verify antenna performance during installation.

As a result of my experiences, I have been asked to evaluate antennas in other canard airplanes.

I have found: a Long-EZ with antennas installed in the usual way (with no balun). It had an SWR ranging from 1.5:1 up to 3:1. The antenna worked reasonably well. A Long-EZ project with antennas supposedly built into the winglets were so poor I could not detect any antennas at all! A Vari-Eze with SWR ranging from 3.5:1 to 6:1. It's SWR was poor and the com antenna was polarized almost horizontally. The owner reported difficulty transmitting and receiving. Another Velocity owner had SWR numbers identical to mine. That was not surprising, since the antennas were installed by the same factory as mine.

In talking with builders I get the sense that most would rather not concern themselves too deeply with antennas. It's much easier to just build it as shown in the manual or as a friend did it. Builders may be lulled into a false sense that their antennas are fine based on nothing more substantial than they seem to work. Builders should remember that *any* piece of wire will work as an antenna. Only if you test the antenna can you determine <u>how well</u> it is working. <u>How well</u> the antenna works makes the difference between a transmit range of 100 miles or only 5 miles.

Antennas must be constructed using proper technique and that it be confirmed by testing prior to glassing them permanently in place. All antennas, whether of good or bad design, are position sensitive. Where you put them and how you install them makes a tremendous difference. Well designed antennas can be installed to work poorly. Poorly designed antennas can be installed to work acceptably. The trouble is you will never know which you have - or how best to position your antennas, unless you test them.

To test them, take the wings outside, well clear of electrically conductive objects and people. Place them as high above the ground as practical. A wooden picnic table could be used for support. Run an SWR sweep, using an SWR analyzer or com transmitter plus SWR meter. Plot SWR values every 1 or 2 Mhz. Reposition the antennas and feed lines as necessary until you achieve the lowest, flattest possible SWR curve within the frequency band of interest. If the SWR curve goes up too high at the low end of the band, as my nav antennas did, the antenna elements should be longer. Conversely, if the SWR curve goes too high at the top end of the band, the elements should be shortened. Make adjustments 1/2" at a time with an effort toward centering the SWR curve on the band of interest.

If you have not built your antennas, take the time to do it properly. The extra time and few dollars spent on a well designed antenna installation will provide superior radio performance for the life of your plane and may well prevent an unexpected trip to the radio repair shop. If antennas are already installed, check them anyway and decide a course of action.

In my case I determined the antennas

Step 1:
Half hitches around the main line. In some versions the second half hitch crosses over the first one but exits in the same place

of finding something we've lost than we do. I don't know how many times I'll be running around the house looking for something, and my wife will point it out sitting right in front of me. Looking not seeing. That's how mistakes are made. And we all make them.

One of the really aggravating aspects of making a mistake while building an airplane is that a big one at the wrong time means taking many steps backward to set it right. That's hard to do psychologically. We always want to be moving forward and hate to take steps back. It's at that point, while sitting in the shop looking at a buggered piece and trying to make up our minds whether we should back up and do it over or not, that we should remember what it is that we're building. If something fails, we can't coast over to the curb and call our spouse to come get us. The call to them may not be from us, and it may not be pleasant. So, if something needs fixing, be 100 percent safe, back up, and do it over.

Looking not seeing. That's how mistakes are made. And we all make them.

One of the few attributes of growing a little older is that our patience seems to increase. I know I'm now perfectly willing to redo a piece two or three times just to get it as right as I can get it. Don't confuse that for the ravings of a perfectionist. I'm anything but. However, I very much value my own hide and the happiness of my loved ones, so cutting corners to save time is something I outgrew decades ago. This is a highly recommended trait for builders.

PHOTOGRAPHY COURTESY OF **BUDD DAVISSON**

Step 2: *In some versions the third half hitch goes over the top of the main line, rather than under, and curls under.*

[redacted]

However, there are mistakes and then there are *mistakes*. Some are cosmetic and visually irritating while others introduce flight safety issues. If a rivet set leaves a string of smiley faces across part of a panel, the airplane's structure is unaffected. Do the same thing with a screwdriver, plowing a deep gouge across the same panel, and it's a different story. The safety is affected and a repair needs to be considered. Undercutting a weld at the end of a cross tube at the rear of the fuselage is less worrisome than the same thing on a landing gear or wing fitting. Then cutting and splicing is sometimes called for.

