Federal Aviation Administration

Topic of the Month
November
E/AB Flight Testing

Presented to: Salem Area Pilots

By: Thomas Gorski CFI

Date: November 22, 2014

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Interactive presentation style: Ask relevant questions frequently. It is important to address your concerns and your questions.

Holding pattern for unanswered questions. We can learn much from each other. Questions and answers are very important, so frequent interaction is encouraged.

Focus is seminar. Seminar is primary, Webinar is secondary.

10 Min break.

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Outline

- Presenter's Background
- Brief Overview of FAASTeam
- Seminar Focus: E/AB Flight Testing – Details of Flight Test Plan
- Audience Response Quiz Game
  (Based on AC 90-89A)

Presenter's Background

- 1976 – US Army Avionics (Radar) Technician
- 1984 – CFI & Charter Pilot
- 2004 – FO LR-JET
- 2006 – CA LR-JET
- 2008 – FO B747-200, LCF, 400
- 2010 – CA B747-400 Director of Flight Standards
- 2013 – Present Contract Pilot/CFI

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Activities of the FAASTeam are organized and indexed through the Website FAASAFETY.GOV

Faasafety.gov is a direct portal between the faa and the aviation community.

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Mission Statement:
Improve the Nation's aviation accident rate

by conveying safety principles and practices

through training, outreach, and education;
while establishing partnerships

and encouraging the continual growth

of a positive safety culture

within the aviation community.

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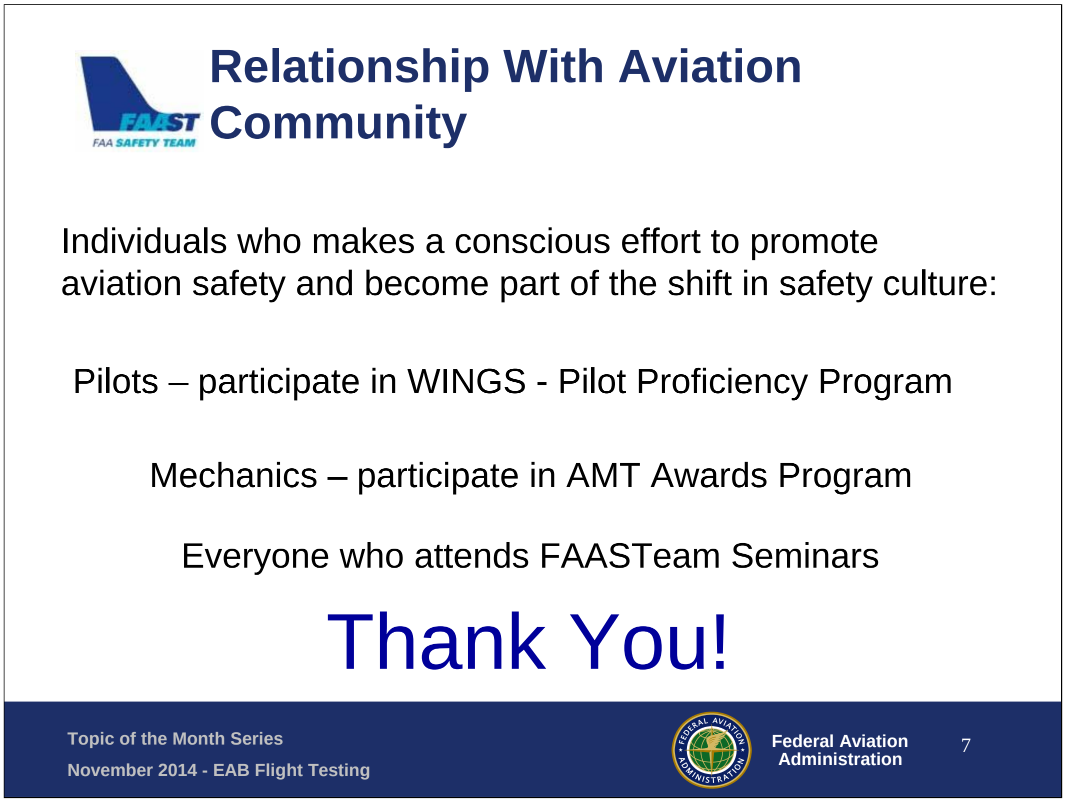


FAASTeam Members are individuals who makes a conscious effort to promote aviation safety and become part of the shift in safety culture. Members are:
Pilots - WINGS

