During EAA Oshkosh '88 EAA and FAA signed a joint agreement to develop a multi-media program to alert pilots of amateur built aircraft to the need for special care in the first 40 hours of flight in their new aircraft. This article by Tony Bingelis is the first of three installments on test flying a homebuilt and is part of EAA's participation in the multi-media program which will ultimately include both slide and video tape presentations.

Many builders have the mistaken notion that flight testing an amateur built aircraft must take place immediately after the FAA certification inspection and that it consists merely of that legendary first flight. Most are aware, however, that the homebuilt will have to fly off its 20 hour quarantine in an approved flight test area. The minimum is 40 hours for homebuilts with uncertificated engines or propellers.

The idea prevails, too, that this mandatory time be flown off as quickly as possible. The impatience is understandable. After all, there's EAA Oshkosh and so many other fly-ins to attend and awards to win. But reaching that tempting goal must never be at the expense of a thorough testing of the new airplane. And for good reason, too.

FAA records show that 56% of the fatal accidents happen within the 40 hour test phase.

Think about it. A thorough and realistic test program for your airplane is essential. Here are five good reasons why:

1. It leaves nothing to chance.
2. It enables you to fine tune its flight characteristics.
3. It uncovers any problems needing correcting.
4. It helps instill confidence in your new airplane.
5. It reveals the full potential of your new airplane.

Unfortunately, in the past there has been no test program guide for first time builders of amateur built aircraft. Not that there has been a lack of information on test flying an aircraft - far from it.

Actually, a number of articles on the general aspects of testing have appeared in our own SPORT AVIATION magazine and in other EAA publications. But, this sort of information is difficult to recall, much less to locate again by anyone who suddenly realizes he needs it right now. Even after one finds a reference or two on the subject, it may not be all he had hoped for. There might be a lack of uniformity in the material found and it seems in many instances that the information is either incomplete or, perhaps, contains a number of recommended flight test procedures and objectives that may be unnecessary, too advanced or far too sophisticated to be practical for most of us. This sort of conclusion is enough to frustrate most conscientious would-be test pilot with more information and data than he needs - or, for that matter, would know how to use during those anxiety inducing moments that engulf most first flights.

Hopefully, all that will be changed when the proposed FAA Advisory Circular being prepared jointly by the EAA and FAA is released. In the meantime, let's see if we can simplify and better organize the basic test flying information many of us have been using... by dividing it into the following three steps:

STAGE ONE: MAKING PREPARATIONS FOR FLIGHT TESTING
STAGE TWO: MAKING THE INITIAL FLIGHT TEST
STAGE THREE: EXPANDING THE FLIGHT ENVELOPE

Note: In order to establish a common starting point, the assumption is that the FAA certification requirements have been met and the aircraft has just been issued an Airworthiness Certificate in the Experimental Category (Amateur Built). Let's begin our flight test program at that point.

Incidentally, this is not intended as a Primer on "How To Fly" - the test pilot selected should already know how, and should be familiar with basic flight maneuvers.

Stage One: Making Preparations For Flight Testing

1. SELECT A GOOD AIRPORT - If your airplane is not yet at an airport, select the best airport in your area hav-
Don't just look. Touch, twist, pull and tug on everything you check - that's the only way to inspect.

ing at least a 3,000 foot runway, preferably paved, and with good approaches. A fast homebuilt with a retractable gear and a high wing loading will have an even greater need for a long runway ... say one in excess of 4,000 feet. The greater the number of other facilities and resources at the airport, such as the availability of fuel, hangars, maintenance, etc., the fewer problems you will have to cope with alone.

Obtain permission from the airport owner or manager beforehand to conduct the test flights.

If at all possible, obtain the use of a hangar during the testing activities at the airport. Hangar space is scarce at most airports but often arrangements can be made to share a hangar temporarily.

2. SELECT THE TEST PILOT - It doesn't have to be the builder. If you do not have the experience and current qualifications to make the first flight, find someone who is willing and capable of performing it for you.

Don't let your emotions and foolish pride override your better judgment. You spent years and a lot of money building the airplane and too much is at stake to risk EVERYTHING now.

Talk with or correspond with others who have flown this kind of aircraft. You can learn much from them regarding the flight and handling characteristics of the airplane. Remember though, you may have modified your airplane "slightly", or your aircraft may be much heavier (or lighter) and may not perform or handle exactly as "advertised".

If possible, try to get checked out by a sympathetic owner of the same kind of aircraft. Even a ride would be helpful. Unfortunately, you don't have this option when the test airplane is an original design, or a single seater.