It is seldom we don't recognize the correct solution for a mistake the instant it is discovered. We almost always automatically know what "should" be done. We know when a panel should be replaced or a weld redone or spliced. Or the paint

Step 3:
This is the tautline hitch as seen on most knot tying websites. However, there are variations on the tautline theme.

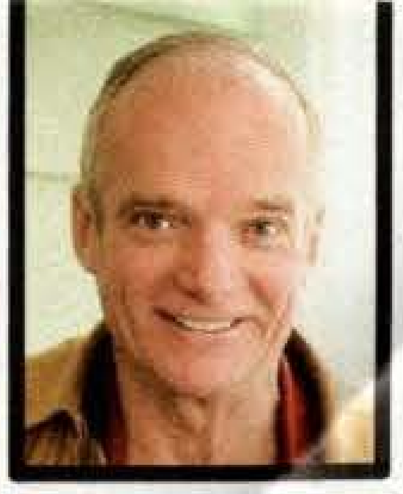
Far too many times we try workarounds that look easier in the short term, but almost never work out in the long run.

stripped and done over. However, it is seldom that we give in and say to ourselves, "We screwed up so let's cut to the bottom line and do it right." Far too many times we try workarounds that look easier in the short term, but almost never work out in the long run. We know that, but we try them anyway and almost always regret it. Most of the time, giving in to what we know deep inside is the correct solution is the right thing to do – regardless of the time involved. And that brings us back to that stupid knot.

Having made the mistake about the knot last time around, the right thing to do is to start over. So, I will. Here are the steps to doing it right. The line going from the ground to the airplane is on the right. Sorry I screwed up! Incidentally, in rectifying my stupidity, I Googled taut-line hitch and found at least four variations on a theme. Most having to do with whether the last half-hitch goes over or under the main line. Todd's version runs the second half-hitch over top of the first one. Try them all and see what works best for you. *EAA*

Budd Davisson, EAA 22483, is an aeronautical engineer, has flown more than 300 different types, and has published four books and more than 4,000 articles. He is editor-in-chief of *Flight Journal* magazine and a flight instructor primarily in Pitts/tailwheel aircraft. Visit him on www.AirBum.com.

PHOTOGRAPHY COURTESY OF **BUDD DAVISSON**



Revisiting Engine Failure Training

Building proficiency in handling the unexpected

BY CHARLIE PRECOURT

REACHING A RUNWAY in an engine-out training scenario has always been one of my favorite training exercises. Obviously, we can't achieve a runway landing in every scenario, so a big part of this training is also meant to build judgment for when to go for a runway and when to find an off-field alternative. When you think about it, engine failure, especially in a single-engine aircraft, is among the most serious emergencies we might face. Yet we can anticipate and train for this eventuality and increase our chances for success. The challenge comes with the endless number of circumstances we might confront — takeoff, climb-out, cruise, in the weather, on approach, or in the pattern. It really boils down to a math problem, knowing the numbers for your aircraft and following the primary rule — fly the airplane first.

What does it mean to know the numbers? In short, knowing how much performance you can extract from your aircraft when you are engine-out. What are the glide speed and glide ratio? How much altitude do you lose in a 360-degree turn at max glide speed (both in cruise and in landing configuration)? How far can you glide from a given altitude? In the space shuttle (obviously an engine-out scenario), we lost 12,000 feet of altitude for every 90 degrees of turn in the arrival phase prior to rolling out on final — yikes! In the MiG-21, we needed 6,000 feet from a high base position to make a turn of 180 degrees to the runway. In the L-39 jet trainer, I could achieve a full 360-degree overhead turn to touchdown from only 1,000 feet above the runway. What do you need for your aircraft?

If you don't really know what to expect of your aircraft, you can easily learn in a controlled manner. For the takeoff phase, go to a safe altitude in your practice area, say 3,000 feet above the ground, and fly a simulated takeoff climb, at climb speed, and chop the power and perform a 180-degree turn. Measure how much altitude you lost. Then add 50 percent to that and make it your minimum altitude to attempt a return to the runway if you ever lose an engine on takeoff. Why add the 50 percent? Because if you perform a 180-degree turn, you'll be offset by your turning radius from the runway centerline requiring you to turn further than 180 degrees to angle back to centerline for landing. Reduce the offset by planning this turn into the crosswind. So a simple 180-degree reversal maneuver ends up closer to 270 degrees of turning in the return-to-the-runway scenario. If you don't account for this, you can end up in the dreaded stall-spin crash attempting to get to the runway. If the engine fails below your minimum turnaround point, fly straight ahead or make minimum turns to pick the best off-field spot. And fly the airplane all the way to a stop!

