U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

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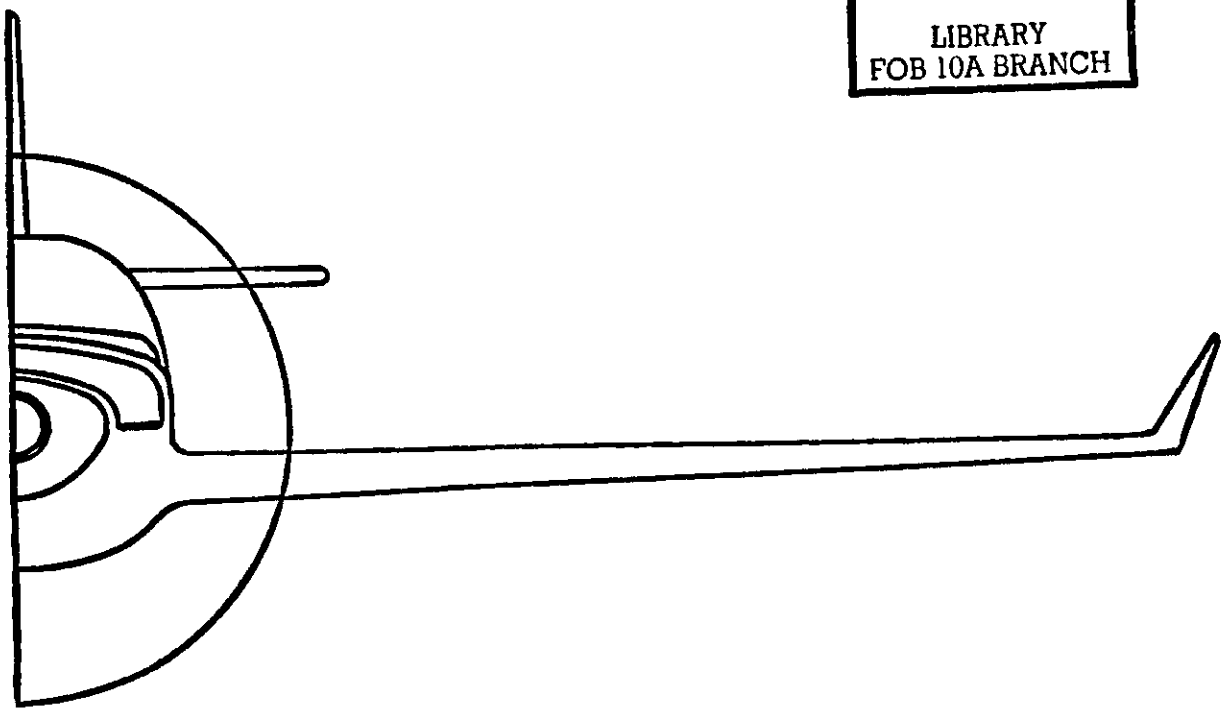
AC-90-89

Amateur-Built Aircraft Flight Testing Handbook



Initiated by: AFS-20

U.S. Department
of Transportation

**Federal Aviation
Administration**

Advisory Circular

Subject: AMATEUR - BUILT AIRCRAFT FLIGHT TESTING HANDBOOK

Date: 9/18/89
Initiated by: AFS-20

AC No: 90-89
Change:

1. **PURPOSE.** This advisory circular (AC) sets forth suggestions and safety related recommendations so that an amateur aircraft builder can develop a Flight Test Plan for his/her individual aircraft.

2. **RELATED READING MATERIAL.** A list of selected reading material on amateur-built aircraft flight testing and first flight experiences may be found in appendix 3.

3. **BACKGROUND.**

a. The Federal Aviation Administration (FAA) and the Experimental Aircraft Association (EAA) are concerned and committed to improving the safety record of amateur-built aircraft.

b. FAA Administrator T. Allan McArtor and EAA President Paul H. Poberezny signed a Memorandum of Agreement on August 1, 1988, that recognized the need for educational and safety programs to assist amateur-builders in test flying their aircraft. As part of that understanding, the FAA agreed to publish an advisory circular on flight testing amateur-built aircraft.

4. **DEFINITION.** As used herein, the term amateur-built aircraft means an aircraft issued an Experimental Airworthiness Certificate under the provisions of Federal Aviation Regulations Section 21.191(g).

5. **DISCUSSION.** This advisory circular has two defined initial goals: (1) To make amateur-built aircraft pilots more aware that test flying an aircraft is an important undertaking. This is a task that should be approached with all the seriousness, planning, skill, and common sense that was employed by those first "successful" test pilots, Orville and Wilbur Wright. (2) To provide recommendations and suggestions that can be combined with other sources on test flying, such as the aircraft designer's instructions or the kit manufacturer's Flight Manual or other flight testing data, so that the amateur-builders can develop a detailed Flight Test Plan tailored for their own aircraft and resources.

a. The Flight Test Plan is the very heart of all professional flight testing and should account for every hour in the flight test phase. The Plan should be adhered to with the respect for the unknown that all successful test pilots share. The time allotted for each phase of the Flight Test Plan may vary and each phase may have more separate and different events than what we suggest in this advisory circular. However, the goals should be the same.

b. The ultimate goal for an amateur-builder should be, at the end of the aircraft's flight test phase, to have an aircraft adequately tested, airworthy, and safe to operate and enjoy within its established operational envelope.

6. **ACKNOWLEDGEMENT.** We would like to express our thanks to the Experimental Aircraft Association and other interested parties for their talents and expertise. Without their contributions this advisory circular could not have been published.

7. **HOW TO ORDER.** Copies of AC 90-89 may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Robert L. Goodrich

Robert L. Goodrich

Director, Flight Standards Service

A REQUEST FOR INFORMATION

This advisory circular is intended to be a useful document that amateur-builders of all aircraft designs can refer to into the 21st century.

This advisory circular consists of chapters 1 through 6, which refer to conventionally-designed aircraft with an air-cooled engine that develops less than 200 horsepower.

In order to accomplish our goal, we feel there are more chapters that will have to be written, more information that could be added, or existing chapters that will have to be revised as new lessons are learned and changes take place within the amateur-built industry.

We need *your help* to meet this goal! If you have any comments, information, or suggestions that you feel will improve this advisory circular, please send them to the following address.

U.S. Department of Transportation
Federal Aviation Administration
Flight Standards Service, AFS-20
800 Independence Avenue, SW
Washington, DC 20591

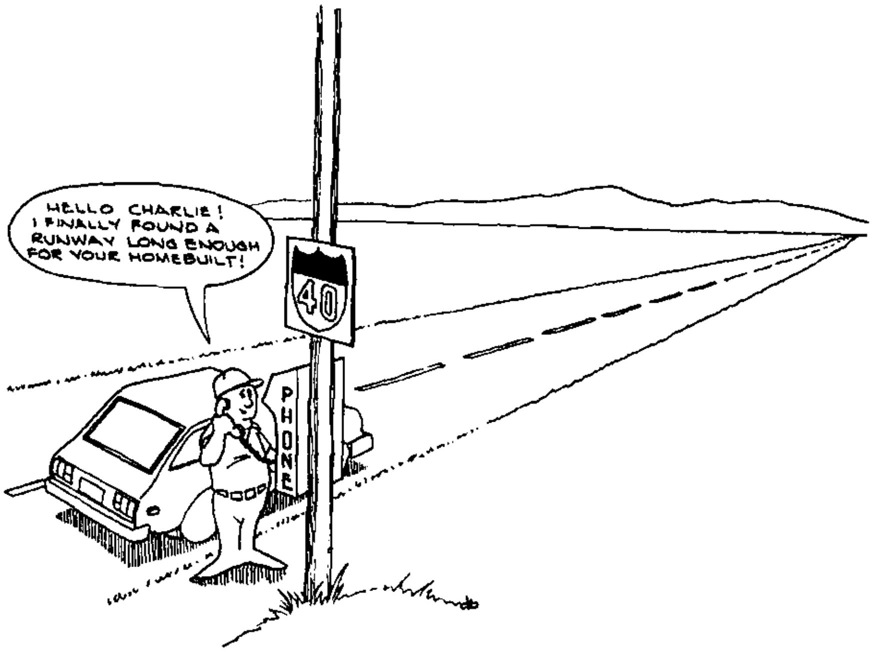
All comments, suggestions, and information will be reviewed and, if appropriate, will be included in the next revision of this advisory circular.

CONTENTS

CHAPTER 1. PREPARATION

" The Laws of Aerodynamics are unforgiving and the ground is hard." Michael Collins (1987)

SECTION 1. AIRPORT SELECTION

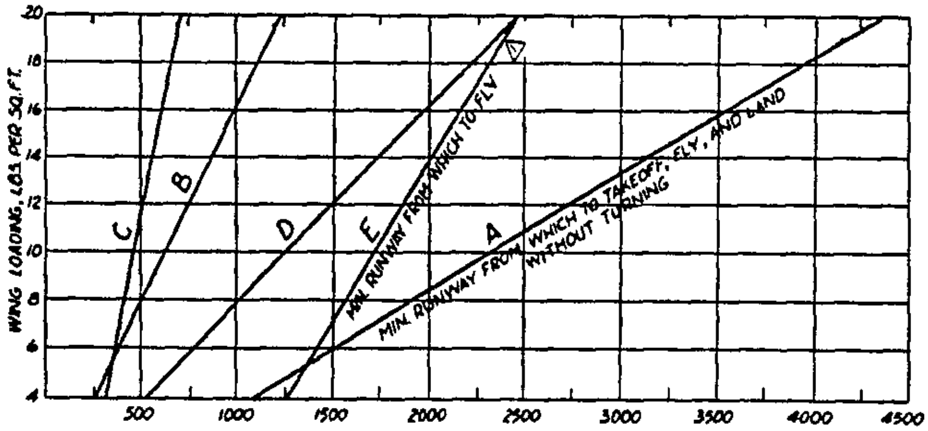


One of the first important decisions you must make is the selection of the airport where you are going to conduct your flight tests.

The airport/grass field you select should have at least one runway aligned into the prevailing wind. Avoid airports in heavily developed areas or with a high utilization rate. The runway should have the proper markings with a windsock or other wind direction indicator nearby.

To determine the appropriate runway you can use the chart in figure 1, or use the following rule of thumb:

> The runway should be more than 4,000 feet long and at least 100 feet wide. If you are testing a high performance retractable gear aircraft, or you intend to operate in a high density altitude environment, the airport runway should be more than 6,000 feet long and 150 feet wide to give yourself a wider margin of safety.



A - Distance to takeoff at minimum smooth lift-off speed, fly for 5 seconds at that speed without climbing, land and stop straight ahead.
B - Distance to reach minimum smooth lift-off speed.
C - Distance covered in 5 seconds of flight at minimum smooth lift-off speed.
D - Distance to stop from minimum smooth lift-off speed (includes air and ground distance).
E - Distance to takeoff at slow approach speed and climb thereafter at an angle of 1 in 20 to 50 ft. altitude —this distance will allow most airplanes to accelerate to normal climb speed before crossing end of runway.

FIGURE 1. Runway Length Chart

Pick emergency landing fields located within gliding distance from any point in the airport pattern. Since 1983, engine and mechanical failures have accounted for 38% of amateur-built aircraft accidents and incidents. Since there is a possibility of this type of emergency occurring, preparations for engine/mechanical failures should be a *mandatory* part of your Flight Test Plan.

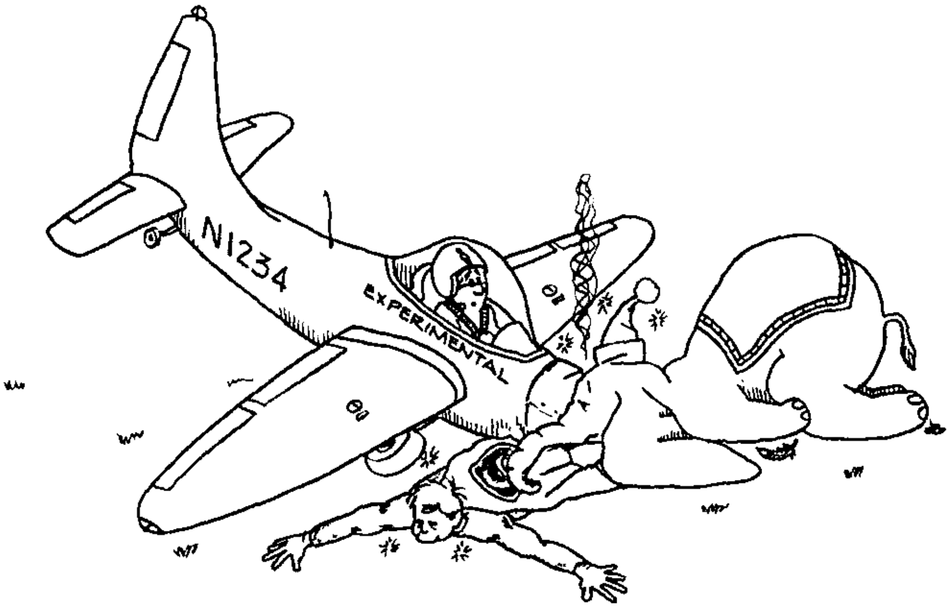
Communications. If the test aircraft is not equipped with a radio, it is still a good idea to conduct flight tests from an airport with an active UNICOM or tower. Individuals using an uncontrolled field can set up their own communications base. A portable radio can be borrowed or rented. Along with the radio, we recommend a headset with a mike and a push to talk switch on the stick/yoke. These items will help reduce cockpit workload. The added insurance that radio communications gives to the overall level of safety should more than make up for the rental fee.

Additional requirements for airport selection that one should consider are the availability of hangar space and ramp areas. These will be needed so the aircraft can be tested and inspected without being subjected to inclement weather or possible vandalism. The airport should have a telephone, firefighting equipment and/or fire extinguishers in good working order.

Make an appointment to talk with the airport manager, or owner, and explain your Flight Test Plan and emergency plans. The airport manager may be able to assist you in obtaining temporary hangar space and in providing ground/air communications or emergency equipment for use during your flight test.

SECTION 2. EMERGENCY PLANS AND EQUIPMENT

"The object of the game, gentlemen, is not to cheat death: the object is not to let him play."
Patrick Poteen, Sgt. U.S. Army.



SOME THINGS ARE HARD TO PLAN FOR !

Every test of an amateur-built aircraft should be supported by a ground crew of one to four experienced individuals. The ground crew's function is twofold: First, to assist the pilot to safely test the aircraft; second, to provide assistance to the pilot in case of an actual emergency. Some builders choose to use a chase plane to complement the ground crew's safety functions.

Each builder should develop two sets of emergency plans: One set for in-flight emergencies; the other for ground emergencies. The in-flight emergency plans should cover procedures for engine failure, especially after takeoff, severe out-of-rig or control problems, and the possibility of fire. The ground emergency plans should include a briefing for the ground crew and the airport fire department crash crew on the following:

1. The airplane canopy or cabin door latching mechanism.

2. The pilot's shoulder harness/seatbelt release procedure.

3. The location and operation of the fuel valve shutoff.

4. The master switch and magneto/ignition switch "off" positions.

5. The battery location.

6. The engine cowling removal procedures.

It is an excellent idea for everyone on your ground team to know the locations and telephone numbers of the hospitals and fire rescue squads in the vicinity of the airport and flight test area. If the test pilot is allergic to certain medications or has a rare blood type, some kind of medical alert bracelet or card should be carried or worn to alert medical personnel of the condition.

There should be several fire extinguishers available for the ground crew and a halon-type fire bottle securely mounted in the cockpit within easy reach of the pilot. In addition, a fire ax or other tool capable of cutting through the canopy should also be mounted in the cockpit.

If the airport does not have a fire rescue unit, then a four-wheel-drive vehicle equipped with a portable radio, first-aid kit, tools to cut through metal, fire extinguishers, and persons trained in first aid, is a must.

SUGGESTION: In some locations, for a small donation, local volunteer fire and rescue companies will gladly provide the amateur-builder the extra insurance of a trained emergency team during the first critical flights.

The possibility of a flash fire should be considered during all phases of flight testing. Ideally, the pilot should wear coveralls and gloves made out of Nomex. If not available, clothing made of all cotton or wool will offer some protection from heat and flames. Pilots should never wear nylon or polyester clothing as the synthetics melt when exposed to heat and stick to your skin. A helmet, or at the very least a hard hat, along with aviation goggles will provide some head and eye protection against impact forces and smoke. A shoulder harness should be properly fitted to prevent or reduce head and upper torso impact injuries, yet allow the pilot to reach all the cockpit controls.

Parachute. To wear one or not during testing depends, for the most part, on the kind of aircraft, the altitude, and the phase of operation. Some amateur-built aircraft have forward hinged canopies or have pusher propellers which increase the chance of injury to the pilot while exiting the aircraft. Other aircraft designs may pose no exit problems at all.

Flight testing at or below pattern altitude may not allow enough room for safe parachute deployment. For spin, stall, and other critical tests a parachute for the pilot is recommended. When using a parachute, make sure that it was packed recently by a qualified parachute rigger, and does not interfere with cockpit management. Also, the pilot should plan and practice how to safely exit the aircraft and deploy the parachute as part of the in-flight emergency plan.

SECTION 3. TEST PILOT

"We are looking for a few good men!" *Marine Corps advertisement (1987)*

General: Ideally, you as the amateur-builder should be competent in an aircraft of general configuration and performance as the one being tested. The costs involved in maintaining pilot competence should be budgeted for, along with the cost of the plans and materials that go into completing the project.

A test pilot should have at least the following qualifications:

1. *Physically Fit.* Test flying an aircraft is a stressful and strenuous occupation.

2. *No alcohol in the last eight hours, or under the influence of alcohol or drugs.*

3. *Rated, current, and competent* in the same category and class as the aircraft being tested.

4. *Current medical and biennial or annual flight review as appropriate.*

Note: The following suggested number of flight hours are only an indication of pilot skill, not of competence. Each test pilot must honestly determine if his/her own level of performance is adequate or if additional flight training is necessary.

1. *At least 100 hours solo time* for a kit plane or an aircraft built from plans of a time proven design.