At the very least, read as much as you can about the design's flight characteristics. For example, some kitplane manufacturers have excellent flight manuals containing extremely valuable guidance for that particular design ... don't ignore it. (Sequoia now has a Flight Testing Manual and even an Advanced Flight Testing guide for their Faico builders.)

Aviation magazines are another source for flight reports covering numerous homebuilt types. These are fairly good general sources of information. Still, if possible, get your information from more than one such source.

Be sure the pilot you choose is current and has flown aircraft similar to yours. Obviously, if the test airplane is a taildragger, the selected test pilot must be proficient and experienced in the type.

3. COMPLETE A LAST MINUTE READYNESS INSPECTION - Not another inspection?? Yes! You can't be too careful at this point. Not when 38% of the accidents or incidents have been attributed to mechanical failure - primarily due to engine failure, propeller tip failures and to poor fuel system installations.

Even though your aircraft has been issued its FAA Airworthiness Certificate and Operating Limitations, certain last minute preparations and functional tests must be accomplished, or even reaccomplished before any attempt is made to fly the homebuilt for the first time.

Although your aircraft may have passed its certification inspection, it may not, in fact, be ready ... or safe to fly.

There is always that risk that something may have been completely overlooked. Too often it is a missing nut, bolt or cotter pin.

This last minute shakedown inspection should be made with the help of an extra pair of eyes. Ask an experienced aircraft mechanic, EAA Technical Counselor or fellow builder for help with the inspection. You, having been so close to the project, might have missed some important detail even though you have inspected everything several times over.

This time you and your helpers should account for the presence of every single nut and bolt. Don't just look ... touch, twist, pull and tug on everything checked - that's the only way to inspect.

As for the recommended functional and systems checks, these can be accomplished in a few hours. You may notice though that the list is generalized and not all-inclusive. Your particular aircraft might require attention to additional details peculiar to that design.

Most or all of the following checks should have been completed prior to the FAA inspection. If not, do them now. Sure, it might take you longer to get ready for the test flight but be patient and don't rush ... remember, eternity is forever.

4. FUEL FLOW TEST (Described in my book, Firewall Forward, page 175) - This test is extremely important and should have been completed prior to the certification inspection. If not, do it now.

Pressurize the fuel system if an electric fuel pump is installed and check for leaks.

You must be convinced that the engine will be getting all the fuel it needs at full throttle (actually 125% more than it needs) and at extreme climb angles.

5. WEIGHT AND BALANCE CALCULATIONS - Go over your figures one more time. How will the airplane be loaded for the test flight? Will it be under gross?

Don't fly the airplane with an aft CG condition. If necessary, add ballast and fasten it securely. Be sure the ballast will not interfere with the controls, or chafe on installed wiring and fuel lines.
 Carry plenty of fuel for the first flight but limit it to no more than half your fuel supply.

If you distrust your calculations, use actual weights and remeasure the moment arms.

6. RECHECK THE WHEEL ALIGNMENT - Toe-in or a cocked wheel could lead to dangerous runway control problems. Strive for a zero toe-in/toe-out, or a neutral alignment. If you have to deviate slightly - opt for a bit of toe-out rather than toe-in.

7. THE BRAKE SYSTEM - Check it for positive pedal pressures, leaks and the fluid level. In the case of mechanical brakes, the security and correct routing of the cables, especially at the wheels, should be verified. Locked brakes can spell real trouble.

New brake pads have to be burned-in properly, otherwise continuous heavy brake applications can carbonize and ruin the brake pads.

8. FLAP OPERATION - If installed, activate them. They must function smoothly, and the control handle or flap switch must be easy to reach and should operate in the logical direction.

The maximum deployment angle should be limited. Could a safe go-around be initiated with full flaps?

9. ENGINE OPERATION - With the cowling removed, look the engine compartment over. Look for possible chafing of wiring, hoses, as well as fuel and oil cooler lines. Secure all wiring and lines that need to be kept away from the exhaust pipes.

Operate the engine briefly through full power (not more than 30 seconds - or as permitted by the engine manufacturer) to assure yourself that the acceleration and power is there.

Make magneto check for both mags. Momentarily switch the ignition switch off (at idle rpm) to be sure the magneto ground connections are good and that the engine will stop.

If necessary, adjust the idle rpm to that recommended for your engine. You don't want it to quit on throttling back for landing. On the other hand, if idle is too high, you may not be able to reduce the rpm enough to land.

When shutting the engine down with the mixture control, you should get a slight rise in rpm as the mixture control is moved to the idle cut-off position. Otherwise, the mixture should be readjusted.

If the engine exhibits fluctuating fuel pressure, excessively high oil temperatures or cylinder head temperatures during ground operations, do not attempt to fly without correcting the problem. They will only become worse with the high power settings, and the relatively low speeds encountered during take-off and climb.