Mechanics - AMT

Everyone who Attends Seminars **(Next Slide)**

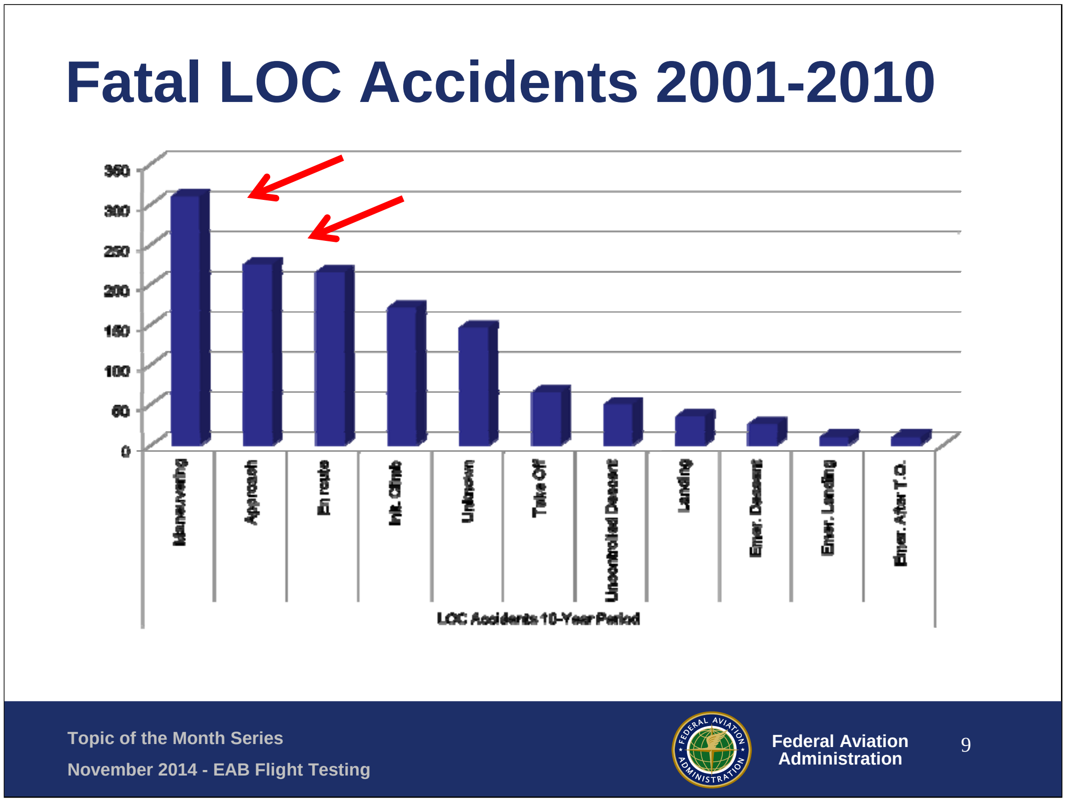
Overview

- E/AB Accidents
- Loss of Control Work Group Recommendations
- Flight Test Guidance
- Overview of 90-89A
- Any of us may become a test pilot

In this presentation we'll talk a little bit about Experimental & Amateur-built accidents and recommendations from a work group that studies loss of control.

We'll also talk about AC 90-89A and how to use its guidance to write and conduct a good flight test plan. And we will discuss how any pilot can become a test pilot. It happens more frequently than you might think.

Presentation Note: *If you'll be discussing additional items, add them to this list*
(Next Slide)



There were 1250 fatal loss of control accidents from 2001 through 2010. **(Click)**

About half of those accidents occurred in the maneuvering and approach phases of flight – think stall/spin/crash

It's also true that many accidents occur when pilots fly aircraft they're unfamiliar with.
In fact the first 50 to 100 hours in a new aircraft type are particularly dangerous; especially when a formal testing and transition training program is not followed.

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Fatal Accidents

- **Standard Aircraft 2.0 / 100,000 Hrs.**
- **Amateur built Aircraft 4.2 / 100,000 Hrs.**

- **First 50 hours of flight in Experimental/Amateur Built Aircraft are particularly hazardous**
  - Transition Training can make this period much safer.
  - Flight Testing Programs are essential to success.

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Here we can see that Fatal accidents in Amateur built aircraft occur at more than twice the rate for Standard Aircraft.