2. *At least 200 hours solo time* for a "one of a kind" or a high performance aircraft.

3. *At least 10 hours of recent conventional (tailwheel) aircraft time if the aircraft to be tested is a taildragger.*

The test pilot should:

1. Be familiar with the airport and the emergency fields nearby.

2. Talk with and, ideally, fly with a pilot in the same kind of aircraft to be tested at the same airport to be used for the tests.

3. Fly a similar aircraft with like flight characteristics. For example, if your aircraft has a short wingspan, get dual instruction in a similar type certificated aircraft such as a Grumman American *Yankee* or Globe *Swift* until proficient. If your aircraft is a taildragger, instruction in a Bellanca *Citabria, Decathalon,* or similar aircraft is recommended. A pilot is competent when he or she can demonstrate a high level of skill in all planned test maneuvers in these similar performance aircraft prior to test flying the amateur-built aircraft.

4. Study the emergency procedures developed for the aircraft and practice them in aircraft with similar flight characteristics.

5. Have at least one hour of practice in recovery from unusual attitudes within 30 days of the first flight test.

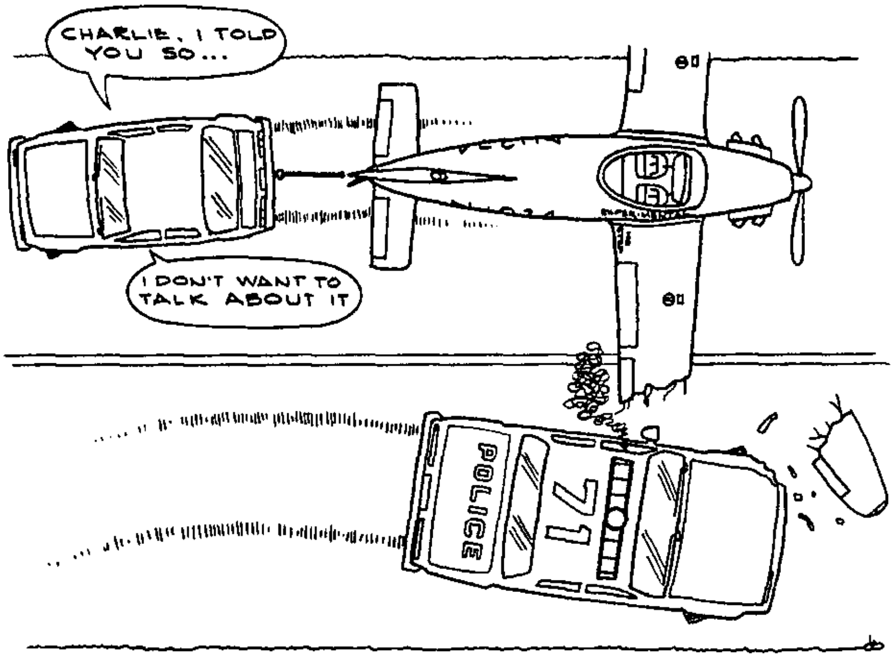
6. Study the performance characteristics of the aircraft to be tested. Refer to the manufacturer's instructions, articles written by builders of the same make and model aircraft, and watch actual or video tape demonstrations of the aircraft.

7. Review the FAA/NTSB/EAA accident reports for the same make and model aircraft to learn what problems others have had with the aircraft. (See appendix 2 for the addresses.)

8. Memorize the cockpit flight controls, switches, valves, and instruments so, in time of emergency, your hands will not have to bother your eyes at this critical time.

SECTION 4. TRANSPORTING YOUR AIRCRAFT TO THE AIRPORT

"If you want to move the earth, first move yourself." Socrates



A poorly planned and executed move from your workshop to the airport can cause more damage to your aircraft than 10 hours of hard landings. To prevent this from happening, follow these suggestions:

1. Use a truck or flat bed truck/trailer that is large enough to accommodate your aircraft and the additional support equipment.

2. If your aircraft wings are removable, build padded jigs or fixtures to hold and support them during the trip to the airport.

3. Secure the fixtures to the truck/trailer; then secure the wings to the fixture.

4. Use two or more ropes at each tiedown point for safety.

5. Heavy moving pads used for household moves are ideal for protecting wings and fuselage. Most rent-a-truck firms will rent them to you.

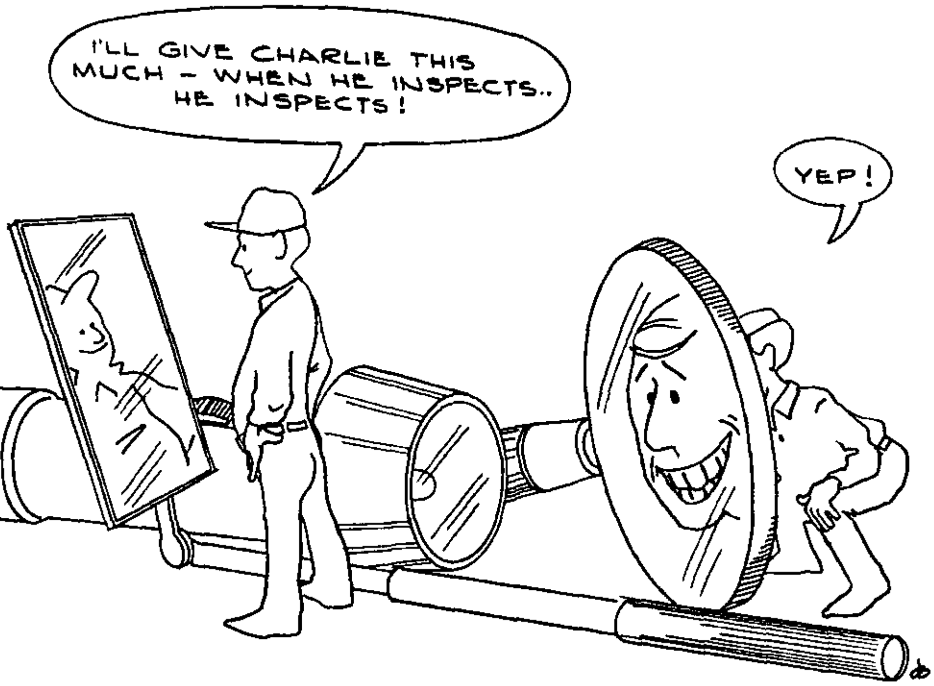
6. If applicable, obtain the proper permits early on and follow the local ordinances for transporting an oversize load. Ask the local police if they can supply you with an escort to the airport.

7. Brief your moving crew thoroughly before loading and unloading the aircraft.

8. If it has been awhile since the designated driver has driven a truck/trailer, ask the driver to take a dry run to the airport to get familiar with the road and the vehicle.

SECTION 5. ASSEMBLY AND AIRWORTHINESS INSPECTION

"Complacency is one of the major causes of accidents, no matter how well things are going, something can go wrong."
Art Scholl



If the aircraft must be reassembled—take—your—time. This is a very critical time. Mistakes are easily made due to the amateur-builder's preoccupation with the impending first flight of the aircraft. To prevent mistakes, carefully reassemble the aircraft according to the designer's or kit manufacturer's instructions or use a checklist you designed. At the completion of each event be sure that another pair of expert eyes checks your work—your life depends on it.

Once the aircraft is reassembled, perform a preflight inspection similar to an annual inspection. This in-depth inspection should be accomplished even if the aircraft has just been issued a special airworthiness certificate by the FAA. Remember, even if an amateur-builder was 99 percent perfect and performed 10,000 tasks building the aircraft, there could still be a hundred items that would need to be found and corrected before the first flight.

The following safety checklist items will not be applicable to all amateur-built make and model aircraft, but are presented for your review and evaluation.

Airframe Inspection.

1. *Control Stick/Wheel.* Should have a free and smooth operation throughout its full range of travel. There should not be any evidence of binding or contact with the sides of the fuselage, seat, or instrument panel.

2. *Rudder Pedals.* Move the rudder pedals through the full range of travel. The pedal movement should be smooth with no indication of binding. Ensure that the test pilot's shoes will not catch on exposed metal lines, fixtures, or electrical wire harnesses.

3. *Brakes.* Hand and/or toe brake pressure should be firm with no tendency to bleed down or lock up. Spongy brakes or low brake fluid in the reservoir, after a few brake applications, is a sure indication of a fluid or an air leak in the system.

4. *Main Landing Gear.* Ensure that the gear attach points, wheels, brakes, and wheel fairings are airworthy. One critical inspection you should make is to ensure the main landing gear alignment toe-in/toe-out is zero or matches the specifications called out in the plans. Even with one landing gear wheel out of alignment the test pilot could be the invited guest to a ground loop party.

5. *Control Surfaces.* Perform another rigging check to ensure that stick input results in the proper amount of travel and direction of the control movement and that contact with the stops are made. An important part of this check is to ensure that the control cable tension is

correct by checking it with a calibrated tensiometer. (These checks should include trim tab systems.)

If your cable tension is less than what specifications require, the "in-flight" air loads will prevent full travel of the control even if the control stick hits the cockpit stop. The desired control movement input will be absorbed by the slack in the cables. This makes for an interesting first flight when the pilot realizes a very slow roll rate and recovery time. While you are checking cable tension, make sure there is no "free play" in the flight control hinges and rod ends. Free play and loose cable tension, combined with control mass imbalance, set the stage for flutter.

6. *Instrument Panel.* All the instruments should have at least preliminary markings on them. Airspeed indicator and engine tachometer should be marked with the expected performance range markings. Oil temperature and oil pressure must have the engine manufacturer's recommended operating range marked. If the markings are on the instrument glass face, a white slippage mark painted on the glass and on to the instrument panel will prevent misreading the instrument in case the glass moves. A temporary placard, attached to the instrument panel with the expected climb and glide speeds, is a handy reference in times of emergency.

7. *Behind the Instrument Panel.* Very few amateur-built aircraft have the same instrument panel design. Each amateur-builder must inspect this hard to see and reach area to ensure that all line connections are tight, that nothing will interfere with the control movement, and that there are no loose wires or possible fuel leaks.

Another check you can perform is for potential carbon monoxide leaks. Wait until night or put the aircraft in a dark hangar. Get in the cockpit and have a friend take a bright flood light and hold it close to the firewall. If you see any light leak into the cockpit, that is where carbon monoxide will seep in. Mark it and seal it.

8. *Engine and Propeller Controls.* All controls should be positive in operation and securely mounted. The control should have full movement with at least a 1/4-inch of "cushion" or "spring back" at the full travel position. The control cables should be firmly attached to the fuselage along each 12 inches of its run to prevent whipping of the cable and limit cable movement at the other end. Control cables with ball sockets should have large area washers on either end of the bolt connection. This will ensure the control will remain connected even if the ball socket fails and drops out.

9. *Pitot-Static System.* The "ideal" procedure to check your altimeter and airspeed for leaks and accuracy is to have the entire system checked in accordance with FAR Part 43, Appendix E, and performed by an FAA-approved repair station.

The following is a field check that an amateur-builder can perform to see if the aircraft's instrument system is leaking. You will need two people. One to read the cockpit instruments; the other located outside the aircraft.

a. *Airspeed Check.* First slip a rubber hose over the pitot mast. Surgical tubing is recommended. With one person reading the airspeed, the other person should very slowly roll up the other end of the tubing. This will apply pressure to the instrument. When the airspeed reaches approximately the aircraft's recommended cruise speed, pinch the hose shut and hold that reading. The airspeed needle should remain steady for at least a minute if the system is sound. A fast dropoff will indicate a leak in the instrument, fitting, lines, or your test hose attachment.

b. *Altimeter/Vertical Speed Static Check.* To check the static side you must apply low suction at the end of the static vent port. First, tape all the static ports closed. The easiest way to gain access to the static system is to remove the static line at the static port. Next, get two feet of surgical tubing, seal one end, and roll it tightly so it looks like a miniature fire-hose and attach the open end to the line. Now, very slowly unroll the tubing. This will apply a suction, or low pressure, to the static system.

The altimeter should start to show an increase in altitude. The vertical speed indicator should also indicate a rate of climb. The airspeed might show a negative indication if the needle does not have a stop at the zero position. When the altimeter reads approximately 2,000 feet, stop and pinch off the tube. There will be some initial decrease in altitude and the vertical speed will read zero. The altimeter should then hold the indicated altitude for at least a minute. If you lose altitude, you must check for leaks.

> REMEMBER: These tests are not to be considered the equivalent of airspeed or static system accuracy tests as certified by an FAA repair station, but just an indication of the system's possible performance.

10. *Fuel System.* Since 1983, more than 70 percent of engine failures in amateur-built aircraft were caused by fuel system problems. Many times the direct cause of engine failure was dirt and debris in the fuel tank and lines left over from the manufacturing process.

Before the aircraft fuel tanks are filled, the amateur-builder should vacuum them out carefully. Next, the system should be flushed several times to remove any debris from the tanks and lines. The fuel filter and/or gasolator screen and carburetor finger screen should also be cleaned. This should "sanitize" the fuel system for the moment.

When it is time to fill the tanks, place the aircraft in the straight and level cruise position. Next, add fuel in measured amounts to calibrate the fuel tank indicators. Allow the aircraft to sit for a while to see if any leaks will develop. During this time, inspect the fuel tank vents to see if they are open and check the fuel tank caps to see if they seal properly. If there are no leaks and the fuel system has an electric boost pump, pressurize the system and again check for leaks. The fuel selector and fuel drains should be properly marked and tested for operation.

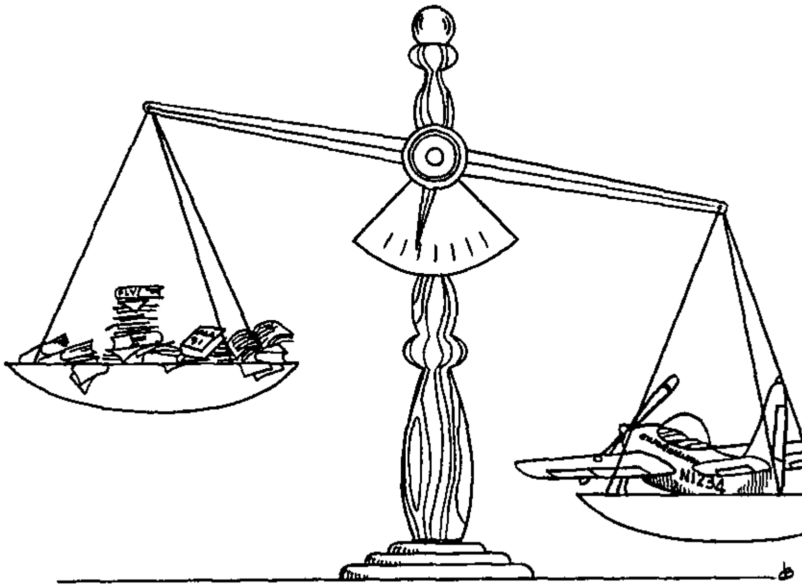
NOTE: Many amateur-built aircraft take between five to eight years to build. Many rubber based oil/fuel lines and gaskets installed early in the building process may have aged, hardened, cracked, or turned brittle. The amateur-builder should carefully inspect these items to prevent fuel leaks, engine failure, or fire hazards, and replace as necessary.

11. *Hydraulic and Electrical Systems.* Each system should function dependably and positively in accordance with the designer's intent. Retractable landing gear should be repeatedly cycled, including the emergency landing gear extension system. Electrical systems can be checked for operation of lights, instruments, and basic nav/comm performance. Other electrical systems, such as generator/alternator output can be checked during the taxi and test flights.

12. *Seatbelt and Shoulder Harness.* These items should be checked for condition and proper installation.

SECTION 6. PAPERWORK

"The job's not finished until the paperwork is done." Item 5 of the Bureaucratic Creed.



THE WEIGHT OF THE PAPERWORK = THE WEIGHT OF THE AIRCRAFT
FLY !!

Weight and Balance. The weight and balance for your aircraft should be figured with great care. You should make at least four calculations: the empty weight center of gravity, the gross weight center of gravity, the center of gravity and weight for each flight test, and the worst forward and aft loading center of gravity range. Keep a copy of the current weight and balance in the aircraft at all times.

NOTE: Because weight and balance calculations are so *critical* to aircraft performance, the use of calibrated aircraft scales is recommended with two people each reading the scales to reduce the possibility of errors.

Airworthiness/Registration/Operating Limitations. These must be on board or the aircraft is not legal to be operated.

Checklists. In addition to the assembly checklist that we have already discussed, the amateur-builder should prepare the following checklists: *Preflight, Before Starting, Starting the Engine, Taxi, Before Takeoff, Takeoff/Climb Cruise, Descent/Before Landing, After Landing, Securing the Aircraft,* and *Emergency Procedures.* This may seem like we are asking for more than necessary, but the ten checklists will fit on the front and back of a single 5x8 card, and be similar in design to a Cessna 150 checklist.

NOTE: The amateur-builder should anticipate revisions to the checklist.

Flight Manual. Is there a book written by the builder/kit manufacturer that describes the *anticipated performance* of the aircraft? The Flight Manual should be revised over the flight test phase into a reliable description of the aircraft's performance.

Maintenance Records (Logbooks). You, as the amateur-builder, should record in the aircraft's logbooks all inspections and maintenance performed. This will serve as a maintenance history for the aircraft and is a very useful tool to spot recurring problems.

SECTION 7. POWERPLANT TESTS

Ensuring good powerplant operation first starts with a properly installed propeller. Each propeller should be checked for proper tracking (blades rotating in the same plane of rotation). The following procedure is easy to do and takes less than 30 minutes. First chock the aircraft so it cannot be moved. *Then remove one sparkplug from each cylinder.* This will make the propeller easier and safer to turn. Rotate the propeller so that one blade is pointing straight down. Now place a solid object (e.g., a heavy wooden block that is at least a couple inches higher off the ground than the distance between the propeller tip and the ground) next to the propeller tip so it just touches. Rotate the propeller slowly to see if the next blade "tracks" through the same point (touches the block, see figure 2).

Each blade should be within 1/16-inch from one another. If your propeller is out of track, it will cause vibration and stress to the engine and airframe and may cause premature propeller failure.