Finally, with the cowling and propeller spinners reinstalled, make a full power check to be sure the engine will accelerate and run smoothly at full throttle. Keep the airplane pointed into the wind to take advantage of the cooling air. And, of course, the aircraft should be choked. It wouldn't hurt to tie it down either during engine operations.

NOTE - A serious engine break-in problem faces some amateur builders for which there has been little guidance. For example, a newly overhauled engine with chromed cylinders, or even a new engine, must be broken in properly. That is, the engine needs to be operated at high rpm and the temperatures kept low or the rings will never seat. Unfortunately, this means that the engine temperatures during initial ground operation will be critical, and often the engine operations must be severely limited. This usually precludes prolonged taxi testing and high speed runway tests. Such a limitation, unfortunately, coupled with an untested airplane, creates a dilemma that begs for a solution.

It's ironical but this is a situation that gives all the initial advantages to the builder who has had to install a used engine in his airplane without overhauling it. He may not have a fresh overhaul, but neither does he have an engine break-in problem to worry about. In addition, he can, ordinarily, perform all the taxi tests he feels he needs, concentrating on testing the airplane and not the engine.

An untested engine in an untested airplane doubles the potential for the unexpected happening.

You must . . . whatever the status of your engine . . . operate it in strict conformance with the manufacturer's recommendations. To do otherwise will result in serious engine damage or an engine that, at the very least, will always burn a lot of oil because the rings failed to seat.

10. RETRACTABLE LANDING GEAR - If installed, perform another retraction test to verify that the gear goes down and locks, that the gear doors are adjusted properly and that the limit switches are set correctly.

Extend the gear with the emergency crank (or system). No need to manually crank it up, really, unless the entire retraction system is strictly manual.

Do your warning and gear position light indicators work?

11. TAXI TESTS - Unless you have already done so, try a number of slow taxi tests (no faster than a fast walk) to familiarize yourself with the steering and braking effectiveness, and to become proficient in handling the aircraft on the ground. Learn how much runway or taxiway width is needed to turn the airplane around.

12. HIGH SPEED TAXI TESTS - The real purpose for high speed taxi testing is to learn how the airplane feels and behaves just before reaching lift-off speed.

For safety's sake, select an abort reference point (marker) about halfway down the runway. You should be able to cut your power when you reach that point and still have sufficient runway left for a safe stop without burning up the brakes and tires.

High speed runs down the runway must be limited to approximately 10 mph below anticipated lift-off speed.

Control effectiveness can be readily determined within that speed limitation. All flight controls, even the ailerons, normally become effective at relatively low speeds. You should, therefore, be able to work the controls to determine whether or not they are operating properly . . . and do so without trying one of those kamikaze lift-offs.

"Controlled lift-offs", particularly down a runway that is less than 5000 feet long, are dangerous and should not be attempted by inexperienced test pilots.

High speed taxi runs can also be helpful in verifying your weight and balance estimates. For example, if the tail is difficult to raise (taildragger) at moderate runway speeds, you probably have a tail heavy (att CG) weight and balance situation. Return to the ramp and recheck the weight distribution and your figures again. Correct the problem.

Similarly, with a tricycle gear airplane, try raising the nosewheel after the elevator becomes effective. If you can't pick up the nosewheel at a fairly high taxi speed, you may likewise have a weight and balance problem . . . a forward CG condition. The proper technique is to get up to speed (10 mph below estimated take-off speed) - cut the throttle and check for rotation. This will save you the embarrassment of an accidental kangaroo take-off.

Make a couple of runs with and without a partial deployment of flaps. Is there a noticeable difference?

Pay attention to the amount of rudder input that is necessary to counteract engine torque and to keep the airplane straight on the runway. Watch out for fast applications of throttle at low speeds.

VW engines generally rotate opposite to the Lycomings and Continentals so are prepared to use left rudder on take-off for torque correction.

Glance at your airspeed indicator during the high speed runs to see that it is working.

Monitor fuel and oil pressures, oil temperature and, also, the cylinder head temperature. If any of the indications are suspect, return to the ramp immediately.

Keep the tailwheel on the ground, with stick back pressure, at low runway
sles (taildraggers) until rudder effec-
tiveness is obtained (about 30 mph) . . .
especially in crosswind conditions. Likewise be very careful when the throt-
tle is reduced after a high speed tail high
taxi run and the tail starts to settle. Inad-
vertent back pressure on the control stick (too soon and too quick) might
cause a surprise lift-off and difficult run-
way control problems.