Now for the takeoff phase, you have some math that works for you — a minimum turnaround altitude. Bank angle matters, too. Do a turn at 30 degrees of bank and another at 45 degrees; you will be surprised at the difference in altitude loss. The absolute minimum altitude loss for a turn reversal occurs at pretty steep bank angles — but that's not a place to be when you're close to the ground. Make sure you always maintain best glide speed or slightly higher.

ILLUSTRATION BY BRANDON JACOBS

For cruise scenarios, we add some more math. How far away from a runway can you be and make it if you lose the engine? If your glide ratio is 12-to-1 (lift-to-drag ratio max is 12), then for every nautical mile high you are (6,000 feet altitude), you can glide 12 nm distance. Obviously, this is without wind, so you'll need some margin for that, too. Here's where knowing how much altitude you lose in a 360-degree turn really helps. If you have enough margin to glide to a runway and still perform a 360-degree turn over the field, then you are in pretty good shape. That extra altitude will allow you to align with the best runway for landing. If you have ForeFlight, you can use the Glide Advisor feature to help you with this math (see "New Tools for Max Glide," Flight Test, July 2017).

Engine failure, especially in a single-engine aircraft, is among the most serious emergencies we might face. Yet we can anticipate and train for this eventuality and increase our chances for success.

My favorite exercise is to go to a nontowered field when there's no traffic, pick various starting altitudes and distances, pull the power to idle, and perform a glide to the runway. Go to 6,000 feet at 12 miles out, as in the 12-to-1 glide ratio airplane example above, and see what you can do. Enter from a variety of angles. Use the math for your airplane's glide ratio and speed. Each time you set up the exercise, go through the pilot's operating handbook engine failure procedure, maintain best glide speed, aim for the center of the airport until you get close enough to determine whether you can achieve a particular runway, and then execute the close-in procedure. What's that? The close-in procedure is establishing check altitudes at key points in the pattern to your chosen runway, such as 1,500 feet midfield downwind, 800 feet turning base, and 300 feet rolling out on a half-mile final. These key checkpoints, which are repeatable and reliable for the performance of your aircraft, are what you should develop in your own training. My numbers are only a generic example. The goal is to take any initial condition at a distance from the airport and manage your glide and energy to arrive at a known point relative to a landing runway that provides you the "numbers" you need to reach the runway. So, as you fly these approaches, you should get very familiar with what it takes from midfield downwind, abeam the numbers, and turning final. In the military, we called these "key positions." Being at or a bit above the key numbers is the goal. Always keep a little money in the bank. Initially, aim for a touchdown one-third of the way down the runway, and carry 5-10 knots above best glide speed on final. Glider pilots usually use half spoilers on base and final, allowing them to extend the glide if they misjudge the glide on final. Remember, you are going from a tailwind on downwind to a headwind on final.

Once the runway is made, you can always dump extra energy by adding flaps, performing a slip, or extending a base to final turn. Go out and try a number of these. If you can't make the runway, go around and make note of that initial condition and try again from a bit closer-in condition. Over time you will gain a really good feel for what's achievable. The more situations you practice, the better you'll be at handling the real thing.

Remember, too, that your goals include optimizing performance by establishing best glide speed immediately upon losing the engine (simulated or real) and holding it all the way into where you know you can reach the runway. If you can't reach the runway, find a suitable off-field alternative and fly your key positions to that chosen location. Get the checklist down pat — it enables you to potentially recover power and get you back to a field if there's time to troubleshoot. The most important thing in all of this, though, is to maintain aircraft control. Fly the aircraft first!

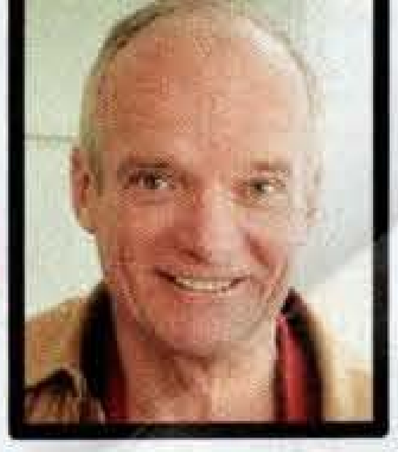
Your goals include optimizing performance by establishing best glide speed immediately upon losing the engine (simulated or real) and holding it all the way into where you know you can reach the runway.