> NOTE: This is a good time to preoil the engine. You can use an external pump or, with the spark plugs still out, rotate the propeller in the direction of rotation until oil is forced into the rocker-box covers. With the engine preoiled, take a cold compression test of each cylinder. The results will serve as an initial benchmark for comparing other compression tests taken after the engine has been run-up to operating temperature.

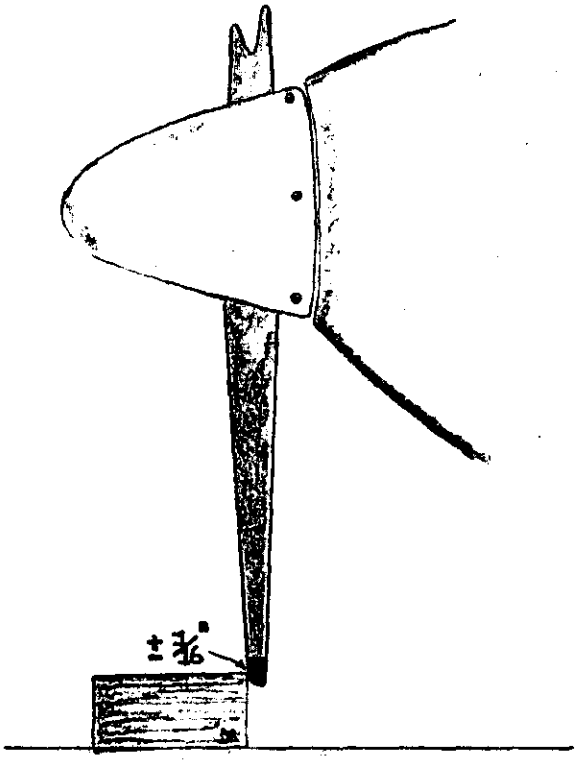


FIGURE 2. Propeller Tracking

Most amateur-builders start with a newly overhauled engine and proceed to "run it in" on the airframe due to a lack of facilities for a test cell and a special "club" propeller. Much has been said pro and con about using an airframe to run-in an engine, *but the best advice has always been to follow the engine manufacturer's instructions.* These instructions are found either in the overhaul manuals, service bulletins, or service letters. This advice is especially true if the engine has chrome cylinders which require special run-in procedures.

Some amateur-builders use an engine, with known performance and reliability, removed from a flyable aircraft. Even with this kind of background, the amateur-builder should still conduct the same checks and adjustments that would be used on an overhauled engine to ensure its airworthiness.

Before beginning, inspect the engine and propeller carefully. All fuel and oil line connections should be tight. Check the engine mount attaching bolts' torque. Make sure there are no tools, hardware, or rags lying between the cylinders or under the magnetos.

Check and see if you have the proper amount of oil in the engine, and that the oil dipstick reads the oil quantity properly. Some engines are mounted in type certificated aircraft *on an angle* requiring a special part number oil dipstick. The same engine-mounted level in an amateur-built aircraft will not show the correct oil quantity using that same dipstick.

When inspection is completed, you will need the following: 50 feet or more of tiedown rope, tiedown stakes, two chocks for each wheel, fire extinguisher, assorted handtools, safety wire, cotter pins, ear and eye protection, grease pencil, logbooks, clipboard and paper, a watch to time the tests, rags, manufacturer's instructions, and a box to carry everything.

If a cylinder head temperature gauge is not installed in the aircraft, you will need to attach a cylinder head temperature test gauge to the engine. The most common thermocouple designs are the sparkplug washer and the bayonet type. After mounting the cylinder head gauge and the selector switch in the cockpit, you must match the proper numbered thermocouple for each cylinder. The pilot may then select the cylinder to monitor and read the cylinder head temperature gauge.

If you have only one thermocouple, attach it to the rearmost cylinder on the right side of the engine (as viewed from the cockpit). This cylinder usually runs the hottest but, to be sure, run the same tests on all the cylinders.

Additional test equipment you will need are calibrated oil pressure and temperature gauges to test the accuracy of the instruments installed in the aircraft.

Safety Precautions. Before the first engine run, ensure that the aircraft is tied down, the brakes are on, and the wheels are chocked. You and your helpers should wear ear and eye protection and be checked out on fire extinguisher operation. During all engine runs no one should stand alongside the engine, or in line with the propeller. Making minor adjustments to a running engine, such as idle and mixture settings, could be a *very dangerous procedure* and should be done with great care by experienced individuals.

The First Run. The first start of the engine is always a critical operation. Attach an external calibrated oil temperature and pressure gauge to the engine. Your main concern should be getting an oil pressure reading within the first 20 to 30 seconds. If no oil pressure reading—shut down.

There are two common problems that could cause no oil pressure. The first would be air in the oil pressure gauge line. This is easily fixed by loosening the line connection near the oil pressure gauge and squirting oil into the line until full. Another option is, with the engine running, to carefully "bleed" the air out of the line near the oil gauge by loosening the B-nut that connects the oil line to the gauge. The second problem could be an internal problem within the engine, most likely the oil pump, and this will require an engine teardown.

With good oil pressure/temperature readings and the engine running smoothly, ensure that the engine oil pressure and temperature gauges in the cockpit read the same as the calibrated oil pressure and temperature gauges you attached to the aircraft for the first run. The accuracy of the cockpit engine gauges is critical, not only for the engine run-in period, but also for in-flight cooling tests.

Work your way through the engine manufacturer's run-in schedule. The majority of the engine manufacturers recommend a series of engine runs from low rpm to maximum rpm in 200 rpm increments. The runs last about 20 minutes each with a cool down period in between. Each test includes a warm up rpm, then a gradual increase to the desired rpm, followed by a gradual cool down period where the rpm is decreased to idle. The secret to a successful engine run is letting the engine cool off completely between engine runs.

> NOTE: Engines with chrome cylinders or chrome rings require quite different, high power, run-in programs. Follow the manufac-

turer's run-in instructions to ensure the engine will perform satisfactorily over its lifetime.

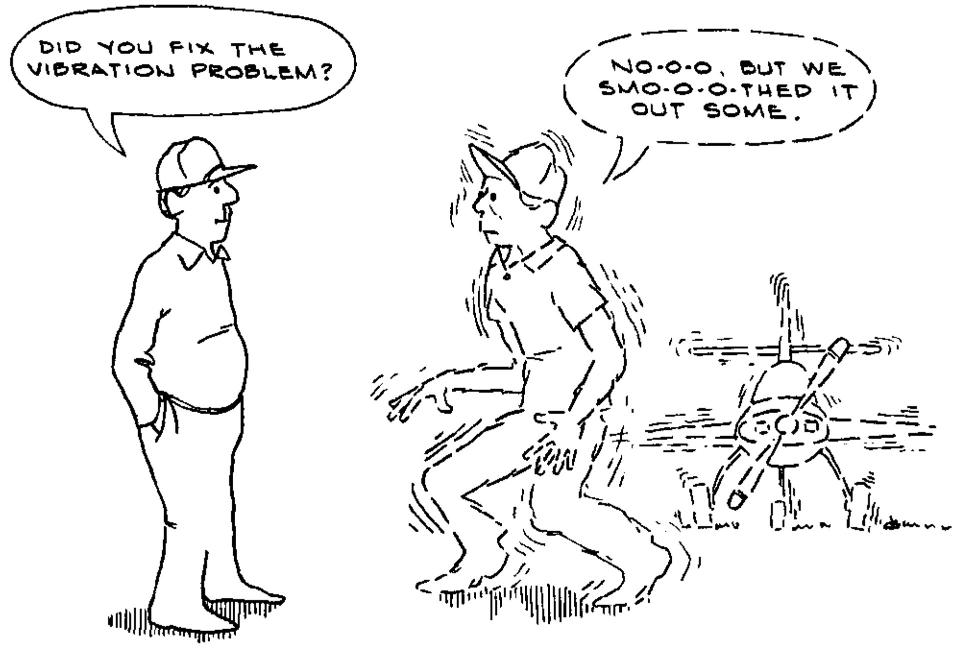
This cooling off period usually takes about an hour. Why so long? A newly overhauled engine needs time for the internal parts—such as rings, cylinders, valves, bearings, and gear faces—to expand and contract several times to obtain a smooth surface that retains its "memory" from then on. For the new engine it is a painful process even when done right. So please, do not skip any of the recommended runs to save time. If you do it will cost you in overall engine performance, oil consumption, reliability, and engine lifespan.

During the engine run monitor the cylinder head temperature, oil temperature, and oil pressure. Record all the readings and adjustments made for future reference. If you notice the cylinder head temperatures are rising close to the red line, reduce power and stop the test. Some causes of high cylinder head temperatures are: sparkplugs with the improper heat range, cooling baffles missing or broken, partially plugged fuel nozzles (applicable to fuel injected engines), fuel lines of improper internal diameter, engine improperly timed both mechanically and electrically, or excessively lean fuel mixture.

Within the first two hours of running the engine, drain the oil and pull the oil screen/filter. Check the screen/filter for ferrous metal with a magnet. Next, wash and inspect the screen/filter for nonferrous metal, such as brass, bronze, or aluminum.

A very *small quantity* of metal in the screen is not uncommon in a new or newly overhauled engine. It is part of the painful process of "running-in" mentioned earlier. However, if subsequent oil screen checks (two hours apart) give evidence that the engine is "making metal," this means a small war is being waged inside the engine and a teardown inspection is required.

SECTION 8. ADDITIONAL ENGINE TESTS



Idle Speed and Mixture Settings. When the initial engine "run-in" tests are complete, doublecheck your idle speed and mixture settings. To find out if your mixture setting is correct, perform the following:

1. Warm up the engine until all readings are normal.

2. Adjust the engine rpm to the recommended idle rpm.

3. Slowly pull the mixture control back to idle cut off.

4. Just before the engine quits, the engine rpm should rise about 50 rpm above where it would be if the mixture is properly adjusted. If the rpm drops off without any increase in rpm, then the idle mixture is set too lean. If at cutoff the mixture increases more than 50 rpm, then the mixture is set too rich.

> NOTE: Some amateur-builders, after properly setting the idle mixture/rpm to the manufacturer's specifications, increase the engine idle rpm by 100 rpm for the first 10+ hours of flight testing. This is to ensure that the engine will not quit when the throttle is pulled back too rapidly, or when power is reduced on final.

Magneto Check. Your magneto checks should be smooth and the difference between magneto rpm drops should average about 50 rpm. You should also perform a "hot mag" check to ensure against the engine, on its own, deciding when and where to start.

To perform a hot mag check, run up the aircraft until the engine is warm. At idle rpm, turn the magneto switch off; the engine should stop running. If the engine continues to run, one or both of the magnetos are hot (not grounded).

The usual causes for a hot magneto are the "P" lead coming out of the magneto is broken (open circuit) or there is a bad magneto switch. *This is a real threat to the safety of anyone near your aircraft and must be repaired at once.*

If the engine is misbehaving and you determine it is an ignition problem, run the engine on the bad magneto for about 30 seconds at 1500 rpm. Without switching back to both magnetos, shut off the engine. Your assistant should quickly mark with a grease pencil an area on the exhaust stacks about an inch from the flange that attaches the stacks to the cylinders.

Now check the marks on the stacks. If the grease mark has not been burned to a grayish-white color and it still retains most of the original color, then you have identified the "cold cylinder." The problem is most likely a sparkplug, ignition lead, or the magneto. To identify if the sparkplug is bad, switch the sparkplug which is fired by the bad magneto to another cylinder. If the grease pencil test proves the problem moved to the new cylinder, then the sparkplug is bad. If the problem remains with the original cylinder, then the ignition lead or the magneto is bad. This same test can be performed by using either the aircraft's cylinder head or EGT gauges, if so equipped, to determine the cold cylinder.

Carburetor Heat. During your engine tests, ensure that you get a positive reduction in rpm when you apply "carb heat." If you notice no reduction in rpm, check the carb heat control for full travel and for air leaks or poor installation of the air tube from the heat muff to the carburetor air box.

Fuel Flow Check. This is a field test to ensure that the aircraft engine will still get enough fuel to run properly at all times, even if the aircraft is in a steep climb or stall attitude.

First the aircraft must be placed at an angle five degrees above the aircraft's highest anticipated climb angle. This is usually done by building a ramp to get the nose of the aircraft at the proper angle. Make sure the aircraft is tied down and chocked. With *minimum fuel in the tanks,* disconnect the fuel line to the carburetor. The fuel flow with a gravity flow system should be 150 percent of the fuel consumption at full throttle. With a pressurized fuel system, the fuel flow should be at least 125 percent.

Since full power fuel consumption of most modern engines is around .55 pounds per brake horsepower per hour for a 100 horsepower engine, the test fuel flow should be 82.5 pounds, or 13.7 gallons per hour, for gravity feed, or 68.75 pounds, or 11.5 gallons per hour, for a pressurized system. No one wants to wait an hour, so divide the pounds per hour by 60 and you get 1.4 pounds and 1.15 pounds per minute fuel rate, respectively.

> NOTE: Formula for fuel flow rate gravity feed .55 x engine horsepower x 1.50 = pounds of fuel per hour divided by 60 to get pounds per minute, divided by six to get gallons per minute. For a pressurized system just substitute 1.25 for 1.50 to determine fuel flow rate.

If the aircraft's fuel flow rate is less than planned and there are no restrictions in the lines, install a mechanical or electrical fuel pump or larger internal diameter fuel lines prior to first flight.

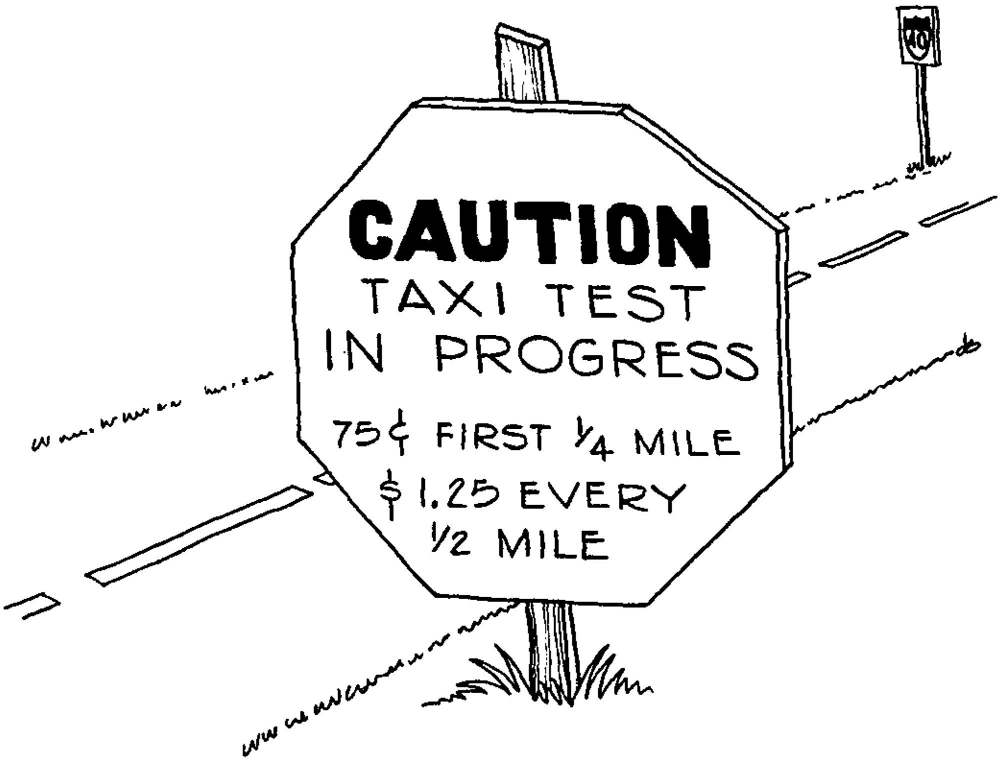
When you have completed your engine run-in procedures, perform another differential compression check on the engine and record the findings. If a cylinder has *less than 60/80 reading* on the differential test gauges, the cylinder is suspect. With a sturdy friend holding the propeller at the weak cylinder's top dead center position, and with compressed air still being applied by the differential compression tester—*Listen!* If there is the sound of air coming out of the exhaust pipe, then the exhaust valve is not seated properly. If air is heard coming out of the air cleaner/carb heat air box, an intake valve is bad. If you remove the oil dipstick and you hear air rushing out, the piston rings are the problem.

Visually inspect the engine carefully in preparation for the taxi tests. Do not fly the aircraft if anything is wrong, no matter how minor.

CHAPTER 2. TAXI TESTS

SECTION 1. LOW SPEED TAXI TESTS

"Leave nothing to chance." Tony Bingelis



> NOTE: Both low and high speed taxi tests should be made as if each were the first flight. The pilot should be wearing proper clothing, seatbelt/shoulder harness, and helmet, and be mentally prepared for the possibility of flight.

The purposes of the taxi tests are:

1. To identify the aircraft's ground handling characteristics and to ensure there is adequate directional control at all speeds.

2. To determine if the aircraft's engine cooling and braking systems are adequate.

3. To predict the flight trim of the aircraft and its handling characteristics during takeoff and landings.

4. To allow the pilot to become proficient with the braking characteristics of the aircraft.

Prior to beginning taxi tests in a taildragger, the pilot should sit in the cockpit while someone raises the tail almost to the level flight position. The pilot should spend some time getting use to the attitude of the aircraft. This is the approximate attitude of the aircraft in the takeoff position. An unexpected deck angle on the first flight is not a welcome experience.

> NOTE: Taxi tests should always be monitored by at least one other member of the flight test team, who will watch for evidence of fire/smoke or other problems not visible to the pilot.

The taxi tests should begin with a taxi speed no faster than a person can walk. The pilot should spend this time getting acquainted with the aircraft's low speed handling characteristics by practicing 90°, 180°, and 360° turns and braking action. The pilot should also keep in mind that monitoring the oil pressure, oil temperature, and cylinder head temperature, and maintaining them within limits are critical job functions that must not be forgotten.

> NOTE: The builder should be aware that some aircraft brake manufacturers have *specific brake lining conditioning procedures* (break-in) for metallic and nonasbestos organic linings.