NOTE - Complete each of the follow-
ing component and system checks
even if you know you have previously
accomplished them prior to certification.

13. THE CONTROL SYSTEM - Your
control system is vital to safe flight and
requires very close scrutiny.

Operate the rudder, elevator and ailer-
on controls through their maximum
travel.

Assure yourself that ALL the controls
are connected, secured and safetied -
and that they ALL OPERATE
SMOOTHLY AND IN THE CORRECT
DIRECTION.

No play should be permitted in the
control hinges . . . sloppiness may in-
duce flutter. Likewise the trim tabs, if
installed, must be free of play.

Do your control stops allow sufficient
control travel?

The control balance weights must be
secure and must not interfere with the
control travel.

14. THE FUEL SELECTOR VALVE
HANDLE - Some types can be installed
in any of four positions. Is yours cor-
correctly positioned? Labeled? It must
function easily with a definite click in
each tank position.

Verify that the engine will continue to
run in each tank position selected (ex-
cept OFF, naturally).

15. TAILWHEEL - If one is installed,
examine it to see that its pivot axis is
vertical or, preferably, slopes back
slightly (trail). Defective runway handling
often results when the tailwheel pivot
axis is raked forward and the tire con-
tacts the ground ahead of the imaginary
projected pivot axis.

Be sure the linkage and springs on a
steerable tailwheel are tight (slightly
tensioned).

16. PROPELLER - Retorque and re-
safety the propeller bolts - especially if
a wood prop is installed.

Track the propeller and check the
spinner for run-out.

17. FUEL CONNECTIONS - Smell
fuel in the cockpit? Check the connec-
tions for each fuel line. A fuel leak can-
not be tolerated.

Are your vent lines open (are you
sure?) and properly exited outside the
aircraft? Protect vent openings with
aluminum screen wire to keep bugs out.

18. ENGINE CONTROLS - Verify di-
rection of movement and security of at-
tachment at the engine. This means
somebody needs to check the move-
ment at the carburetor . . . takes two
people to do it.

Beware of possible spring-back or in-
adventent locking in the linkage when
any engine control (throttle, mixture,
prop, carburetor heat, etc.) is moved to
its extreme position.

19. COCKPIT PLACARDS AND
CHECKLISTS - No excuses, you need
them. Review them for accuracy, com-
pleteness and ready access.

20. IGNITION SWITCH - Will it kill
the engine when turned off (good
ground connections)? Is it mounted
securely and is the wiring behind ade-
quately protected and separated
behind the panel?

21. RADIOS OPERATIONAL?

22. SAFETY BELTS AND SHOUL-
DER HARNESS - Check them good.

Are the attachment ends secured and
safetied?

23. CANOPY LATCH - Be sure it
works and is easily reached. What pro-
vision do you have for a rapid escape
in an emergency? In a nose over? For
an inflight bail out?

24. COWLING - It has to be secure.
All fasteners in place?

25. CARBURETOR HEAT - Is it con-
ected and functioning properly? With
the engine running and warm, applica-
tion of carburetor heat should cause a
definite drop in rpm.

26. ELECTRICAL SYSTEM - Check
the functioning of all installed electrical
gages and units. If it is there (installed),
it must work. Be sure the battery is se-
cure and correctly vented.

27. CORRECT ALL DISCREPAN-
cies Found.

28. OTHER IMPORTANT PREPA-
RATIONS - Try to plan and prepare for
all possible contingencies. Assure your-
self that your standby crew knows
where the nearest phone is located -
and that they have the EMS and Fire
Station phone numbers.

A car should be available and your
standby crew (one or two dependable
gents) should have a few tools, a fire
extinguisher and first aid kit onboard -
and, possibly, a hand held radio to per-
mit two-way communications.

A chase plane would be comforting
to have, especially if a retractable gear
or pusher type aircraft is being tested.

Be sure both pilots know the radio fre-
quency to be used (122.750).

A pusher pilot would have no early
warning of an engine compartment fire
unless reported by a chase plane.

Similarly, a pilot of a retractable may
need to know if his gear is down in the
event of some system failure.

A Final Note

All preparations are now completed
and you know the airplane is in tip-top
mechanical condition.

Service the airplane with sufficient
fuel and oil for the scheduled test flight.

Put the airplane away for today and go
home and relax knowing your airplane
is ready to fly.

Don't allow yourself to be rushed now
after years of hard work.

Wait until tomorrow, or the next day
when you are physically and mentally
rested.

Next month, Stage Two - Making
the Initial Flight Test

If you wish to contact the author
of this column, Sportplane Builder,
for additional information, please
write to Tony Bingelis, 8509 Green-
flint Lane, Austin, TX 78759.