The first 50 hours in Experimental/Amateur Built aircraft are particularly hazardous. Constructors must conduct a test flight program to develop performance and control parameters and, based on those test flights, adjustments and modifications may be required - all while learning how to fly a new aircraft. Constructors use the test flight data to produce a Pilot's Operating Handbook that may be comprehensive or minimal. At least future pilots of that aircraft with access to the POH will have something to go on but for the original constructor it's all new territory. Many Amateur-built aircraft are faster and less crash worthy than standard aircraft Higher stall speeds and different handling characteristics

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Background: In 2012, NTSB completed a safety study of E-AB aircraft that included an EAA survey of E-AB pilots. Among other findings, NTSB concluded that the flight test period—the first 50 hours of flight—is uniquely challenging for most E-AB pilots because they must learn to manage the handling characteristics of an unfamiliar aircraft while also managing the challenges of the flight test environment. Example: instrumentation that is not yet calibrated, controls that may need adjustments, and possible malfunctions or adverse handling characteristics. NTSB added that the E-AB safety record could be improved by providing pilots with additional training resources.

2010-2014 PDX, NM-09 FSDO

- **Total Accidents 152**
- **Total Incidents 58**
- **Total Fatal Accidents 27 (17.3%)**

An analysis of collected data and strategies to mitigate the identified risk will be discussed here.

58 Total Incidents

152 Total Accidents

27 Total Fatal Accidents (17.3%)

Total Accidents 152

Loss of Control (LOC)
Flight + LOC Landing Accidents = 85, or 55.9%

Total Accidents 152

Loss of Control (LOC)
Flight + LOC Landing Accidents = 85, or 55.9%

How do you loose control of your aircraft?

2010 – June 2014 Accidents by Category

	General	Ag	Glider	ELSA	EAB	Heli	Balloon	Total
2010	20	2		1	7	4	1	35
2011	25				9	3		37
2012	27	1	1		4	4		37
2013	15		1	1	7	5		29
2014	6				6	2		14
Total	93	3	2	2	33	18	1	152

EAB & ELSA operations account for 23% of NM-09 total accidents, averaging **7 per year.** The following are identified hazards ---

- Airport location for aircraft construction
- Functional testing of the fuel system
- Failure to develop and follow a Flight Test Plan
- Confusion by builders relating to flight test hour requirements
- Failure to utilize accumulated flight test data to develop an AFM and emergency procedures
- Purchasing used aircraft without an AFM
- Certification issues (Weight & Balance, Documentation/Built Log)
- Differences in the performance of maintenance between Light Sport Aircraft, Experimental Light Sport Aircraft, and E/AB Aircraft
- Acquiring or utilizing a trained test pilot
- Lack of Transition Training

Airport location for aircraft construction

Functional testing of the fuel system

Failure to develop and follow a Flight Test Plan

Confusion by builders relating to flight test hour requirements

Failure to utilize accumulated flight test data to develop an AFM and emergency procedures

Purchasing used aircraft without an AFM

Certification issues (Weight & Balance, Documentation/Built Log)

Differences in the performance of maintenance between Light Sport Aircraft, Experimental Light Sport Aircraft, and E/AB Aircraft

Acquiring or utilizing a trained test pilot

Lack of Transition Training

Read the book (POH)

- Aircraft Limitations
- Performance Charts
- Speeds for safe operation
- Weight & balance
- Mission planning
- Emergency procedures
- Systems

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You've often heard that pilots should approach transitioning into any new aircraft by reading the POH.

That's good advice. A comprehensive POH will give pilots the information they need to operate their aircraft safely and efficiently.

But what if there is no book? What if you have to write one?

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Write the book

- Aircraft Limitations
- Performance Charts
- Speeds for safe operation
- Weight & balance
- Mission planning
- Emergency procedures
- Systems

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Amateur builders of aircraft are all faced with writing their own POH→AFM and developing all of the limitations, performance data and procedures it contains. Some constructors do this better than others and the results are reflected in the documents they produce. And they're sometimes tragically reflected in accident records.

(Next Slide)

But I don’t build airplanes.

- **Do you fly, ride in, or maintain them?**

I know what some of you are thinking. I don’t build airplanes so none of this applies to me. **(Click)**

Well that may be true but if you fly or ride as passenger in an Experimental or amateur-built aircraft you may want to know a little more about how they should be tested.

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Manufactured Aircraft

- **Are also tested for:**
  - Type certification
  - Modifications, upgrades, improvements
  - Avionics and instrument certification
  - Post maintenance checks

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Even pilots of manufactured aircraft may find themselves in a test pilot role. Manufactured aircraft are run through a Flight Test program during type certification of course.