Proper brake lining conditioning should be completed before starting the low and high speed taxi tests. If not properly conditioned, the brake lining will wear quickly and give poor braking action at higher speeds.

After each taxi run, inspect the aircraft for oil and brake fluid leaks. No leak should be considered a minor problem. Every leak must be repaired and the system serviced prior to the next taxi test.

SECTION 2. HIGH SPEED TAXI TESTS

"Know your airplane, know it well, know its limitations, and above all—know your own limitations." Bob Hoover

> NOTE: The first high speed taxi tests should be made in a no-wind or a light headwind condition. The pilot should ensure that the tests will not interfere with normal airport operations nor create a safety hazard for other aircraft.

The pilot must determine *which way the propeller rotates.* Propeller rotation will determine which rudder pedal you press to compensate for the asymmetrical thrust of the propeller blades. For example, a Volkswagen engine that rotates counterclockwise, viewed from the cockpit, will need left rudder pedal held during takeoff.

As with every part of the flight testing program, the high speed taxi tests should follow the *Flight Test Plan.* Start slowly and do not progress to the next step until thoroughly satisfied with the aircraft's and the pilot's performance.

Each taxi run should be five mph faster than the last run until the aircraft is within 80 percent of the predicted stall speed. Prior to reaching the predicted stall speed, the pilot should note aileron effectiveness by being able to rock the wings slightly. As taxi speeds increase the pilot will notice the rudder becoming more responsive and directional control will improve.

In a *nose gear aircraft* the pilot should be able to raise the nose of the aircraft to a takeoff attitude at 80 percent of the stall speed. If the aircraft's nose cannot be raised at this speed, then the weight and balance and center of gravity range should be rechecked. Most likely it is a forward center of gravity (CG) problem or the main gear is too far aft.

In a *tailwheel aircraft* at 80 percent of stall speed, the pilot should be able to lift the tail and assume a takeoff position. Again, if the tail cannot be raised, recheck the weight and balance and center of gravity range. Most likely it is a rearward CG problem or the main gear is too far forward.

> CAUTION: Heavy brake action at high speeds in tailwheel aircraft may cause directional control problems (ground loops) or nose over.

Duplicate each taxi test with the flaps in the takeoff and landing configuration. Record the results in the Flight Manual.

Determine the approximate point on the runway where lift-off will occur and mark it with a *green flag* if no convenient existing reference is available.

Next, you should determine how much runway the pilot will need if it is necessary to abort the takeoff. This is usually accomplished by accelerating to 80 percent of lift-off speed, bringing the engine back to idle, then applying heavy braking action to bring the aircraft to a full stop.

When you have determined the distance required to come to a full stop after aborting, add 20% to the distance. Measure that distance from the opposite end of the runway of intended use and mark it with a *red flag* if no existing reference is available.

The taxi tests are completed when the pilot is satisfied with both his/her own and the aircraft's performance. Prior to the first flight, the aircraft should be *thoroughly inspected* with special attention paid to the landing gear, brake system, engine, and propeller.

During this inspection all discrepancies should be fixed. Next, examine the oil screens/filters for metal, flush the fuel system, clean all the screens/filters, and perform a leak check on both the engine and the fuel system by running up the aircraft.

SECTION 3. THE ROLE OF THE CHASE PLANE

The primary purpose of the chase plane is to watch the parts/systems of the test aircraft not visible to the pilot and report any problems, to assist the test pilot in following the flight plan, and to watch for other aircraft. The following suggestions and recommendations should be considered.

A single chase plane should be used on at least the first two flights and the first time the amateur-built aircraft's gear is retracted. The chase plane pilot should have some formation flying experience and be thoroughly briefed on the intended flight.

Have two persons on board the chase plane. One to fly the aircraft and maintain a *safe distance* from the amateur-built aircraft. The other should be an observer to visually check the test aircraft and communicate with the pilot (122.9 MHz).

A good chase plane position is about 100/200 feet off the left side and slightly behind and below the test aircraft.

Pilots of both aircraft must keep each other informed of their intended action or maneuver prior to execution.

The secondary purpose of a chase plane is to function as airborne communications for the test plane in the event of radio failure or if the test aircraft has gone down off the airport. The chase plane can direct emergency personnel to the test aircraft location and maintain radio communications with the tower/air traffic control facility.

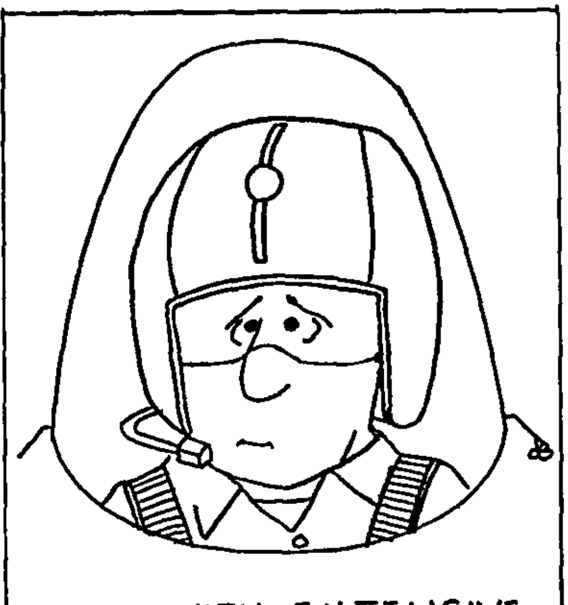
AN IMPORTANT POINT!

All flight testing of amatuer-built aircraft is restricted to a specific flight test area. If a pilot needs to run tests that require more airspace, contact the FAA district office that issued the aircraft's operation limitations and request a change. If a pilot is found to be operating an experimental aircraft in violation of the operation limitations, the FAA may take certificate action or impose a civil penalty.

CHAPTER 3. THE FIRST FLIGHT

"It is critically important that a test pilot never succumb to the temptation to do too much too soon, for that path leads but to the grave." Richard Hallion (1987)

PILOT WITH ZERO PREPARATION ON FIRST FLIGHT.



PILOT WITH EXTENSIVE TRAINING, PLANNING AND TESTING BEFORE FIRST FLIGHT.

Note: A properly secured portable tape recorder with a voice activated mike and/or a pilot's knee board are two suggested ways to record test flight data.

Recommendation: The best time to test fly an aircraft is usually in the early morning when the winds are calm and the pilot is well rested.

SECTION 1. GENERAL

The first flight is an important event in an amateur-builder's life. However, as proud a moment as this is, it should not be turned into a social occasion sometimes called a "First Flight Party." This kind of situation puts enormous peer pressure on the pilot to fly an aircraft which may not be airworthy or to try a takeoff in marginal weather conditions.

A professional amateur-builder can avoid this trap by following the Flight Test Plan and inviting only those members of the crew needed to perform specialized tasks when testing the aircraft.

A safe first flight begins with ensuring that all emergency equipment and personnel are standing by, radio communications are functional, members of the crew are briefed, weather is ideal, and the aircraft is airworthy. The pilot must be rested and physically and mentally ready for the first flight. In addition, the pilot should review any new data developed for the Flight Manual.

The first flight should be thoroughly flown, first on paper—next in the pilot's mind—then in actuality. The flight should be so well-rehearsed that the actual event is a nonevent.

The aircraft should be given a good preflight inspection by the pilot and one other experienced individual. A thorough aircraft preflight inspection should show:

1. Four times the amount of clean, usable fuel with the proper octane rating onboard than needed for the planned flight.

2. Current weight and balance check. Your CG should be in the forward end of the safe CG range.

This will reduce the chances of instability during approach to a stall and enhance a recovery from one.

3. Oil and brake fluid levels full.

4. Canopy or cabin door latches lock securely and will not vibrate loose in flight.

5. Fuel valve in the correct position.

6. Trim tabs/flaps set in the takeoff position.

7. Altimeter set to the field elevation and cross-checked with the local altimeter setting.

8. Complete control system functional check.

9. Communications check.

10. Engine cowling and airframe inspection plates/fairings secured.

11. The airspeed indicator marked with sticky tape at the *predicted Best Climb* speed, *Best Glide* speed, and *Maneuvering* speed. If these speeds are not available from prototype flight test data, the following conservative guidelines to initially determine the referenced speeds are:

a. BEST ANGLE OF CLIMB (Vx) = 1.5 times the aircraft's predicted lift-off speed.

b. BEST GLIDE SPEED = 1.5 times the aircraft's predicted lift-off speed.

c. MANEUVERING SPEED = 2 times the aircraft's predicted lift-off speed.

SECTION 2. EMERGENCY PROCEDURES

"At the worst possible time, the worst possible thing will happen." Murphy's Law

The *Flight Test Plan* you developed should have a special section on emergency procedures. The responses to each emergency should have been developed based on the aircraft's predicted flight characteristics, airport location, surrounding terrain, and emergency fields nearby.

The following is a list of possible emergencies that may arise during your flight test phase and some suggested responses.

Problem: Engine failure on takeoff.

Response: *Fly the Aircraft!* Establish best glide speed and try to restart engine, if time permits. If you are below 800 feet and the engine will not restart, land straight ahead or 20° on either side of the runway centerline. This is suggested because in most cases you will run out of altitude or airspeed if you try to make a 180° turn back to the airport. *Declare an emergency and shut off the master switch, fuel, and magnetos.*

If you are above 800 feet the chances of making a 180° turn to land downwind on the runway, or to another emergency field nearby, are proportional to the number of practice emergency landings you have made.

Problem: Engine vibration increases with rpm.

Response: *Fly the Aircraft!* Reduce power to minimize the effect of vibration, but maintain safe airspeed and altitude and land as soon as possible.

Problem: Smoke in the cockpit.

Response 1: *Fly the Aircraft!* If the smoke smells like plastic wire installation burning (electrical problem), shut off the master switch, open the fresh air vents to clear the cockpit of smoke/fumes, and land as soon as possible.

Response 2: If the smoke is bluish/grey and has an acrid odor like burning oil, shut the fresh air/hot air vents, and monitor oil pressure and temperature. Be prepared to shut the engine down and land as soon as possible.

Problem: Engine fire.

Response: *Fly the Aircraft!* Shut off the fuel, master switch, and magnetos. Declare an emergency and land as soon as possible.

Problem: Out of rig condition.

Response: *Fly the Aircraft!* Try to use the appropriate trim to offset control pressures. Keep the airspeed high enough to maintain altitude. Make small control inputs, reduce power slowly to avoid controllability problems, and land as soon as practical.

SECTION 3. FIRST FLIGHT

"Always leave yourself a way out." Chuck Yeager

General: The two Flight Test Plan objectives of the first flight are to determine engine reliability and flight control characteristics.

With the preflight inspection completed, you, as the pilot, should ensure that the seatbelt/shoulder harness is properly fitted and allows easy access to all the cockpit controls (verified by a crewmember). *Following the Flight Test Plan and using the starting checklist,* warm up the engine until the engine instruments indicate normal operating temperatures and pressures. A complete check of each aircraft system (e.g., carb heat, magnetos, static rpm, brakes, and controllable pitch propeller, if so equipped) should be performed.

If the airport does not have a tower/UNICOM available, you should transmit over 122.9 MHz the following message:

> "This is experimental aircraft ______ on a local flight test, departing runway ______ at ______ Airport." Every five or ten minutes transmit your N number, location, and intentions.

If the airport is equipped with a tower, notify them that you are an *Experimental Aircraft* on a local flight test and request takeoff instructions.

After receiving permission to takeoff, clear the area, line up on the runway centerline, release the brakes, and *slowly* add power. When the throttle is fully advanced, glance at the engine instruments and tachometer to see if they are in the green and giving full power. A type-certificated engine of 100 horsepower will produce between 2100 to 2300 rpm on the takeoff roll, depending on the type of propeller installed. If the engine oil pressure or tachometer is reading low, *Abort the Takeoff.*

If there is any unusual vibration, rpm exceeding the red line, or engine hesitation, *Abort the Takeoff!*

If you are in a tailwheel aircraft, keep the tail on the runway until the rudder is effective. This usually happens about 35 mph on most aircraft.

As you accelerate and approach the predicted lift-off point (green flag) and reach flying speed, gently ease back on the stick. The first takeoff should be a gentle and well-controlled maneuver with the aircraft doing all the work.

If the aircraft does not want to rotate or you experience unusual stick forces, *Abort the Takeoff!*

If your aircraft has a retractable gear, do not raise the gear on your first few flights until you have explored the aircraft's flying characteristics a little further.

It is recommended that after establishing a safe climb angle: *Do NOT* throttle back, switch tanks, or make large inputs into the flight controls for the first 1,000 feet. At your preselected altitude, reduce power slowly to avoid a pitchup or pitchdown that might be associated with rapid power reductions.

Note if you must hold any additional stick or rudder pressure during the climb. Try reducing any abnormal stick pressures with trim. Each control input should be small and slow. Unusual engine vibrations, rapid oil pressure fluctuation, oil and cylinder head temperatures approaching red line, and decreasing fuel pressure are good reasons to land as soon as possible.

SECTION 4. FIRST FLIGHT PROCEDURES

"In my opinion, about 90% of your risk in a total program comes with a first flight. There is no nice in-between milestone. You have to bite it off in one chunk." Deke Slayton

Climb to at least 2,000 feet AGL and level off. Reduce power slowly. Complete your *cruise checklist.* Circle the airport or emergency field as you monitor engine performance.

Limit your cruise speed to no more than 1.5 times the predicted stall speed of the aircraft. This will reduce the chances of flutter. If the engine appears to be behaving itself, try testing the flight controls.

With the airspeed being monitored, each control input should be gentle and small. Start with the rudder first. Yaw the nose of the aircraft about five degrees left, then right. Note the response. Next, raise the nose about three degrees up, trim, and note the response. After the aircraft is stabilized, level off and try three degrees nose down, trim and note the response. Next try a gentle bank of no more than five degrees to the left, then one to the right. If the aircraft is stable and feels good, try a few 90° clearing turns, followed by two 360° turns, first one to the left then one to the right at a bank angle of 10 degrees.

If the aircraft responds normally, gradually increase the bank angle in succeeding turns of 20°. If you encounter no problems, slowly climb to 5,000 feet AGL (using the climb checklist and monitoring engine gauges), level off, fly an imaginary pattern, test the flaps, and do not forget to announce every 5 to 10 minutes over the radio your location, altitude, and intentions. Next, practice approach to landing by descending to 4,000 feet AGL first, then to 3,000 feet AGL, *using your descent checklist.*

During these maneuvers, control forces should increase in proportion to control deflection. Remember to keep informing the tower/UNICOM/chase plane of what is happening. About 10 minutes into the flight you should plan a couple of minutes for resting, flying straight and level, monitoring the gauges, and enjoying the view.

At low cruise power setting, straight and level, observe how the aircraft trims out. Do the "fixed" trim tabs on the rudder and aileron need adjustment? Is the adjustable elevator trim control reasonably effective? Is the stick/yoke slightly forward of the midposition in straight and level flight?

Climb slowly back up to 5,000 feet AGL. Now, you need to establish two things:

1. Is the aircraft *controllable* at low speeds?
2. What is the *approximate stall speed?* Both of these questions can be answered with an approach to a stall. Do not perform *full stall* checks at this time!

Level off at altitude and make two clearing turns. Stabilize airspeed, heading, and altitude; apply carb heat; set the flaps in the landing configuration; and reduce power slowly to 900 rpm. *Trim!* If you cannot trim the aircraft properly, as it is not uncommon on first flights, you can still safely proceed with the test as long as the stick forces are not unusually heavy.

With the aircraft speed approximately 1.4 times faster than the predicted stall speed, raise the nose slowly. You want the aircraft to start decelerating slowly, about 1/2 mph/knot a second. Even slower is fine, there is no rush. A 30 mph/knot deceleration at 1/2 mph/knot per second will take only a minute.

As the aircraft slows down, take note of all the things that happen as the speed bleeds off. Look at the changing nose attitude. See how the stick force changes. Make sure you keep the wings level and the ball in the middle.

Note how much rudder it takes to keep the ball centered. Every few seconds make very small control inputs to make sure the aircraft is still behaving itself. If the aircraft does not respond to small control inputs—and you should not expect it to respond as quickly as it did at higher speeds—then make the input a little bit larger. Increase the amount of input progressively, not all at one time. Pay particular attention to the response to nose-down elevator inputs, which is what you need for recovery.

Notice any changes in flight characteristics and the speeds at which they take place. Be especially alert for the onset of prestall buffet. Do you feel the buffet through the stick? Through the airframe? Through the seat of your pants? Does the nose of the airplane want to rise on its own? How strong is the buffet? Would it get your attention if you were concentrating on something else? Is the buffet continuous?

NOTE: On some clean, high performance aircraft or aircraft with unusual wing designs, a prestall buffet may not exist and the stall may be abrupt and violent with a large amount of wing drop.

Keep making small control inputs at intervals to check the aircraft's responses. At approximately five mph/knots before the predicted stall speed or at the first sign of a prestall buffet, note the airspeed and *stop* the test. Recover and write down the prestall indicated airspeed. This airspeed should be the reference stall speed for your first landing.

The prestall recovery response should be a smooth, but quick, forward stick movement. This response should be enough to reduce the angle of attack to the point where the airplane is flying normally again.

A wing drop may occur in the approach to a stall but, if it becomes necessary to raise a low wing, do it with rudder—*Not Opposite Aileron.* Use of ailerons at a lower speed raises the chances for a stall or a departure from controlled flight.

There is no need to do more than gain a few mph/knots to fly out of a prestall condition. Once more back in straight and level flight and using the information you have learned, you can practice a few more recoveries. Remember, you will be constantly loosing altitude so you will need to slowly climb back up to 5,000 feet AGL to continue with further flight testing.

Do not get so involved in what you are doing that you lose sight of the overall objective on the first flight, which is to *Get the Aircraft Safely on the Ground.*

The First Flight Test Plan should call for no more than 30 minutes of actual flight time. This is to reduce pilot fatigue and the possibility of an engine failure or airframe malfunction occurring due to vibration or possible construction errors.