This proficiency exercise is a good one for all of us in single-engine aircraft, but it is particularly important if you are preparing to enter Phase I flight testing of a new homebuilt. As we roll out our new *EAA Flight Test Manual* to help builders execute Phase I flight testing, it is worth noting that we recommend building proficiency in the same or a very similar aircraft prior to testing your new aircraft. We also recommend that you remain within gliding distance of a suitable runway until you have confidence in your engine. The NTSB identified engine failure and subsequent loss of control as one of the most common accidents in Phase I. That's why we've been pursuing initiatives like the Additional Pilot Program and publishing the *EAA Flight Test Manual.*

So, go out and have some fun and learn what your aircraft can do if you ever lose power in flight. You'll be glad you did come the day you get surprised.

Fly safe. *EAA*

Charlie Precourt, EAA 150237, is a former NASA chief astronaut, space shuttle commander, and Air Force test pilot. He built a VariEze, owns a Piper JetPROP, and is a member of the EAA board of directors.



CHARLIE PRECOURT

COMMENTARY / FLIGHT TEST

Engine Out by the Numbers

Practice leads to preparedness

BY CHARLIE PRECOURT AND CHRIS GLAESER

LAST MONTH, I DISCUSSED some good techniques for "when the engine goes quiet," and I want to continue the discussion regarding some additional tests that you can accomplish with your own aircraft. Chris Glaeser, a test pilot colleague and volunteer on our safety committee, provided some thoughts from his experience flying U.S. Air Force F-16s. Over to you, Chris.

FROM CHRIS GLAESER

According to industry safety expert Ron Wanttaja, EAA 275698, a study of nearly 450 experimental amateur-built (E-AB) engine failure accidents between 2008 and 2018 showed that 42 percent occurred during takeoff or initial climb, 43 percent were en route, and 12 percent happened in the traffic pattern.

Before takeoff, I like to review four things:

- Abort criteria.
- Where I'll land following an engine failure below 500 feet.
- Planned actions for engine issues above 500 feet.
- Immediate actions for a thrust loss.

I always compute my takeoff distance at maximum gross weight, then add about 30 percent more distance to determine an abort point and make sure I have plenty of runway remaining for the abort. If I haven't lifted off before that point, the takeoff is aborted. The *EAA Flight Test Manual* flight test card 10 discusses how to test for takeoff performance. Many of the E-AB accidents in Ron's database are partial power failures, and a failure to be airborne when expected is all you need to know to abort.

Once power is set, I target specific parameters to verify if the engine and propeller combination are performing properly. These parameters can be rpm, manifold pressure, and both fuel flow and fuel pressure. All it takes is a targeted look at those parameters in the initial part of the takeoff roll. If your avionics are programmable, the airplane will provide a caution or warning if you set the limits of these key parameters and will alert you if a parameter is out of limits subsequent to your targeted look.

Once airborne, I maintain runway heading, which results in the aircraft drifting with the crosswind. This will reduce the turn radius necessary for an emergency 180 back to the runway, and any turn

Any delay in lowering the nose following a loss of power on takeoff will result in a very slow airspeed.

following engine failure should be made into the wind. Maintain V_Y (best rate of climb speed) to maximize your climb rate, while reducing your distance from the runway. Below 300 feet AGL, an emergency landing should be made with only 15-30 degrees of heading change maximum. This heading change can be increased at altitudes above 300 feet AGL. I always turn crosswind at 400 feet in the traffic pattern to minimize my distance from the runway. By 500 feet on crosswind, I am pretty much assured of being able to accomplish a downwind landing, having already achieved a 90-degree heading change. Don't forget to preplan for the use of crosswind runways, if one is available.

If your engine fails during initial climb, your "first responsibility is to maintain flying speed. The pilot must immediately lower the nose to achieve the proper pitch attitude necessary to maintain the appropriate approach airspeed. Make the initial turn into the wind." That quote is directly stated in the FAA's *Glider Flying Handbook* to help pilots in the event the towrope breaks during the initial part of the climb. It stresses an immediate nose-down move to maintain adequate airspeed.

Here is a test you should do to understand how your particular airplane performs in a similar event. For safety, do this test at or above 3,000 feet AGL:

- Stabilize at V_Y at takeoff power and takeoff configuration.
- Note the pitch attitude (it will be a few degrees higher during actual takeoffs).
- Retard the power over 3-4 seconds, simulating an engine failure.
- Immediately lower the nose to achieve V_G (best glide speed) and record the necessary pitch attitude.