But they also undergo testing when they've been modified, upgraded, or improved.

Or, when new avionics and instruments are added or certified.

And often after maintenance has been performed. So it's not unlikely that you'll need to be a test pilot.

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Any Aircraft

- **Changes add up:**

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No matter who built it – changes to any aircraft add up. **(Click)**

Perhaps most of the modifications to this Beaver were part of a package that was flight tested by the STC holder. The airplane would be tested after modification to confirm that it still met certification requirements and to document any changes in weight and balance, performance, or operational procedures.

But what if the changes were made one at a time by an individual aircraft owner. Multiple STCs are not typically tested in aggregate and that could lead to some unexpected performance parameters.

Another case for running the airplane through a test program.

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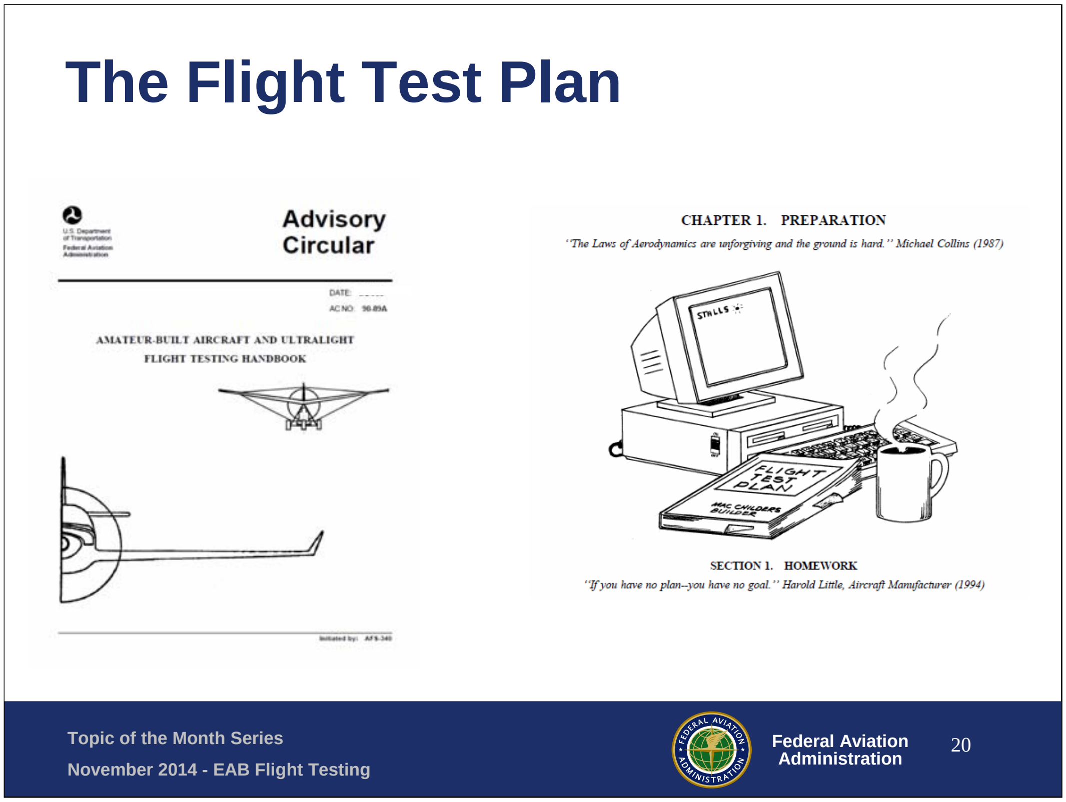

A robust flight test program begins with a solid Flight Test Plan. Time and effort spent in constructing this document will reap benefits for the life of the aircraft so constructors are well advised to approach the task with as much diligence and patience as they've exercised in building their craft. **(Click)**

FAAs Advisory Circular 90-89A is the go to source on Flight Testing amateur built & ultralight aircraft. **(Click)**

Chapter 1 guides builders in preparing for the flight test program. Subsequent chapters cover everything from initial taxi checks through the first 40 hours of flight.
The objective of a FLIGHT TEST PLAN is to determine the aircraft's controllability throughout all the maneuvers and to detect any hazardous operating characteristics or design features. This data should be used in developing a FLIGHT MANUAL that specifies the aircraft's performance and defines its operating envelope.
The most important task for an amateurbuilder is to develop a comprehensive FLIGHT TEST PLAN. This PLAN should be individually tailored to define the aircraft's specific level of performance. It is therefore important that the entire flight test plan be developed and completed BEFORE the aircraft's first flight.