> NOTE: You, as the pilot, may elect to make several practice approaches to landing at altitude or low approaches to the active runway in order to get a good grasp of the lower airspeeds, aircraft attitude, and overall feel of the aircraft as it is set up in the landing configuration. Before each low approach at the airport, you should advise the tower/UNICOM of your intentions, avoid other traffic in the pattern, and use the *landing checklist.*

When you have completed all the tests called for by the Flight Test Plan, notify the tower/UNICOM of your intention to land. *Complete your landing checklist before entering downwind.* Keep all turns in the pattern less than 20° of bank. Do not cross-control by using the rudder to move the nose. This will increase the bank angle which most pilots will use opposite aileron to correct. If allowed to continue, and with back pressure on the stick, a cross-control stall and a near vertical bank attitude with no altitude left for recovery will result.

On final approach the aircraft speed should be no less than 1.3 or more than 1.4 times your recorded "first flight" prestall speed. Landings, especially the first one in your amateur-built aircraft, are always exciting. Take your time and do not over control. If the landing conditions are not ideal, you should be prepared to go around.

The actual touchdown should take place within the first 1,000 feet with brake action being applied before the red (abort) flag marker on the runway.

After taxiing in, secure the aircraft, and debrief the flight with your crewmembers. Perform a careful postflight inspection of the aircraft and take the rest of the day off.

CHAPTER 4. THE FIRST 10 HOURS

"One can get a proper insight into the practice of flying only by actual flying experiments." *Otto Lilienthal (1896)*

SECTION 1. THE SECOND FLIGHT

Before the second flight, you, as the pilot, should ensure that all discrepancies noted on the first flight are corrected. If this will require more ground run-ups, rigging adjustments, or taxi tests, so be it. One of the biggest mistakes would be for a pilot to takeoff in an aircraft with known airworthiness problems. The Law of Aerodynamics does not often forgive this kind of mistake.

The preflight inspection should be similar to the one performed earlier for the first flight, including inspecting the oil and fuel screens for contamination.

The second flight, again lasting 30 minutes, should be a carbon copy of the first one with the exception that all discrepancies have been corrected since the first flight. If problems are not corrected, all further flight testing should be cancelled until solutions are found.

SECTION 2. THE THIRD FLIGHT

"Plan the flight, fly the Plan." Sign on the wall at Naval Test Pilot School, Paxtuxent River, MD

The third flight should concentrate on engine performance. This flight should be one hour long at 5,000 feet AGL or higher, and never further than gliding distance from the airport or emergency landing field.

Engine oil pressures, oil temperatures, fuel pressure, and cylinder head/coolant temperatures should be monitored and recorded from 55 percent through 75 percent rpm. At the higher engine rpm do not exceed 80 percent of the maximum cruise speed. This is to reduce the possibility of encountering a flutter condition. Record the engine responses to the application of carb heat, leaning the mixture at altitude, and changes to power settings, airspeed, and propeller pitch settings, if applicable.

Resist the temptation to explore the more exciting dimensions of flight. Stick to the Flight Test Plan and *perform a good evaluation of your engine.* After landing, review the data with your crewmembers, make adjustments as needed, and perform another good postflight inspection of the aircraft.

After the first two hours of flight testing, the pilot should be able to make the initial determination that the engine is reliable and the aircraft has good control response.

SECTION 3. HOURS 3 THROUGH 10

"Keep your brain a couple steps ahead of the airplane." Neil Armstrong

These next eight hours of one-hour test segments should confirm the results of the first two hours and explore the following areas:

1. Gear retraction (if applicable)
2. Climb and descent effects on engine operation
3. Airspeed indicator in-flight accuracy check

NOTE: After each test flight *all discrepancies* should be cleared before the next flight. The aircraft must be *thoroughly inspected* each time.

Gear Retraction. Before the gear is retracted in flight for the first time, it would be wise to put the aircraft up on jacks and perform several gear retraction tests, including the emergency gear extension test. This test will determine if, in the last couple hours of flight testing, any structural deformation or systems malfunctions have occurred. In addition to the gear retraction tests, the pilot/chase pilot/ground crew should review the Flight Manual and emergency checklist procedures for malfunctioning gear and plan accordingly.

If at any time the aircraft has suffered a hard landing or side loading on the gear during flight testing, the gear should be tested for operation and condition.

Your first gear retraction test should be done with the aircraft flying straight and level at or above 5,000 feet AGL. The airspeed must be well under the maximum landing gear retraction airspeed. When the gear is being retracted, note if there is any tendency for the aircraft to pitch or roll. Record what changes to the aircraft trim are required to maintain straight and level flight.

If there are no adverse flight reactions or system malfunctions, cycle the gear several times. When you are satisfied with the straight and level gear retraction tests, try an emergency gear extension *only if this is practical.*

Next, with the gear extended, slow the aircraft to 1.3 times the preflight stall speed, stabilize, lower the flaps to the takeoff position, trim, and maintain straight and level flight.

Simulate a normal takeoff by increasing rpm to full power, raising the nose 3°, trimming, and then retracting the gear. Note the following: Aircraft reaction in pitch or roll, length of time for gear to retract, trim requirements, and time to maintain a steady 1,000-foot climb before leveling off.

Practice a simulated takeoff several times to ensure that the aircraft's response is predictable and the gear retraction system is mechanically reliable.

Climbs and Descents. The purpose of these tests is to *monitor engine performance and reliability.* The pilot should only start the tests after the aircraft has been flying straight and level for at least 10 minutes to stabilize engine oil pressure and temperatures.

Engine oil pressure and temperatures must be kept within the manufacturer's limits at all times during these tests. High summer temperatures might place some restrictions on the flight test program because both oil and cylinder head temperatures will increase 1° for each 1° increase in the outside air temperature.

The first climb should be at a shallow angle at full power. Start at a designated altitude and climb for one minute. Record the engine temperatures and pressures. Reduce power, stabilize the engine temperature, and repeat the test—except this time increase the climb time by 30 seconds, record the results. Repeat the tests until you have encountered an engine limit or you have reached a five-minute climb period at full throttle.

Descent should begin above 5,000 feet AGL with both the engine temperatures and pressures stabilized. The test pilot should use *carb heat and clear the airspace* below him before starting the descent. The first descent should be at a shallow angle, at low rpm, and last for 30 seconds, not exceeding 1.5 times the estimated stall speed of the aircraft. During long, low power descents, the pilot must be on the alert for a too rapid cooling of the engine (drop in cylinder head temperature). A rapid cooling of the engine (e.g., cowl flaps left open) may cause the engine cylinders to crack.

Conduct each test as before, except increase the time by 30 seconds until limited by the manufacturer's restrictions or you reach five-minute descents. Record your temperatures, pressures, altitudes, and airspeeds data for possible additions to your Flight Manual.

Airspeed In-Flight Accuracy Check. We offer, for your evaluation, the following procedure for airspeed calibration. A measured course should be chosen with readily identifiable landmarks at each end. The landmarks should be a known distance apart and the length of the course should be at least three miles long.

The pilot must fly a precision course, ideally in a no wind condition, while maintaining a constant altitude, magnetic heading, engine rpm, and airspeed. The pilot must record the temperature, pressure altitude, and the time over the course in each direction. The average of these speeds is the true groundspeed of the aircraft. An E6B computer will convert the temperature, altitude, and groundspeed into Calibrated Airspeed.

> NOTE: The difference between the E6B computer reading and the aircraft's airspeed indicator reading is the error in the instrument or compressibility, and/or caused by the installation of the system in the aircraft.

The airspeed indicator calibration runs must be made several times for each of the selected airspeeds. Such accuracy test runs should be at 500 to 1,000 feet in each direction. Start at the lowest flying speed and work up to a high cruise speed using 10 mph/knots increments. Most errors will be found at the lower speed range due to the angle of the pitot mast to the relative wind and/or the location of the static ports.

If you have a retractable gear aircraft, you should test the airspeed indicator with the gear up and gear down.

Record all the data in order to prepare an airspeed calibration table for your Flight Manual.

CHAPTER 5. EXPANDING THE ENVELOPE

"Checklist! Checklist!! Checklist!!!" Jim Byers, Flight Instructor/Examiner

SECTION 1. GENERAL

Before beginning the next series of flight tests, it is highly recommended that the aircraft have an "annual" type inspection. It is important for you, as builder/pilot, to inspect the aircraft as, within the last 10 hours, it has been subjected to what can be kindly referred to as a "shakedown cruise."

During the inspection you should check the *torque on the engine mounts, propeller bolts, and landing gear.* Doublecheck the flight control hinges, rod end bearings, and cable installations and attachments in addition to completing all the standard inspection and maintenance items. This includes checking the oil and fuel filters for metal or other forms of contamination.

Even if there are no telltale odors or fumes, perform another carbon monoxide (CO) test using a floodlight or an industrial CO test meter. There is a strong possibility that recent operational vibration and landing stress have opened new paths for CO to enter the cockpit.

SECTION 2. HOURS 11 THROUGH 20

"Fly Scared!" Rear Admiral Jack Ready, U.S.N.

The next 10 hours of flight testing should look at:

1. Stall speed.
2. Best rate of climb speed.
3. Best angle of climb speed.
4. Slow flight.

NOTE: It is recommended that the following tests be conducted with the aircraft's fuel tanks full and a forward center of gravity (CG).

Stall Speed Tests.

1. As with any unknown, approach incrementally, slowly, and follow your Flight Test Plan. To improve safety and reduce the possibility of spins, the aircraft should be tested with a forward CG loading. Start the stall tests at least 6,000 feet AGL. Make your clearing turns and stabilize your airspeed and altitude. Your first full stall should be with power off, no flaps, and gear up, if applicable. After clearing the area, reduce the airspeed to 1.3 times the predicted stall speed and trim.

NOTE: Some clean high performance aircraft may not have any prestall buffet. The stall may be abrupt and violent with large amounts of wing drop.

2. The prestall and stall behavior that we would most like to see is an unmistakable warning buffet starting lightly, about 5 to 10 mph/knots above the eventual stall speed, and growing in intensity as the aircraft slows down.

3. The desired stall characteristics should be a straightforward nose drop with no tendency for roll or pitchup. This docile and forgiving behavior implies a stall that has started at the wing root and progressed smoothly outboard. This gives an early warning to the pilot in the form of the buffet from separated airflow over the tail. The ailerons will continue to operate in the attached airflow until the aircraft's stall speed is reached and the wing stalls.

4. Begin by using the exact same procedures that you employed on your first flight. Cockpit items secured and carburetor heat on. Decelerate slowly at 1/2 mph/knot a second. Make small control inputs, keep the ball centered, and note the aircraft's reaction. Let the aircraft stall—recover immediately with stick forward and increased power. Note the stall speed.

5. Practice the same stall sequence several times at 1/2 mph/knot speed bleed down rate to determine the power-off, one G. stall speed. Next, practice the same stall series with flaps, starting with the lowest setting first and working slowly to the full flap configuration. Record your findings.

6. After exploring the stall and recovery behavior in a slow deceleration with the ball in the middle, try a series of stalls with flaps up and then flaps down with a faster rate of deceleration. Do not exceed the

deceleration rate that you would expect in normal operations.

7. *Power-on Stalls.* As before, use the same procedures moving from the known to the unknown. Increase power incrementally and run a stall test, until you reach full power. It is not wise to jump from idle to full power with the resultant large changes in pitch attitude, torque reaction, and slipstream effect on the wing and tail.

8. *Conducting Power-on Stalls.* It is recommended that the aircraft be stabilized in the level flight at lift off speed. The power-on stall point is reached by slowly increasing the power to desired power setting while steadily increasing the pitch attitude. You should keep the ball in the center until the onset of stall buffet. A power-on stall may be more likely to cause a wing drop than one at idle. This is due to the torque reaction and because the propeller slipstream tends to keep the flow of air over the inboard (root) section of the wing despite the higher angle of attack. This will allow the root portion of the wing to continue flying after the wingtip stalls, dropping a wing.

9. Tip stalls usually do not give a warning, and will almost invariably result in a wing drop of some severity. These stalls will be more likely to result in a spin even though the controls are not mishandled. If the spin does not develop, you will still lose considerably more height in the recovery than if the stall had been a normal straight-ahead stall.

10. If you yield to instinct and try to correct the wing drop with aileron, it could result in a spin. Since a sharp wing drop could be regarded as the onset of spin auto rotation, the recommended corrective action is prompt application of full opposite rudder combined with lowering the nose to the horizon or below. Take care to avoid this situation until you have tested the aircraft's spin behavior.

11. Perform the same sequence of events for power-on stalls as you did for power-off stalls, include using flaps unless limited by the designer's instructions. Record all your findings for the aircraft's Flight Manual.

> NOTE: Aircraft with retractable gear will have to go through a separate series of slow flight and stall checks with the gear extended, with and without flaps. Record the different stall speeds in your Flight Manual.

Best Rate of Climb Speed Tests.

1. To determine approximately the best rate of climb speed for your aircraft, the following suggestions are offered: Perform the tests in smooth air, free from thermal activity. Select an altitude (e.g., 1,000 feet AGL) as a *base* altitude. Use a heading 90° to the wind.

2. Begin a full throttle climb below the predetermined *base* altitude and stabilize at a preselected airspeed approximately 15 mph/knots above the predicted best rate of climb speed. As the aircraft passes through the *base* altitude begin a one-minute time check. At the end of one minute, record the altitude gained. Descend back down below the *base* altitude, and run the test again. However, for each succeeding test, the pilot should decrease the airspeed by five mph/knots until reaching an airspeed 10 mph/knots higher than the stall speed of the aircraft. Record the airspeed and altitude for each climb on a graph similar to figure 3.

The airspeed that shows the greatest gain in altitude is the aircraft's best rate of climb speed.

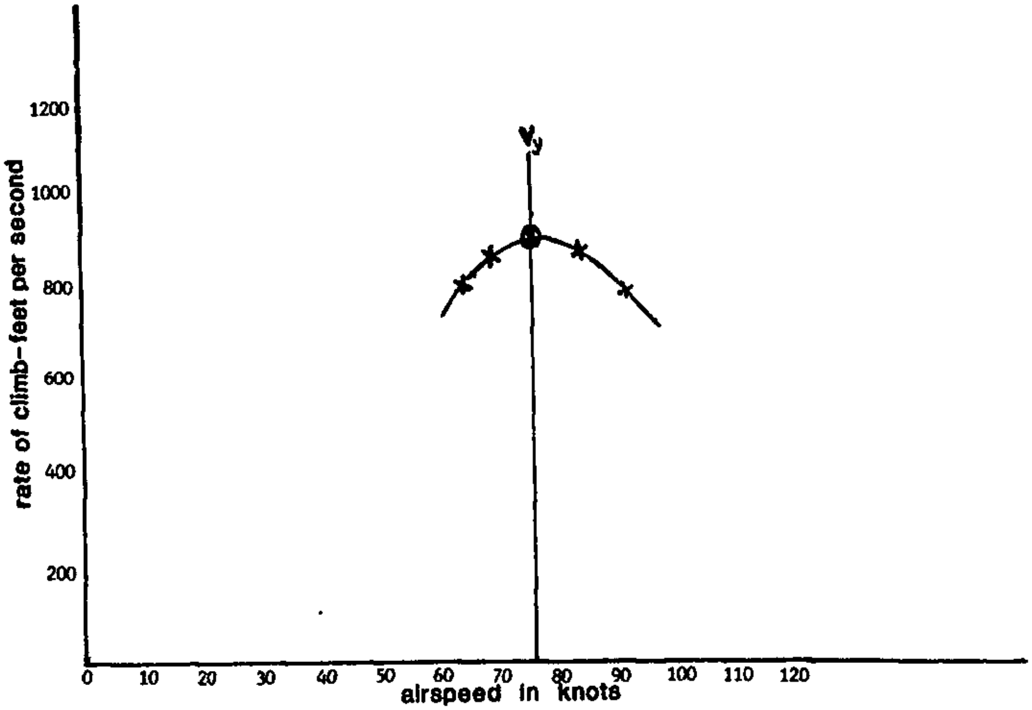


FIGURE 3. Climb Airspeed and Altitude Graph

Best Angle of Climb Speed Tests.

1. Best angle of climb speed can be found by using the same chart developed for your best rate of climb tests. Draw a line from the zero rate of climb feet per minute (see figure 4) outward to a point, on the rate of climb airspeed curve where both lines touch. At this point, draw a line straight down to the airspeed leg of the chart. The airspeed that the line intersects is the best angle of climb airspeed.

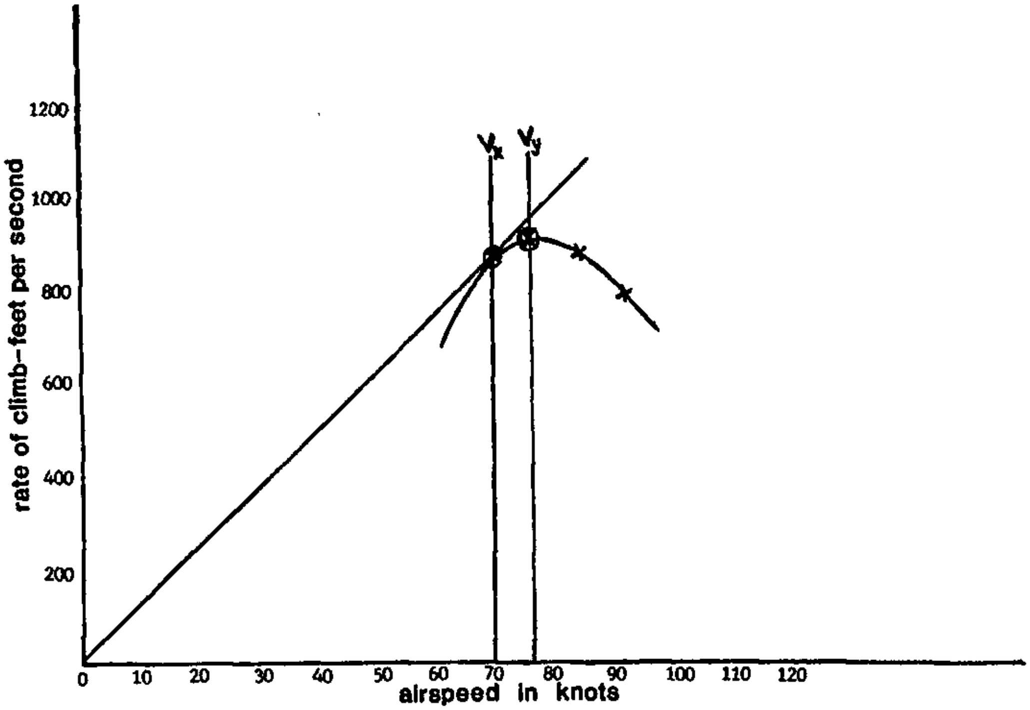


FIGURE 4. Best Rate of Climb Speed Graph

Slow Flight Tests.