A typical takeoff attitude is around 6-9 degrees nose up for a C-172, and a typical glide attitude is approximately 2 degrees nose down. Note that V_Y in a C-172 is approximately 72 knots, while V_G is approximately 68 knots. Any delay in lowering the nose following a loss of power on takeoff will result in a very slow airspeed. Note the difference between the climb pitch attitude and the required pitch attitude for best glide is at least 8 degrees nose down. This critical maneuver is rarely practiced.

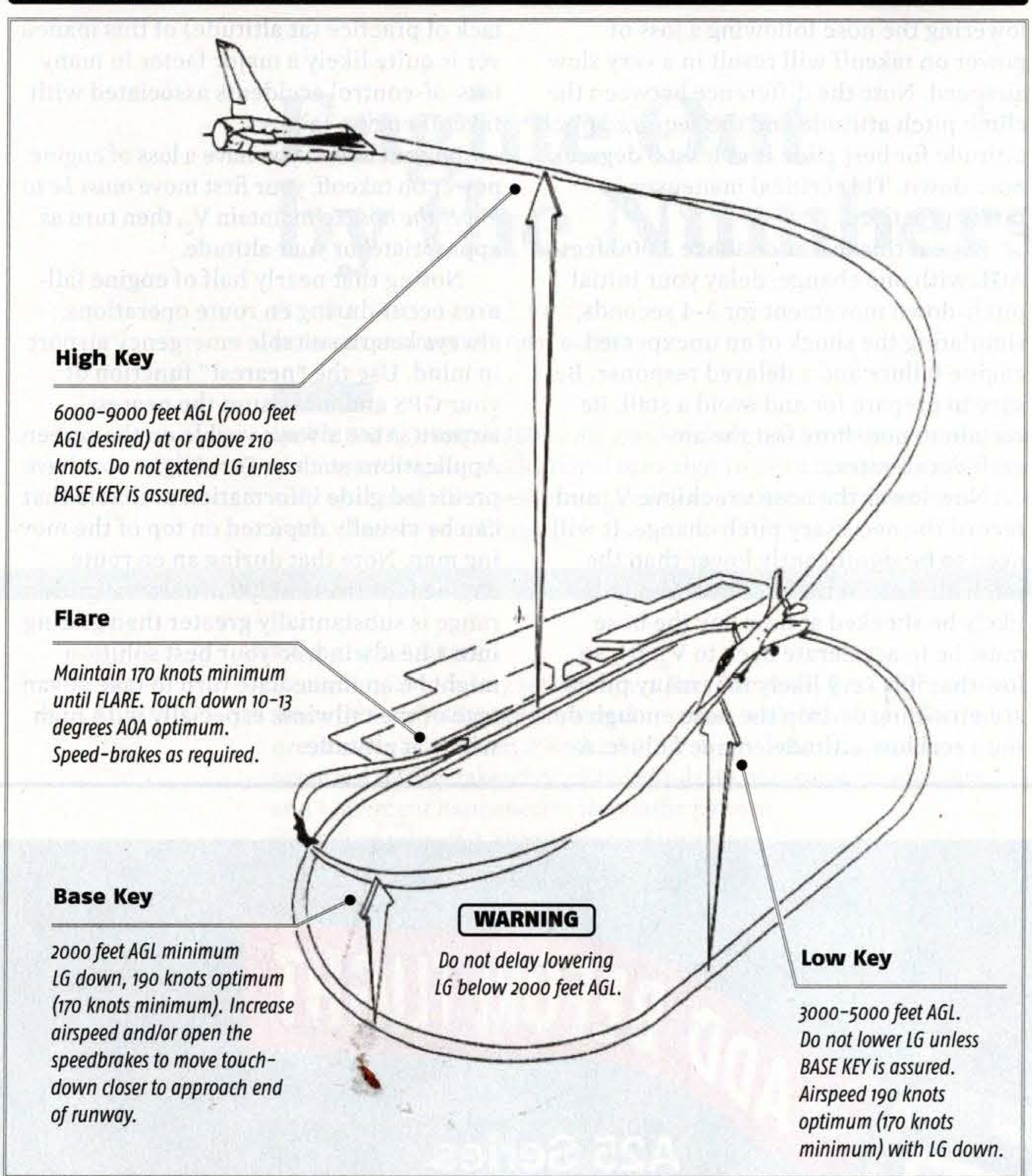
Repeat this test at or above 3,000 feet AGL with one change: delay your initial pitch-down movement for 3-4 seconds, simulating the shock of an unexpected engine failure and a delayed response. Be sure to prepare for and avoid a stall. Be certain to note how fast the aircraft decelerates.