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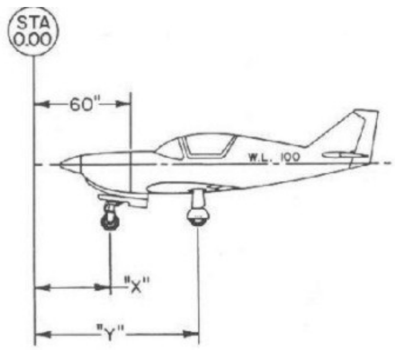
The Flight Test Program



Following AC guidance and the Flight Test Plan, test pilots progress from aircraft inspection and weight and balance calculations **(Click)**

Through taxi and initial flight tests. **(Click)** To maximum performance maneuvers and spins.

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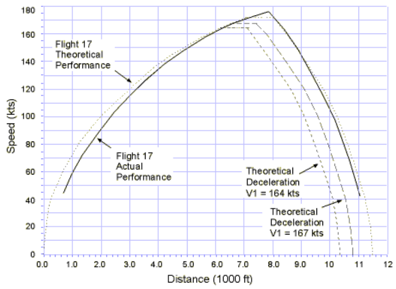
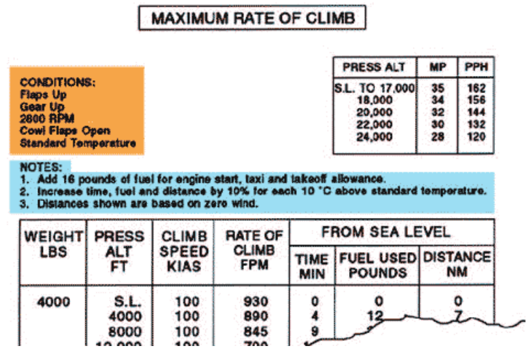
Putting it all together





MAXIMUM RATE OF CLIMB

CONDITIONS:
Flaps Up
Gear Up
2800 RPM
Cowl Flaps Open
Standard Temperature

PRESS ALT	MP	PPH
S.L. TO 17,000	35	162
18,000	34	156
20,000	32	144
22,000	30	132
24,000	28	120

NOTES:
1. Add 16 pounds of fuel for engine start, taxi and takeoff allowance.
2. Increase time, fuel and distance by 10% for each 10 °C above standard temperature.
3. Distances shown are based on zero wind.

WEIGHT LBS	PRESS ALT FT	CLIMB SPEED KIAS	RATE OF CLIMB FPM	FROM SEA LEVEL TIME MIN	FUEL USED POUNDS	DISTANCE NM
4000	S.L.	100	930	0	0	0
	4000	100	890	4	12	7
	8000	100	845	9		

Flight test data are documented as they are acquired and at the end of the program they're presented as limitations, tables, graphs, and procedures in the POH.

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Find a Test Pilot

- **Experienced and current in make & model**
- **Prior flight test experience**
  - Familiar with Flight Test Plan

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Once the Flight Test Plan's complete a test pilot must be selected. Most builders look forward to commanding the first flight in their aircraft but the builder may not be the best pilot for the job. It's hard to do but absolutely imperative that builders assess their capabilities as test pilots. Test pilots need recent experience in the make and model of airplane to be tested and they should have prior flight testing experience. They should participate in writing the Flight Test Plan or at least be thoroughly familiar with it. Builders who don't meet these criteria need to find a suitable test pilot or an instructor who can instruct them in the same or similar make and model of aircraft before flight testing the new bird.

Anyone here have any test pilot experience?

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Canards & Ultralights

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The AC also includes special testing considerations for canard configured aircraft and ultralight vehicles.