1. For added safety, the slow flight tests should be performed at 5,000 AGL or higher to allow room for spin recovery. *The primary purpose of these tests is for you, the pilot, to become familiar with the aircraft's handling qualities at the minimum gear up/down airspeeds and power settings.*

2. The tests should be done with and without flaps. Start the tests with the flaps up and at 1.3 times the stall speed of the aircraft. Once the aircraft is stabilized, reduce the airspeed by five mph/knots. Maintain your altitude. Keep reducing the airspeed until you are approaching a stall.

3. Maintain five mph/knots above your previously determined stall speed. This figure is your initial slow flight airspeed. Next, practice with each flap setting. Note its affect on the aircraft's performance. If the aircraft has retractable gear, you should test in all gear up/down and flaps up/down combinations. Later in the flight test program you will run these tests once more, but with the *aircraft at gross* weight to determine the actual slow flight airspeed and stall speeds.

Remember, to help reduce the possibility of unplanned stalls in slow flight configurations, you should avoid bank angles of more than 5°.

SECTION 3. HOURS 21 THROUGH 35, STABILITY AND CONTROL CHECKS

"A superior pilot uses superior judgment to avoid those situations which require the use of superior skill."
Old Aviation Proverb

General: Before attempting to satisfy the requirement (ref. FAR § 91.42) that the aircraft is controllable throughout the normal range of speeds, you must do two things.

1. Perform another complete inspection of the aircraft, including oil and fuel system filter checks.

2. Carry out a closer examination of the stability and control characteristics of your aircraft.

Stability and control checks will be centered around the three axes of the aircraft: Longitudinal axis, the Lateral axis, and the Vertical axis.

All tests need a starting point. The starting point for stability and control checks is called the State of Equilibrium. An aircraft is said to be in a state of equilibrium when it experiences no acceleration and remains in a steady flight trimmed condition until the force or moment balance is disturbed by an atmospheric irregularity or by pilot input.

Definitions:

1. Static Stability - (positive) is when an aircraft tends to return initially to the state of equilibrium position.

2. Static Stability - (neutral) is when an aircraft remains in equilibrium in a "new" position following a disturbance from an initial equilibrium position.

3. Static Stability - (negative) is when an aircraft tends to move further in the same direction as the initial disturbance from equilibrium.

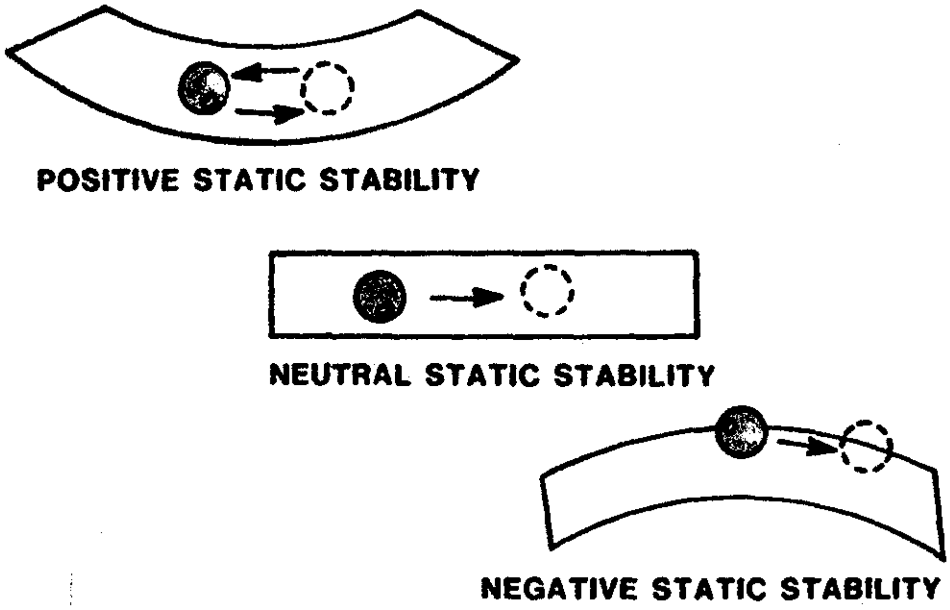


FIGURE 5. Static Stability

4. Dynamic Stability - is the time history of the aircraft's movement in response to its static stability tendencies following an initial disturbance from equilibrium.

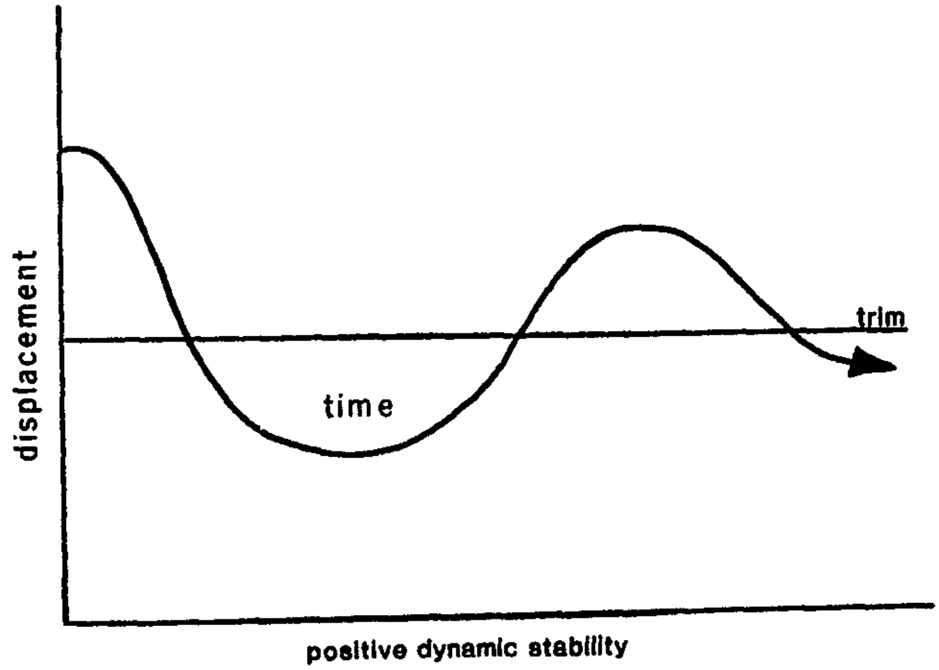


FIGURE 6. Positive Dynamic Stability

Test for Static Longitudinal Stability.

1. This test should be done first. All tests should be conducted with the aircraft in the forward CG. Climb to at least 5,000 feet AGL and trim the aircraft for zero stick force in straight and level flight at cruising speed.

2. Apply a light "pull" force and stabilize at an airspeed about 10 percent less than the trimmed cruise

speed. At this reduced airspeed it should require a "pull" force to maintain the slower speed.

3. If it requires a "pull" force, then you should pull a little further back on the stick and stabilize the airspeed at approximately 20 percent below the initial cruise trim speed.

4. If it requires a still greater "pull" force to maintain this lower airspeed, the aircraft has *Positive Static Longitudinal Stability.* If at either of these test points no "pull" force is required to maintain the reduced airspeeds, the aircraft has *Neutral Static Longitudinal Stability.*

5. If either of these test points require a "push" force to maintain the reduced airspeed, then the aircraft has *Negative Static Longitudinal Stability.*

6. Repeat another series of static longitudinal stability tests using "push" force on the control stick. At an airspeed 10 percent above the trim cruise speed the control stick should require a "push" force to maintain the higher airspeed. If a "pull" force is required, the aircraft has *Negative Static Longitudinal Stability.*

> Warning: If the aircraft exhibits negative static longitudinal stability, seek professional advice on correcting the problem before further flight.

7. After assuring yourself that the aircraft has positive static longitudinal stability, you, the pilot, can check for dynamic longitudinal stability (short period). First, trim the aircraft to fly straight and level at normal trim cruise speed. Next, with a smooth, but fairly rapid motion, push the nose down a few degrees. Now quickly reverse the input to nose up to bring the pitch attitude back to trim attitude. As the pitch attitude reaches trim, release the stick (but guard it). The aircraft may oscillate briefly about the trim attitude before stopping at the trim position.

8. To test the long period dynamic stability, start as before from trimmed, straight and level flight. Without retrimming, pull (or push) the stick to a speed about five mph/knots off trim and release the stick. There is no need to stabilize at the new speed. Expect the aircraft to oscillate slowly about the trim airspeed a number of times before the motion damps out. If there is significant friction in the control system, the aircraft may settle at a speed somewhat different from the original trim speed. If the amplitude of the oscillations does not decrease with time, the aircraft has neutral dynamic stability. If the amplitude increases with time, the dynamic stability is negative, or divergent. This is not necessarily dangerous as long as the rate of divergence is not too great, but it means that the aircraft will be difficult to trim and will require frequent pilot attention.

Lateral-Directional Stability Control Tests.

Lateral (Dihedral Effect) and Directional Stability Tests are to determine if the aircraft can demonstrate a tendency to raise the low wing in a sideslip once the ailerons are freed. They also determine if the rudder is effective in maintaining directional control.

> Caution: This test may impose high flight loads on the aircraft. Do not exceed the design maneuvering speed or any other airspeed limitation.

To check lateral and directional stability, the aircraft should be trimmed for level flight at a low cruise setting and an altitude above 5,000 feet AGL. You should slowly conduct a sideslip by maintaining the aircraft's heading with rudder and ailerons. The aircraft should be able to hold a heading with rudder at a bank angle of 10° or the bank angle appropriate for full rudder deflection. The control forces and deflection should increase steadily, although not necessarily in constant proportions with one another (in some cases, rudder forces may lighten), until either the rudder or the ailerons reach full deflection or the maximum sideslip angle is reached.

At no time should there be a tendency toward a force reversal which could lead to an overbalance condition or a rudder lock.

You should then release the ailerons while still holding full rudder. When the ailerons are released, the low wing should tend to return to level position. You should not assist the ailerons during this evaluation.

To check Static Directional Stability, again trim the aircraft at a low cruise setting above 5,000 feet AGL. Slowly yaw the aircraft left and right using the rudder. At the same time the wings should be kept level by using the ailerons. When the rudder is released, the aircraft should tend to return to straight flight.

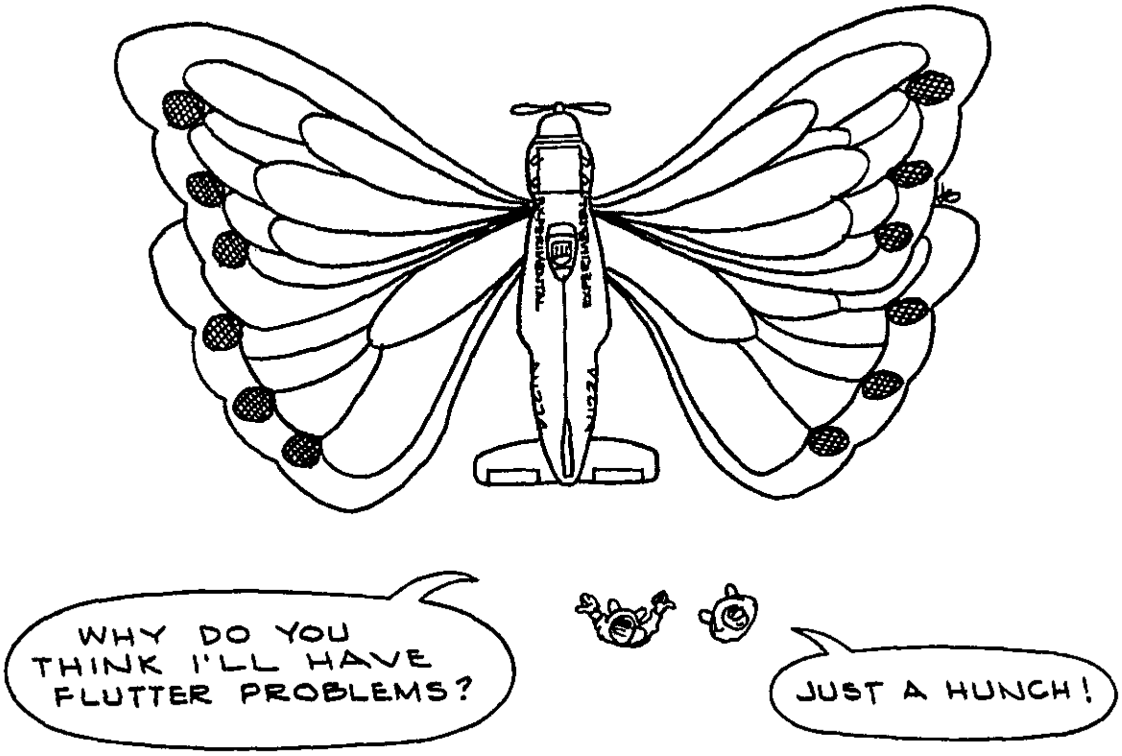
Spiral Stability is determined by the aircraft's tendency to raise the low wing when the controls are released in a bank. To test for spiral stability, apply 15 to 20° of bank and release the controls. If the bank angle decreases, the spiral stability is positive. If the bank angle stays the same, the spiral stability is neutral. If the bank angle increases, the spiral stability is negative.

Negative spiral stability is not necessarily dangerous, but the rate of divergence should not be too great or the aircraft will require frequent pilot attention and will be difficult to fly, especially on instruments.

NOTE: Friction in the aileron control can completely mask the inherent spiral characteristics of the airframe.

SECTION 4. A WORD OR TWO ABOUT FLUTTER

"Stay up on the edge of your seat." Scott Crossfield, Test Pilot



Before concentrating on dynamic stability and control testing at higher airspeeds, this is a good time to discuss the phenomenon known as flutter.

Description: Flutter in an aircraft structure results from the interaction of aerodynamic inputs, the elastic properties of the structure, the mass or weight distribution of the various elements, and airspeed.

The word "flutter" suggests to most people a flag's movement as the wind blows across it. In a light breeze the flag waves gently but, as the windspeed increases, the flag's motion becomes more and more excited. It is easy to see that if something similar happened to an aircraft's structure the effects would be catastrophic. In fact the parallel to a flag is quite close.

Think of a primary surface with a control hinged to it (e.g., aileron). Imagine that the aircraft hits a thermal. The initial response of the wing is to bend upwards relative to the fuselage. If the center of mass of the aileron is not exactly on the hinge line, it will tend to lag behind the wing as it bends upwards.

In a simple, unbalanced, flap-type hinged aileron, the center of mass will be behind the hinge line and the inertial lag will result in the aileron being deflected downward. This will result in the wing momentarily generating more lift, which will increase its upward bending moment and its velocity relative to the fuselage. The inertia of the wing will carry it upwards beyond its equilibrium position to a point where more energy is stored in the deformed structure than can be opposed by the aerodynamic forces acting on it.

The wing "bounces back" and starts to move downward but, as before, the aileron lags behind and is deflected upwards this time. This adds to the aerodynamic down force on the wing, once more driving it beyond its equilibrium position and the cycle repeats.

At low airspeeds, structural and aerodynamic damping quickly suppress the motion but, as the airspeed increases, so do the aerodynamic driving forces generated by the aileron. When they are large enough to cancel the damping, the motion becomes continuous.

Further small increases in airspeed will produce a divergent, or increasing, oscillation, which can quickly exceed the structural limits of the airframe. Even when flutter is on the verge of becoming catastrophic, it can still be very hard to detect. What makes this so is the high frequency of the oscillation which is typically between 5 and 20 HZ (cycles per second). It will take only a very small increase in speed to remove what little damping remains and the motion will become divergent rapidly.

Flutter can also occur on a smaller scale if the main control surface has a control tab on it. The mechanics are the same with the trim tab taking the place of the aileron and the aileron taking the place of the wing. The biggest differences are that the masses involved are so much smaller, the frequencies are much higher, and there is less feedback through the control system. This makes trim tab flutter harder to detect. The phenomenon known as "buzz" is often caused by trim tab flutter.

What Can We Do About It?

Having described how flutter happens, the following suggestions should help reduce the possibility of it happening to your aircraft:

1. Perform a mass balance of all flight controls, if applicable, in accordance with the designer/kit manufacturer's instructions.

2. Eliminate all control "free play" by reducing slop in rod end bearings, hinges, and nut and bolt control attachment hardware.