Now lower the nose to achieve V_G and record the necessary pitch change. It will need to be significantly lower than the pitch attitude in the first test. You will likely be shocked at how low the nose must be to accelerate back to V_G. It's so low that it is very likely that many pilots are unwilling to drop the nose enough during a real low-altitude engine failure. A lack of practice (at altitude) of this maneuver is quite likely a major factor in many loss-of-control accidents associated with takeoff engine failures.

Bottom line: If you have a loss of engine power on takeoff, your first move *must be to lower the nose* to maintain V_G, then turn as appropriate for your altitude.

Noting that nearly half of engine failures occur during en route operations, always keep a suitable emergency airport in mind. Use the "nearest" function of your GPS and make sure the nearest airport(s) are always visible on the screen. Applications such as ForeFlight now have predicted glide information available that can be visually depicted on top of the moving map. Note that during an en route engine failure event, your tailwind glide range is substantially greater than gliding into a headwind, so your best solution might be an immediate turn to take advantage of the tailwind, especially with high winds at altitude.

FLAMEOUT LANDING PATTERN



When I was a U.S. Air Force F-16 test pilot, we were required to routinely demonstrate proficiency in flameout landings. In addition, we always practiced simulated flameout landings at the beginning of test flights that were engine test flights or loss of control (high AOA) test flights because risk of an engine flameout was more likely. Many engine test flights involved an intentional engine shutdown for relight tests. On one occasion, I needed to perform an actual flameout approach after multiple unsuccessful restart attempts.

Note that there are three notes in this F-16 diagram regarding a minimum speed of 170 knots (slightly above V_G). V_G was considered an absolute minimum speed at all times.

I personally fly V_G *plus 10 knots* during all engine-out approaches in my RV-7A to keep a little bit of energy "in the bank." Going below V_G at any time is a really, really bad idea because regaining V_G will require you to lower the nose significantly. If you are short of the runway on final and below V_G, you have zero options for stretching your glide, while V_G plus 10 knots allows you to extend your glide slightly. In strong winds, it's difficult to judge the winds accurately going from a tailwind at "low key" to a headwind on final, and I therefore like to aim a little long and fly a little fast until I can accurately judge the final glide angle.

You should perform glide tests at altitude to determine your altitude loss in a 360-degree turn ("high key"), and a 180-degree turn "low key" using the *EAA FTM* flight test card eight. Knowing your own aircraft's performance is essential in intercepting this flameout landing pattern. Charlie's aircraft lost 925 feet in a power-off 360 in a 30-degree bank turn and 825 feet in a 45-degree turn. You should be comfortable in this maneuver in any case as the Airman Certification Standards requires an emergency descent between 30-45 degrees of bank. To achieve a final approach rollout altitude of 300 feet, Charlie could use a high key of 1,200 feet, low key of 800 feet, and "base key" of 500 feet (all based on a 30-degree bank). You might need an extra 360 turn if you arrive at high key with too much altitude, or you may need to otherwise modify the pattern to lose energy. In any case, it's better to widen the downwind, S-turn, or sideslip than to extend final beyond your normal pattern. Practicing a flameout pattern from pattern altitude (1,000 feet AGL) works well if abeam the numbers and using this point as your low key. Charlie also suggested aiming one-third down the runway to provide a pad for stronger-than-expected headwinds or errors in your approach. Perform S-turns or slips on final to bleed excess energy, but don't extend flaps until you are certain you have the runway made.

Also note that F-16 pilots do not extend the landing gear until they have intercepted the flameout pattern (unless they are below 2,000 feet). If you have an aircraft with retractable gear, it's good to know how the gear affects your descent rate and how long it takes to fully extend and then take both into consideration. Redo *FTM* flight test card eight with the gear up and the gear down (honoring maximum gear speeds) to see how this affects your descent rate.

After you've completed these tests, put an engine failure overhead diagram in your pilot's operating handbook, and make a habit of practicing these approaches from different setups such as high key, low key, or longer range during cruise flight.

Fly safe! EAA

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