Accident rate approximately the same as conventional designed (1) During take-off, the transition from **ground roll to flight can be a more critical** procedure in some canards. (2) Some canards with combinations of CG and pitch control sensitivity will be more likely to over rotate at lift-off. (3) **Some canards** have less visible airframe structure in front of the pilot- may cause the nose to appear too high on takeoff and landings. (4) Canards have very **different take-off characteristics** than conventional. Example: Canard aircraft with pusher propellers need a substantially higher rotation speed on take-off. (5) Conventional aircraft a relatively small amount of lift required, generated at a relatively low airspeed, makes it possible to rotate the aircraft into the take-off position slightly below flying speed. This allows the aircraft to accelerate to flying speed and lift off. In contrast, the canard nose wheel will stay firmly on the ground until an airspeed is reached. Since the main wing may reach flying speed before the canard, the nose wheel will stay firmly on the runway until take-off speed is reached. Rotation will then occur, and the aircraft will literally jump off the ground. (6) Canards with a thrust line above the CG will have appreciable pitch trim change with power. Forward stick motion is required when power is reduced. (a serious surprise to an unwary and inexperienced pilot.) This unfamiliar flight characteristic might cause pilot-induced pitch oscillations with disturbing consequences under some conditions (e.g., an aborted take-off). (7) Due to its unique design, the canard aircraft needs a higher nose up attitude when landing compared to conventional configured aircraft.

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AC 90-89A Chapters

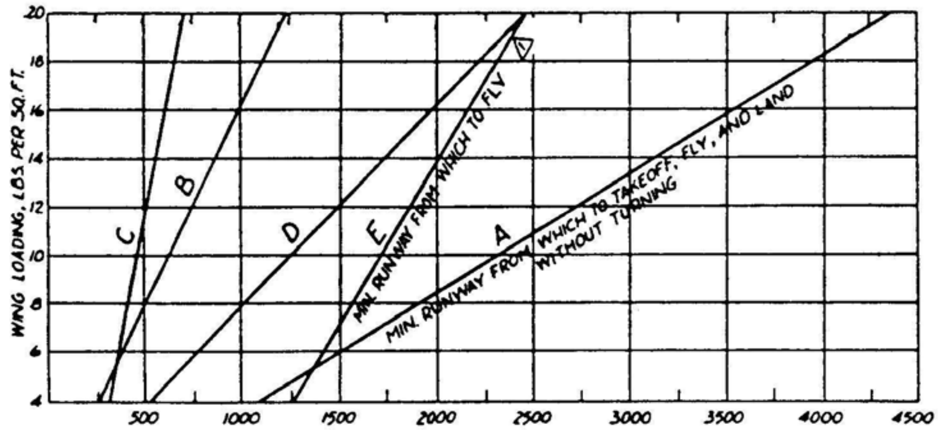
- 1. Preparation
- 2. Taxi tests
- 3. The first flight
- 4. The first 10 hours
- 5. Expanding the envelope
- 6. Putting it all together: 36 hours to ———?
- 7. Thoughts on testing canard type A/B aircraft
- 8. Ultralight airframe inspection
- 9. Ultralight engine/fuel system inspection
- 10. Ultralight test flying recommendations

CHAPTER 1. PREPARATION

- Section 1. Homework
- Section 2. Airport Selection
- Section 3. Emergency Plans and Equipment
- Section 4. Test Pilot
- Section 5. Medical Facts For Pilots
- Section 6. Transporting The Aircraft To the Airport
- Section 7. Assembly and Airworthiness Inspection
- Section 8. Weight and Balance
- Section 9. Paperwork
- Section 10. Powerplant Tests
- Section 11. Additional Engine Tests
- Section 12. Propeller Inspection

Chapter Overview: 10 Chapters each with one or more sections. Section 10: When pulling the mixture control, just before the engine quits, the engine rpm should rise about 50 rpm if the mixture is properly adjusted. If the rpm drops off without any increase in rpm, the idle mixture is set too lean. If the rpm increases more than 50 rpm, the idle mixture is set too rich.

Chapter 1 Sec 2 (Excerpt)



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This Runway Length Chart shows Takeoff Distance. To determine an appropriate runway, use the chart for sea-level elevation, or the following rule-of-thumb: c. The ideal runway at sea-level elevation should be at least 4,000 feet long and 100 feet wide. For each 1,000 feet increase in field elevation, add

500 feet to the runway length. If testing a high performance aircraft, the airport's runway at sealevel should be more than 6,000 feet long and 150 feet wide to allow a wider margin of safety. Other considerations, such as power to weight ratio, wing design, and density altitude, also should be factored into the equation for picking the best runway for the initial flight testing.

A- Distance to takeoff at minimum smooth liftoff speed, fly for 5 sec at that speed without climbing, land and stop straight ahead.

(MIN RUNWAY FROM WHICH TO TAKEOFF, FLY AND LAND WITHOUT TURNING.

B- Distance to reach minimum smooth liftoff speed.