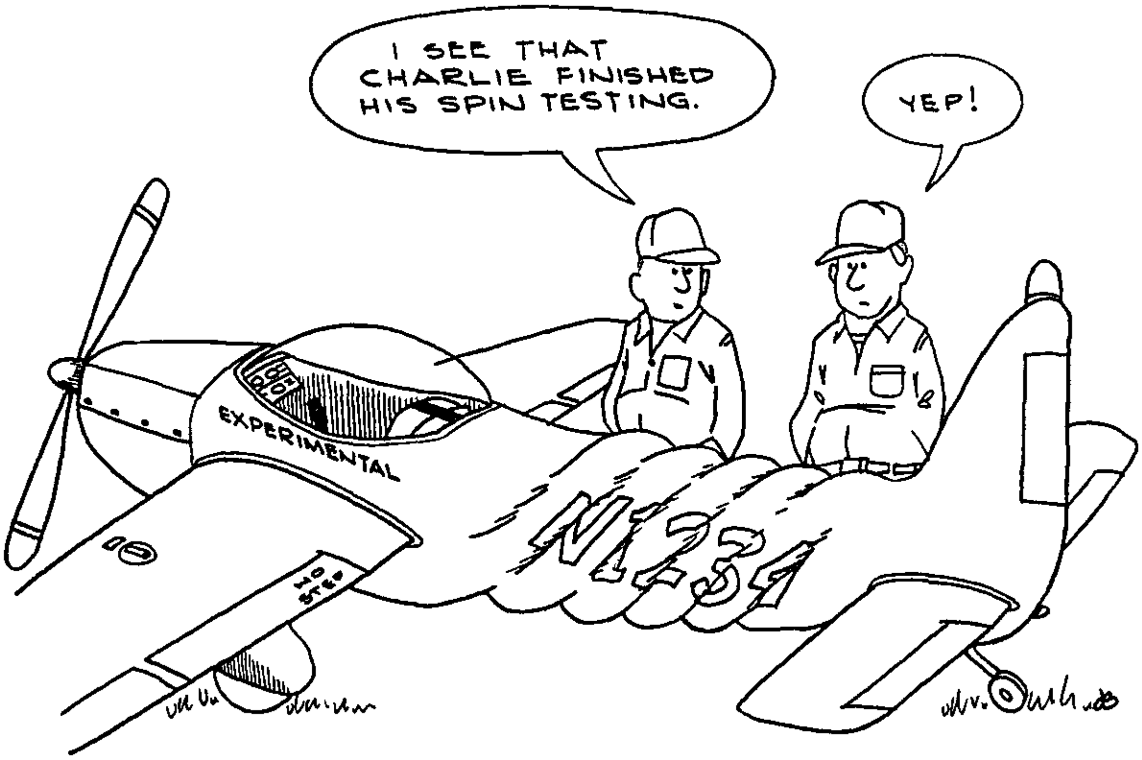
3. Ensure that all rigging and cable tensions are set accurately to the design specifications.

4. Rebalance any of the controls if they have been repaired, repainted, or modified in any way.

> NOTE: If you experienced flutter, or think you did, reduce power immediately and land as soon as possible! Do not attempt further flight until the aircraft has been thoroughly inspected for flutter induced damage. This inspection should include all wing/tail attach points, flight controls, their attach points/hinges, hardware, control rods, and control rod bearings for elongated bolt/rivet holes, cracks, (especially rod end bearings) and sheared rivets.

SECTION 5. SPINS

"Go from the known to the unknown—slowly!" Chris Wheal, Test Pilot



Note: All FAA spin tests for type certification require a spin chute attached to the aircraft. Even though amateur-built aircraft have no such certification requirement, use of a spin chute during testing should be considered.

CAUTION #1

If the manufacturer/designer of your aircraft has not demonstrated satisfactory spin characteristics and safe recovery, *avoid all types of high angle of attack flight testing,* and placard the aircraft: "spins prohibited."

CAUTION #2

If the prototype aircraft has satisfactorily demonstrated spin recovery, the pilot *may consider demonstrating* that the aircraft will recover promptly from inadvertent spin entries. Further tests to prove that the aircraft will recover from a fully developed spin (three turns or more) is not necessary, unless the aircraft is designed for, and will be routinely flown in, aerobatic flight.

CAUTION #3

During all spin tests, it is strongly recommended that a parachute be worn and a quick release mechanism to jettison the canopy or door be installed. If the pilot is unable to exit the aircraft, it is recommended that intentional spins not be conducted even though the design has successfully demonstrated spin recovery.

CAUTION #4

If you have made any modifications/alterations to the airframe design or in its configuration, such as adding tip tanks or fairings, it is not safe to assume that your aircraft still has the same spin recovery characteristics as the prototype aircraft. Spins should not be attempted without consulting a qualified flight test engineer.

CAUTION #5

The pilot who conducts the spin tests should have experience in entry into and recovery from fully developed spins, preferably in makes and models similar to the aircraft being tested. If the pilot needs additional experience, aerobatic training with an emphasis on spins from a qualified instructor is highly recommended.

By this time you have done just about all the preparatory work for spin testing. Plan your flight program just as you did for the first flight through stalls. *It is very important that the center of gravity of the aircraft is at the forward CG limit!*

The aircraft should be tested with the gear (if applicable) and flaps in the up position. The pilot's minimum entry limit altitude for these tests should be no less than 10,000 feet AGL.

> NOTE: The following procedure is one way, but not the only way, of conducting a spin test and executing a recovery. Nonconventional aircraft may require significantly different spin recovery control applications. The pilot should evaluate these procedures and see if they are compatible with the aircraft before attempting any spin testing.

The basic technique you should use for a clean spin entry is to slow down to about a one mph/knot rate in level flight with cockpit secured, carburetor heat on, and the power at idle.

As the aircraft stalls, *apply Full Rudder* in the desired spin direction, followed immediately by full aft movement of the control stick keeping the ailerons neutral.

The transition from a horizontal to a vertical flightpath usually takes about three or four turns and is referred to as the incipient stage of the spin.

During the incipient spin, the aerodynamic and inertia forces have not achieved equilibrium. Many aircraft can recover from the incipient spin phase, but may not be able to recover from a steady state spin.

Normal spin recovery technique is to apply full rudder opposite to the direction of yaw (check your turn needle). Next move the control stick smoothly and rapidly forward towards the instrument panel until the rotation stops.

Quickly centralize the rudder and ease out of the dive. Do not attempt to pull up too rapidly, as you can quite easily exceed the structural limits of your aircraft or stall again. Recover from the first deliberate spin after half a turn. Proceed with the spin tests by extending the spin a 1/4-turn each time until you reached one full turn. If your aircraft is not built for aerobatics, no further spin testing is required. It is recommended the instrument panel be placarded *"SPINS PROHIBITED."*

If further spin testing is required, it is strongly recommended that you use the services of a professional flight test pilot.

SECTION 6. ACCELERATED STALLS

"Does it pass the Common Sense test?" U.S. Air Force, Thunderbirds

Accelerated stall is not a stall reached after a rapid deceleration. It is a stall from flight at more than one G., as in a steep turn or a pull up.

> NOTE: Do not attempt this or any other extreme maneuver unless the designer or kit manufacturer has performed similar tests on a prototype aircraft identical to your own.

There are two standard methods for accelerated stalls: the constant G. (constant bank) and constant speed (increasing bank). The preferred of the two is the constant bank method in which the airspeed is decreased and the angle of bank is held constant, until the aircraft stalls. It is the most preferred because the potential violence of any accelerated stall will be governed by the increasing G. and airspeed.

As with every test, you must plan the sequence of events. Start with small bank angles—30° will produce 1.15 G. Decelerate slowly, ball in the center, do not overcontrol. Work up incrementally to a two G. 60° bank.

You do not have to allow the aircraft to develop a deep stall each time. You only need to record the airspeed and bank angle in which the aircraft hits the prestall buffet. Recover by adding power, forward pitch, and reducing the angle of bank.

CHAPTER 6. PUTTING IT ALL TOGETHER: 36 HOURS TO ______ ?

"Beware of false knowledge; it is more dangerous than ignorance." George Bernard Shaw

SECTION 1. MAXIMUM GROSS WEIGHT AND CENTER OF GRAVITY CHECKS

Up until now all tests have been performed well below maximum gross weight with the possible exception of some single seat aircraft. The complete series of tests at maximum gross weight from stalls, rate of climb, angle of climb, stability, slow flight, through accelerated stalls (with the exception of spin test) should now be investigated.

The purpose of these tests should demonstrate, and the aircraft records should prove, that the aircraft has been successfully flown throughout the center-of-gravity range that it will operate in and at the full range of aircraft weights from minimum to full gross weight.

As before, each phase of the testing should be done slowly, incrementally, with the same careful attention to detail that should characterize all your flight planning.

Increases in the aircraft weight should be done in a series of steps. Usually, 20 percent increments of the maximum payload are added (e.g., sandbags, lead shot) in the aircraft to simulate passengers or baggage weight. The pilot should carefully weigh the ballast used and work a new weight and balance for each test. Stop testing after maximum gross weight is reached.

The testing up to this point has been done at or near the forward CG limit. During these tests the CG should be slowly, but progressively, moved aft between each flight. Limit the change to the CG to about 20 percent of the CG range. Again, the pilot should weigh the ballast and work a new weight and balance for each flight. With each CG change the aircraft longitudinal static stability and stall characteristics should be carefully evaluated by using the same technique discussed earlier. Stop testing when the designer's or kit manufacturer's aft CG limit is reached.

If you discover that the aircraft has neutral or negative longitudinal stability or unsatisfactory stall characteristics at the CG location being tested, *Stop Further Testing!* Establish as your aft CG limit the last satisfactorily tested CG location. If this CG range is not satisfactory, consult with the kit manufacturer, aircraft designer, or a flight test engineering consultant.

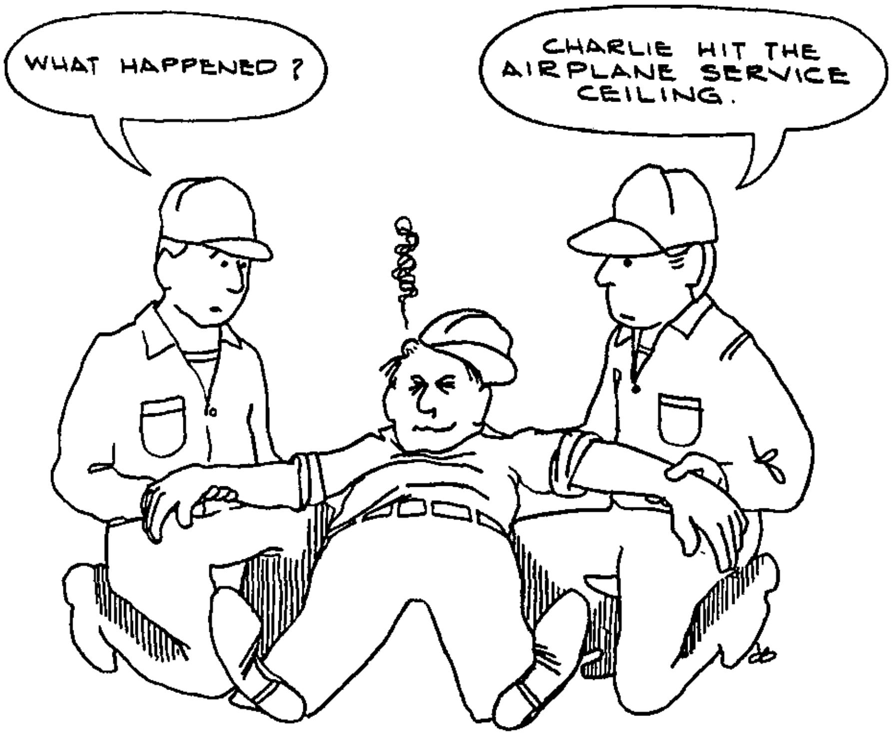
The pilot should avoid the temptation to take a living ballast weight up for a ride for three reasons. First, the aircraft has not been proven safe for the higher weight. Second, it is a sure sign that the pilot has become complacent and sloppy in his/her test program. Third, the pilot will be breaking a contract (Operating Limitations) with the U.S. Government, who is not known to look kindly on such matters.

The pilot should assure that the ballast weight is properly secured in the cockpit. A seatbelt alone strapped over some sandbags will not stop the weight from shifting and getting loose in a cockpit. The last thing a pilot needs is a 25-pound lead shot bag free in the cockpit during a climb test or on a landing. Tie each weight down individually and cover all the weights with canvas or a cargo net. Ensure the ropes/nets and airframe attach points are strong enough to take the load. Also, make sure the passenger seat can take that much localized weight safely.

The maximum gross weight test results should be recorded in the Flight Manual. If there is any change to the stall speed initially marked on the airspeed indicator, it should be changed to reflect the aircraft stall speed at maximum gross weight.

SECTION 2. SERVICE CEILING TESTS

"Man is made for error; it enters his mind naturally and he discovers a few truths only with the greatest effort."
Frederick the Great



Definition: Service Ceiling is the highest altitude at which an aircraft can continue to climb at 100 feet per minute.

Pilots who wish to determine the actual service ceiling of their aircraft are offered the following suggestions:

1. Ask the local Flight Standards or General Aviation District Office (FSDO or GADO) to amend your Operating Limitations to permit a climb to the aircraft's service ceiling.

2. Contact the local Flight Service Station or Air Traffic Control facility and arrange a time and a place to make your test.

3. Install a Mode C transponder (FAR § 91.24) or get a waiver.

4. Have oxygen, if you go above 12,000 feet. (Recommend the pilot becomes familiar with the symptoms and cures of hypoxia and hyperventilation.)

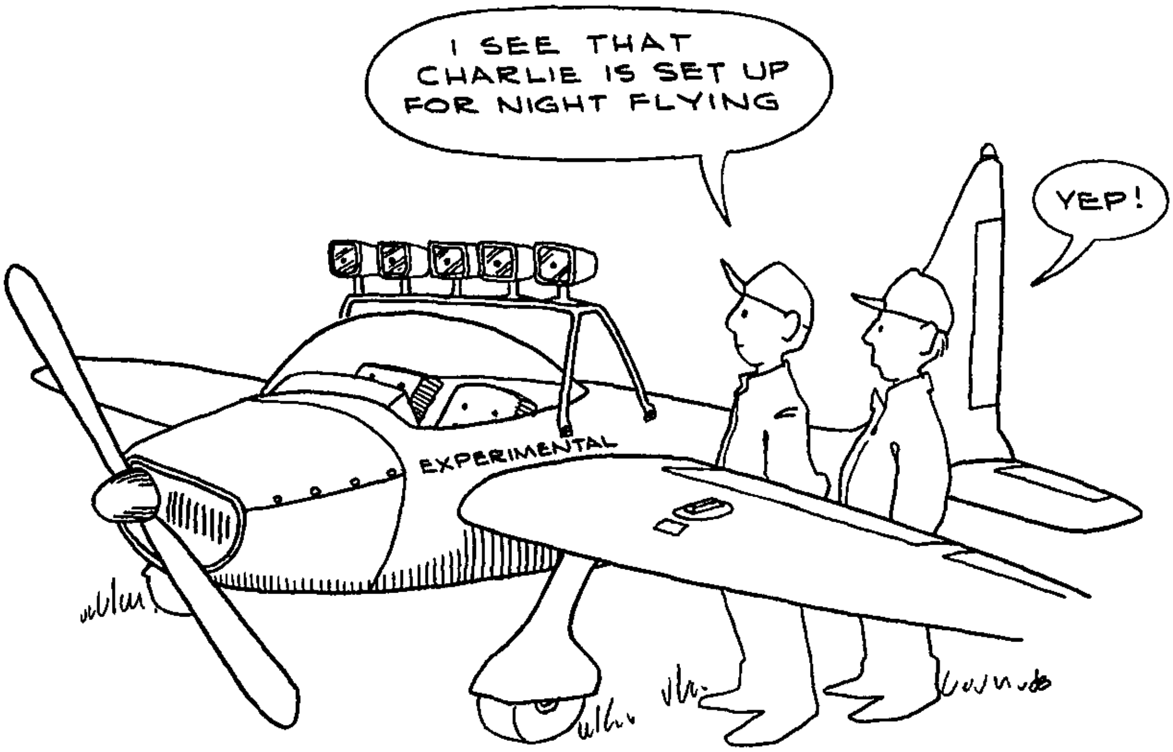
5. Review the engine manufacturer's mixture leaning procedures.

6. Maintain communications with an air traffic facility at all times.

The climb to the aircraft service ceiling should be made at full power in a series of step climbs during which engine performance, temperatures, and pressures are recorded. At the slightest indication of engine performance or aircraft control problems, the pilot should terminate the test and return to the airport.

SECTION 3. NAVIGATION, FUEL CONSUMPTION, AND NIGHT FLYING

"That's one small step for man, one giant leap for mankind." Neil Armstrong



Magnetic Compass.

The magnetic compass should have been initially checked for accuracy prior to the first flight. However, the addition and removal of equipment, changing of wire bundle routing, and airframe modifications may have affected the accuracy of the instrument. The following recommendations are offered:

1. The magnetic compass can be checked by using a compass rose located on an airport or using a hand held "master compass." The master compass is a reverse reading compass with a gunsight mounted on the top of it.

With the aircraft facing North and the pilot running the engine, a second individual "shoots" the master compass right through the aircraft's centerline from 30 feet away facing due South. When the aircraft and the master compass are aligned, the pilot runs the aircraft engine up to approximately 1700 rpm to duplicate the aircraft's magnetic field in flight and reads the compass.

NOTE: Conventional gear aircraft builders will have to reposition the magnetic compass in the instrument panel in a straight and level position for this test, or raise the tail of the aircraft and place it on a movable dolly to simulate a level flight position.

2. If the aircraft compass is not in alignment with the master compass (should read North), then the pilot can make a correction by adjusting the North/South brass adjustment screw with a non-metallic screwdriver (you can make one out of a stainless steel welding rod, brass stock, or plastic) until the compass reads correctly. On the East/West headings use the other brass adjustment screw to make the initial corrections.

3. After moving around the four cardinal points of the compass, begin your check at each 30° increment. However, make only half the correction this time to satisfy the error. This will prevent you from stealing "adjustment" from the heading opposite the one you are on.

4. This procedure will have to be done several times until the maximum error is less than 10° on each heading. If you cannot bring in the compass, try another one. If the new compass cannot be brought in, try a different location in the cockpit away from all ferrous metals and electrical bundles.

NOTE: A common error is to mount the magnetic compass with machine screws and nuts made of steel rather than brass. The steel hardware will drastically affect the compass accuracy.

5. It is a good idea to make two complete compass checks, one with the radios on and one with the radios off, if the deviation in level flight is more than 10° on any heading with the radios on.

6. Record your findings in the aircraft's Flight Manual and make out a compass correction card and mount it near the magnetic compass in the cockpit. Make two cards, one with radios on and one with radios off, if required.

VOR Check.

Perhaps the best guide to check the accuracy of your VOR onboard equipment is the FAR § 91.25, VOR Equipment Check for IFR Operation, or the Airman's Information Manual, Chapter 1.

1. For a ground test of your VOR, you may use a VOR Test Facility (VOT). To use the VOT service, tune in the VOT frequency on your VOR receiver. It is normally 108.0 MHz. With the Course Deviation Indicator (CDI) centered, the omni-bearing selector should read zero degrees with the to/from indication showing "from" or the omni-bearing selector should read 180° with the to/from indicator showing "to." The maximum bearing error should never be more than 4°.