C- Distance covered in 5 seconds at 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. (MINIMUM RUNWAY FROM WHICH TO FLY)

CHAPTER 2. TAXI TESTS

- Section 1. Low Speed Taxi Tests
- Section 2. High Speed Taxi Tests

Taxi tests should be conducted as if you are going to fly.

CHAPTER 3. THE FIRST FLIGHT

- Section 1. General
- Section 2. The Role of the Chase Plane
- Section 3. Emergency Procedures
- Section 4. First Flight
- Section 5. First Flight Procedures

CHAPTER 4. THE FIRST 10 HOURS

- Section 1. The Second Flight
- Section 2. The Third Flight
- Section 3. Hours 4 through 10

CHAPTER 5. EXPANDING THE ENVELOPE

- Section 1. General
- Section 2. Hours 11 through 20
- Section 3. Hours 21 through 35: Stability and Control Checks
- Section 4. A Word or Two About Flutter
- Section 5. Spins
- Section 6. Accelerated Stalls

Chapter 5 Sec 2 (Excerpt)

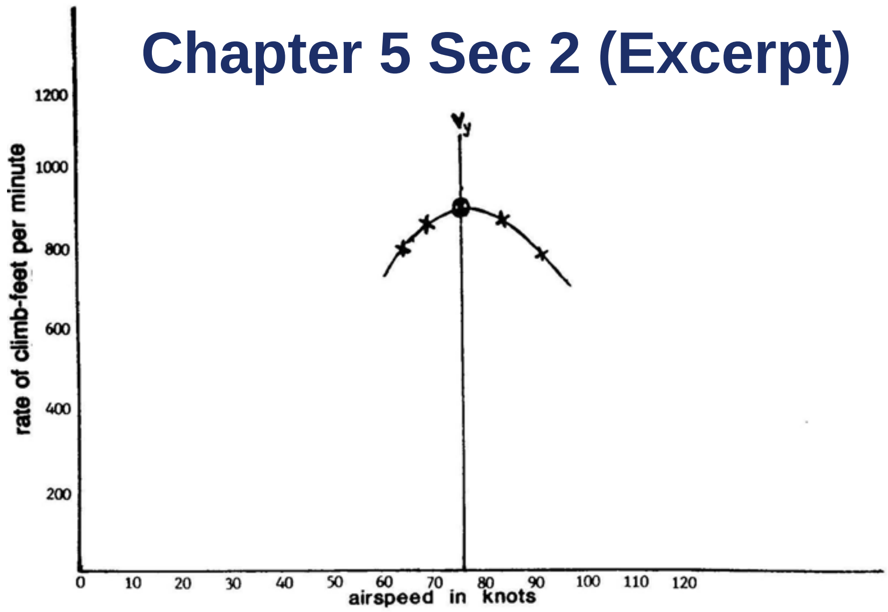

FIGURE 6. Climb Airspeed and Altitude Graph

Best Rate of Climb Speed Tests. To determine the best rate of climb for the aircraft, the following procedures are suggested: (1) Perform the tests in smooth air, free from thermal activity. Select an altitude (e.g., 1,000 feet AGL) as a BASE attitude. Use a heading 90 degrees to the wind and for the best results, reverse the heading 180 degrees after each climb test. (2) Begin a full throttle climb well below the predetermined BASE altitude and stabilize at a preselected airspeed approximately 15 knots/mph 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 1 minute, record the altitude gained. Descend down below the BASE altitude. Decrease the airspeed by 5 knots/mph and run the test again. After each succeeding test, the pilot should decrease the airspeed by 5 knots/mph until reaching an airspeed that is 10 mph/knots higher than the stall speed of the aircraft. Record the airspeed and altitude gained for each climb on a graph similar to figure 6. (3) The airspeed that shows the greatest gain in altitude is the aircraft's best rate of climb speed (Vy).