NOTE: The VOT facilities closest to your location can be found in the Airport/Facility Directory. It is available by subscription from National Oceanic and Atmospheric Administration, Distribution Branch N/CG33, National Oceanic Service, Riverdale Maryland 20737, or contact the nearest FAA Flight Service Station.

2. For the airborne test, select a prominent ground point along the selected radial, preferably more than 20 miles from the VOR. Maneuver the aircraft directly over the point at a reasonably low altitude.

3. Note the VOR bearing indicated by the receiver when over the ground point. The maximum permissible variation between the published radial and the indicated bearing is 6°.

4. If the aircraft has dual VOR's, the maximum permissible variation between the two receivers is four degrees.

Fuel Consumption.

Fuel consumption is a good indication of how much the engine is working for each rpm produced. For a new or recently overhauled engine the fuel consumption should improve each flight hour until the engine finishes its "break-in" period. This usually happens around 100 hours of operations.

1. To determine the aircraft fuel consumption, lay out a race track course with 8- to 10-mile legs. If the aircraft has but one fuel tank or you cannot switch tanks, you will have to do the following: Determine the approximate fuel burn to reach 1,000, 3,000, 5,000, 7,000, and 9,000 feet of altitude and the fuel used in descent. With full tanks, climb to 3,000 feet and run the racetrack course for one-half hour at 55 percent power.

2. Land and measure the fuel used by dipping the tanks with a calibrated fuel stick or by adding measured amounts of fuel to the tank until the tank is full. Subtract the approximate fuel burn for climb and descent from this amount and then multiply the remainder by two to get the fuel burn per hour.

3. The tests are a lot easier, and the results more accurate, if the aircraft has two independent fuel tanks. Simply takeoff on one tank and switch tanks at the test altitude. At the completion of the 30-minute test, switch back to the other tank. Land and measure the amount of fuel added and multiply by two to get pounds/gallons of fuel used per hour.

4. Run the same test at 65 percent and 75 percent power at the same altitude,using the same procedures. Then move up to the next altitude and run the same tests.

Night Operations.

Night operations should be authorized by the aircraft's Operating Limitations and be initially limited to normal climb and descent pitch angles, straight and level flight, and coordinated turns of no more than 30°.

1. The main concern for night testing should be the availability of a horizonal reference (e.g., bright moon or artificial horizon).

2. Prior to every night flight, ensure that you carry a good flashlight with fresh batteries and you have a definite flight plan to follow. Some night testing could have already been determined on the ground. For example:

a. The electrical load review of all the lights, pumps, instrumentation, and avionics should not exceed 80 percent of the aircraft's charging system capacity.

b. The cockpit instrumentation lighting is adequate and was tested for reliability of operation during daytime flights.

c. The pilot should practice taxiing the aircraft at night to be familiar with the different operating environment.

d. The position and anti-collision lights effect on the pilot's vision.

3. The actual night flight will consist of an evaluation of the landing light system's effectiveness, both on takeoff and landing, and the absence of glare or light flicker in the cockpit.

APPENDIX 1. SAMPLE CHECKLIST FOR A CONDITION INSPECTION

AIRCRAFT IDENTIFICATION:

TYPE/SN. ____________________

N NUMBER ____________________

A/F TOTAL TIME ____________________

OWNER ____________________

ENGINE MODEL/SN. ____________________

PROPELLER MODEL/SN. ____________________

ENGINE TOTAL TIME ____________________

PROPELLER TOTAL TIME ____________________

GENERAL:

	Builder/inspector			
	Sat	Unsat	Sat	Unsat
REGISTRATION/AIRWORTHINESS/OPERATING LIMITATIONS				
AIRCRAFT IDENTIFICATION PLATES INSTALLED				
EXPERIMENTAL PLACARD INSTALLED				
WEIGHT AND BALANCE/EQUIPMENT LIST				
WINGS:				
REMOVE INSPECTION PLATES/FAIRINGS				
GENERAL INSPECTION OF THE EXTERIOR/INTERIOR WING				
FLIGHT CONTROLS BALANCE WEIGHTS FOR SECURITY				
FLIGHT CONTROLS PROPER ATTACHMENT (NO SLOP)				
FLIGHT CONTROL HINGES/ROD END BEARINGS SERVICEABILITY				
FLIGHT CONTROLS PROPERLY RIGGED/PROPER TENSION				
INSPECT ALL CONTROL STOPS FOR SECURITY				
TRIM CONTROL PROPERLY RIGGED				
TRIM CONTROL SURFACES/HINGES/ROD END BEARINGS SERV.				
FRAYED CABLES OR CRACKED/FROZEN PULLEYS				
SKIN PANELS DELAMINATE/VOIDS (COIN TEST)				
POPPED RIVETS/CRACKED/DEFORMED SKIN				
FABRIC/RIB STITCHING/TAPE CONDITION				
LUBRICATION				
WING ATTACH POINTS				
FLYING/LANDING WIRES/STRUTS FOR SECURITY				
CORROSION				
____________________				
____________________				
____________________				
____________________				
____________________				
____________________				
____________________				

APPENDIX 1—CONTINUED

	Builder/inspector			
	Sat	Unsat	Sat	Unsat
FUEL SYSTEM:				
CORROSION				
FUEL LINES FOR CHAFFING/LEAKS/SECURITY/CONDITION				
SUMP ALL FUEL TANKS FOR WATER OR DEBRIS				
FUEL CAPS FOR SECURITY				
FUEL PLACARD				
FUEL VALVE/CROSS FEED/FOR OPERATION AND SECURITY				
CLEAN FUEL FILTERS/GASOLATOR/FLUSH SYSTEM				
INSPECT FUEL TANK VENT SYSTEM				
____________				
____________				
____________				
____________				
____________				
LANDING GEAR:				
INSPECT STRUTS/TORQUE LINKS FOR ATTACHMENT				
INSPECT STRUTS FOR PROPER EXTENSION				
INSPECT FOR HYDRAULIC LEAKS				
CHECK ALL BUSHINGS FOR WEAR/FREE PLAY				
CHECK LUBRICATION				
INSPECT WHEELS FOR ALIGNMENT				
WHEEL/TIRES FOR CRACKS AND SERVICEABILITY				
WHEEL BEARINGS FOR LUBRICATION				
INSPECT FOR CORROSION				
INSPECT NOSE GEAR FOR CRACKS AND TRAVEL				
INSPECT TAILWHEEL FOR CRACKS AND TRAVEL				
PERFORM GEAR RETRACTION TEST/CHECK INDICATOR LIGHTS				
EMERGENCY GEAR RETRACTION SYSTEM				
CHECK TIRE PRESSURE				
BRAKE LINING WITHIN LIMITS				
BRAKE DISKS FOR CRACKS, WEAR, AND DEFORMITY				
BRAKE HYDRAULIC LINES FOR LEAKS AND SECURITY				
____________				
____________				
____________				
____________				
____________				
FUSELAGE:				
REMOVE INSPECTION PLATES AND PANELS				
INSPECT BULKHEADS AND STRINGERS FOR POPPED RIVETS AND CRACKED SKIN				
INSPECT FOR DELAMINATED SKIN/VOIDS (COIN TEST)				
INSPECT THE SECURITY OF ALL INTERNAL LINES				
INSPECT WINDOWS/CANOPY FOR CRACKS AND FIT				
INSPECT DOOR OR CANOPY LATCHING MECHANISM				

APPENDIX 1—CONTINUED

	Builder/inspector			
	Sat	Unsat	Sat	Unsat
INSPECT FIREWALL FOR DISTORTION AND CRACKS				
INSPECT RUDDER PEDDLES AND BRAKES FOR OPERATION AND SECURITY				
INSPECT BEHIND FIREWALL FOR LOOSE WIRES AND CHAFFING LINES				
CHECK CONTROL STICK/YOKE FOR FREEDOM OF MOVEMENT				
CHECK FLAP CONTROL OPERATION				
CHECK CABLE AND PULLEYS FOR ATTACHMENT AND OPERATION				
PERFORM FLOODLIGHT CARBON MONOXIDE TEST				
ENSURE THE COCKPIT INSTRUMENTS ARE PROPERLY MARKED				
INSPECT INSTRUMENTS, LINES, FOR SECURITY CHECK/CLEAN/ REPLACE INSTRUMENT FILTER				
INSPECT COCKPIT FRESH AIR VENTS/HEATER VENTS FOR OPERATION AND SECURITY				
INSPECT SEATS, SEATBELTS/SHOULDER HARNESS FOR SECURITY AND ATTACHMENT				
CORROSION				
______________				
______________				
______________				
______________				
______________				
EMPENNAGE/CANARD:				
REMOVE INSPECTION PLATES AND FAIRINGS				
INSPECT CANARD ATTACH POINTS FOR SECURITY				
INSPECT VERTICAL FIN ATTACH POINTS				
INSPECT ELEVATOR/STABILIZER ATTACH POINTS				
INSPECT HINGES/TRIM TABS/ROD ENDS FOR ATTACHMENT AND FREE PLAY (SLOP)				
INSPECT EMPENNAGE/CANARD SKIN FOR DAMAGE/CORROSION				
INSPECT ALL CONTROL CABLES, HINGES AND PULLEYS				
INSPECT ALL CONTROL STOPS				
______________				
______________				
______________				
______________				
______________				
ENGINE:				
PERFORM COMPRESSION TEST #1______ #2______ #3______ #4______ #5______ #6______				
CHANGE OIL AND FILTER (CHECK FOR METAL)				
INSPECT IGNITION HARNESS FOR CONDITION AND CONTINUITY				
CHECK IGNITION LEAD CIGARETTES FOR CONDITION/CRACKS				
CLEAN AND GAP SPARKPLUGS				
CHECK MAGNETO TIMING/POINTS/OIL SEAL/DISTRIBUTOR				
INSPECT ENGINE MOUNT/BUSHINGS				

APPENDIX 1—CONTINUED

	Builder/inspector			
	Sat	Unsat	Sat	Unsat
INSPECT ENGINE MOUNT ATTACHMENT BOLT TORQUE				
INSPECT ALTERNATOR/GENERATOR ATTACHMENT				
CHECK ALTERNATOR/GENERATOR BELT CONDITION				
INSPECT CYLINDERS FOR CRACKS/BROKEN FINS/EXHAUST STAINS				
INSPECT ENGINE BAFFLES FOR CRACKS/CONDITION				
CHECK FOR OIL LEAKS/INSPECT VACUUM PUMP AND LINES				
INSPECT OIL VENT LINES				
INSPECT ALL CABIN HEAT/CARB HEAT/DEFROSTERS DUCTS FOR CONDITION				
INSPECT CARBURETOR FOR SECURITY & CLEAN INLET SCREEN				
INSPECT INTAKE HOSES/SEALS FOR SECURITY/LEAKS				
INSPECT THROTTLE/MIXTURE/CARB HEAT/CONTROL FOR PROPER TRAVEL AND SECURITY				
INSPECT CARB HEAT AIR BOX FOR CRACKS/OPERATION				
INSPECT CONDITION OF FLEXIBLE FUEL AND OIL LINES				
INSPECT OIL COOLER FOR LEAKS AND CONDITION				
CHECK EXHAUST SYSTEM FOR ATTACHMENT AND CONDITION				
CHECK MUFFLER/INTERNAL BAFFLE/ FOR SECURITY				
CHECK EXHAUST PIPES/FLANGES FOR SECURITY & ATTACHMENT				
REPACK EXHAUST GASKETS AS REQUIRED				
CHECK COWLING FOR CRACKS AND SECURITY				
PROPELLER:				
CHECK SPINNER AND BACKPLATE FOR CRACKS				
INSPECT FOR CRACKS/STONE DAMAGE/NICKS				
CHECK FOR DELAMINATION (WOOD/COMPOSITE BLADES)				
CHECK PROP BOLTS TORQUE/SAFETY WIRE				
CHECK FOR OIL LEAKS (CRANKCASE NOSE SEAL)				
GREASE LEAKS (CONSTANT SPEED PROP)				
CHECK PROPELLER GOVERNOR FOR LEAKS AND OPERATION				
CHECK PROP TRACK				
ELECTRICAL:				
SPARE FUSES AVAILABLE				
BATTERY SERVICED AND FREE FROM CORROSION				
BATTERY BOX FREE FROM CORROSION				
ELT BATTERY FREE FROM CORROSION AND CURRENT BATTERY				

APPENDIX 1—CONTINUED

	Builder/inspector			
	Sat	Unsat	Sat	Unsat
CHECK LANDING LIGHT OPERATION				
CHECK POSITION LIGHTS OPERATION				
CHECK ANTI-COLLISION LIGHT FOR OPERATION				
INSPECT ALL ANTENNA MOUNTS AND WIRING FOR SECURITY				
CHECK ALL GROUNDING WIRES (ENGINE TO AIRFRAME, WING TO AILERON/FLAP, ETC)				
INSPECT RADIOS/LEADS/WIRES FOR ATTACHMENT & SECURITY				
INSPECT CIRCUIT BREAKERS/FUSES PANELS FOR CONDITION				
____________________				
____________________				
____________________				
____________________				
____________________				
____________________				
OPERATIONAL INSPECTION:				
VISUAL INSPECTION OF THE ENGINE/PROPELLER				
ALL INSPECTION PANELS AND FAIRINGS SECURE				
PERSONNEL WITH FIRE BOTTLE STANDING BY				
BRAKE SYSTEM CHECK				
PROPER FUEL IN TANKS				
ENGINE START PROCEDURES				
OIL PRESSURE/OIL TEMPERATURE WITHIN LIMITS				
VACUUM GAUGE CHECK				
MAGNETO CHECK/HOT MAG CHECK				
IDLE RPM/MIXTURE CHECK				
STATIC RPM CHECK				
ELECTRICAL SYSTEM CHECK				
COOL DOWN PERIOD/ENGINE SHUT DOWN				
PERFORM OIL, HYDRAULIC, AND FUEL LEAK CHECK				
PAPERWORK:				
AIRWORTHINESS DIRECTIVES				
RECORD FINDINGS AND SIGN OFF INSPECTION AND MAINTENANCE IN AIRCRAFT LOGBOOKS				

APPENDIX 2. ADDRESS FOR ACCIDENT/INCIDENT INFORMATION

Aircraft accident and incident information is available from the following sources:

Federal Aviation Administration
National Safety Data Branch
AVN-120
P.O. Box 25082
Oklahoma City, OK 73125

All make and model aircraft accident/incident data is available for the past two years. Reports for a single accident/incident or a summary accident/incident report for a particular make and model are available. A fee will be charged based on the number of pages for each make and model aircraft accident/incident reports requested (e.g., computer time).

Experimental Aircraft Association
Information Services
Wittman Airfield
Oshkosh WI 54903-3086

A fee of $5.00 is charged for a summary report of each amateur-built aircraft make and model report (accidents only).

National Transportation Safety Board
SP-30
800 Independence Avenue SW
Washington, DC 20594

Accident reports for all make and model aircraft are available. For single reports, the computerized report is two pages long. If the accident is over 18 months old, the report will list probable causes. Accident summaries for a particular make and model aircraft are also available. No fee is charged unless the documents run over 50 pages.

FAA and the NTSB: Require the date, location of the accident, and, if possible, the "N" number for a single aircraft accident you are interested in. Identify the make and model aircraft (Poteen special, model OB-1) only if you want *all* the accidents for that particular aircraft design.

APPENDIX 3: ADDITIONAL REFERENCES ON FLIGHT TESTING

The following references comprise selected additional information sources on flight testing and first flight experiences for amateur-built aircraft. This list of informational material may help amateur-builders in preparing the Flight Test Plan for their aircraft.

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APPENDIX 3—CONTINUED

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APPENDIX 3—CONTINUED

GOVERNMENT PUBLICATIONS:

Advisory Circulars without a stock number and dollar amount can be obtained *free* of charge from the address listed below.

Department of Transprtation
Utilization and Storage Section, M-443.2
Washington, DC 20590

Advisory Circulars with a *stock number* and *dollar amount* can be obtained from:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402-9371

The check or money order should be made payable to the Superintendent of Documents.

Advisory Circular	*Title*
00-2.2	*Advisory Circular Checklist and Status of Other FAA Publications.*
20-27	*Certification and Operation of Amateur-Built Aircraft.*
20-32	*Carbon Monoxide (CO) Contamination in Aircraft—Detection and Prevention.*
20-34	*Prevention of Retractable Landing Gear Failures.*
20-35	*Tiedown Sense.*
20-37	*Aircraft Metal Propeller Blade Failure.*
20-42	*Hand Fire Extinguishers for Use in Aircraft.*
20-103	*Aircraft Engine Crankshaft Failure.*
20-105	*Engine Power Loss Accident Prevention.*
20-106	*Aircraft Inspection for the General Aviation Aircraft Owner. (Available from the Sup. Docs., SN 050-007-00449-4, cost $5.00)*
20-125	*Water in Aviation Fuels.*
23-8	*Flight Test Guide for Certification of Normal, Utility, and Acrobatic Category Airplanes. (Available from the Sup. Docs., SN 050-007-00773-6, cost $10.00)*
23.955-1	*Substantiating Flow Rates and Pressures in Fuel Systems of Small Airplanes.*
23.959-1	*Unusable Fuel Test Procedures for Small Planes.*
61-21A	*Flight Training Handbook. (Available from the Sup. Docs., SN 050-007-00504-1, cost $9.00)*
61-23B	*Pilot's Handbook of Aeronautical Knowledge. (Available from the Sup. Docs., SN 050-011-00077-7, cost $10.00)*
91-8B	*Use of Oxygen by Aviation Pilots/Passengers.*
91-23A	*Pilot's Weight and Balance Handbook. (Available from the Sup. Docs., SN 050-007-00405-2, cost $5.00)*
91-46	*Gyroscopic Instruments—Good Operating Practices.*
91-48	*Acrobatics—Precision Flying with a Purpose.*
91-59	*Inspection and Care of General Aviation Aircraft Exhaust Systems.*
91-61	*A Hazard in Aerobatics: Effect of G-Forces on Pilots.*

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