Chapter 5 Sec 2 (Excerpt)

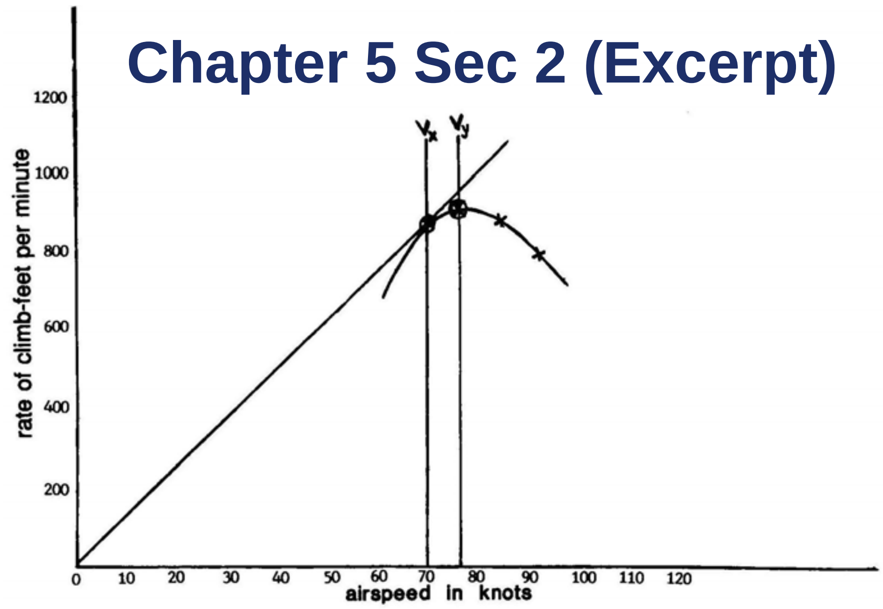

FIGURE 7. Best Rate of Climb Speed Graph

Best Angle of Climb Speed Tests. (1) Best angle of climb speed can be found by using the same chart developed for the best rate of climb tests. Draw a line (tangent) 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, draw a line straight down to the airspeed leg of the chart. (2) The airspeed that the line intersects is the best angle of climb airspeed.

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

- Section 1. Maximum Gross Weight Tests
- Section 2. Service Ceiling Tests
- Section 3. Navigation, Fuel Consumption, and Night Flying

CHAPTER 7. THOUGHTS ON TESTING CANARD TYPE AMATEUR-BUILT AIRCRAFT

- Section 1. Canards

CHAPTER 8. ULTRALIGHT AIRFRAME INSPECTION

- Section 1. Differences
- Section 2. The Test Pilot
- Section 3. Pre-flight Airframe Inspection

CHAPTER 9. ULTRALIGHT ENGINE/FUEL SYSTEM INSPECTION

- Section 1. Engine Inspection
- Section 2. Fuel Systems

CHAPTER 10. ULTRALIGHT TEST FLYING RECOMMENDATIONS

- Section 1. Three Recommendations
- Section 2. Airport Selection
- Section 3. Taxiing
- Section 4. First Flight Differences
- Section 5. Emergency Procedures

THREE RECOMMENDATIONS

a. Even if the builder/owner or pilot is an airline captain with 20,000 hours in type, he/she should NOT climb into an ultralight without first receiving flight instruction from a properly certified or authorized ultralight flight instructor. This must be done in a two-seat ultralight trainer operated in accordance with the EAA or USUA exemption to FAR Part 103.

b. Ultralights by their very nature are highly susceptible to winds **above 15 mph.** All ultralight aircraft **test flights** should be conducted in **light or no-wind** conditions.

c. Even more so than America's top fighter pilots, ultralight pilots must manage airspeed. Due to its small speed range between stall and full power; high drag and low weight, airspeed should become the single most important concern of the ultralight pilot.

FIRST FLIGHT DIFFERENCES

One of the biggest differences between a general aviation aircraft and an ultralight is the effect very quick changes in power can have on aircraft speed. In a light-weight aircraft,

it is possible to go from **cruise speed to a stall in less than 4 seconds.** This is due to the **low mass, high drag** configuration.

CONTROL FEEL. Due to the slow cruise speed and lower weight of ultralights, their flight controls **feel light or sensitive.** Once the flight control input has been made, the rate of **response tends to be slower** than inputs on faster and heavier aircraft.

STALLS. Because of their high angle of dihedral, most ultralight stalls tend to be straight forward, particularly during a power-off stall. Ultralights experience little airframe buffeting. The only stall indications the pilot may recognize: Slowed forward movement, a rapid decrease in altitude, and controls that are suddenly mushy and mostly ineffective.

STEEP TURNS. When performing steep turns in an ultralight, the increasing weight (g load) and high **drag tends to bleed off energy very quickly.** The pilot must monitor the airspeed to avoid inadvertently setting up a stall/spin scenario.

Appendix 1. Sample Checklist for a Condition Inspection

Appendix 2. Addresses for Accident/Incident Information

Appendix 3. Additional References on Flight Testing

Questions?

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Office visits appointments only recommended

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