

Flight Test eXpectations



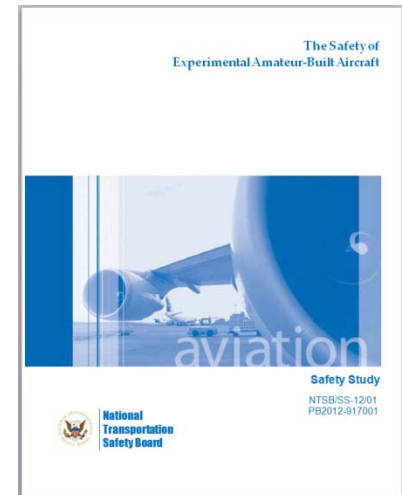
Experimental – Amateur Built Aircraft



By Ron McElroy
FAA Flight Test Pilot

Abstract

- ▶ E-AB aircraft represent 10% of GA fleet, yet account for 15% of total accidents in 2011.
(21% of fatal accidents)
- ▶ E-AB is a growing segment of GA fleet – nearly 33,000 aircraft.
- ▶ Are E-AB statistically unsafe?



E-AB Flight Test Projects

- ▶ “We’re not in Kansas anymore...!”
- ▶ This ain’t Part 23/25 & MilSpec compliance testing.
 - *“The step up is just as big as the step down!”*
- ▶ **Big Bucks (\$\$\$\$)** – NOT!
 - Telemetry vs knee board data.
 - Disciplined Flight Test vs *“gitter done”* mentality.
 - Conformal integrity vs one-of-a-kind.
 - Elaborate support team / oversight vs YOU !



No Guts...No Glory!



Naboo Test Pilot



Naboo Starship Fighter

E-AB Airworthiness

- ▶ Order 8130.2G provides guidance to ASI or DAR to issue Airworthiness Certificate.

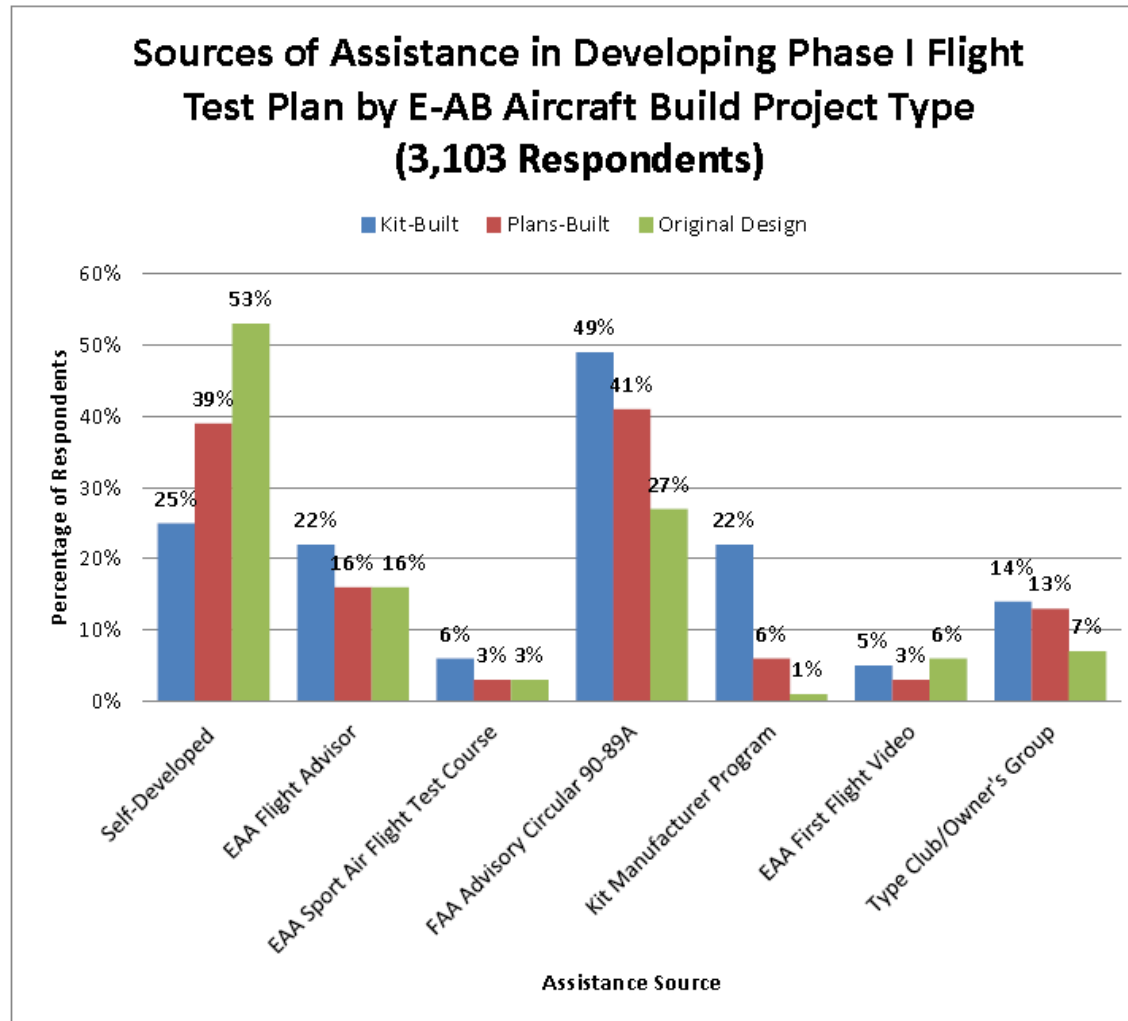


- ▶ But, that doesn't mean your aircraft is free of issues that should be checked by you and/or builder!
 - Ex: Canada requires builder to report the results of a functional test of the aircraft's fuel system to ensure that adequate fuel is supplied to the engine in all flight attitudes.
 - U.S. REMOVED "pre-cover" inspections in 1990.

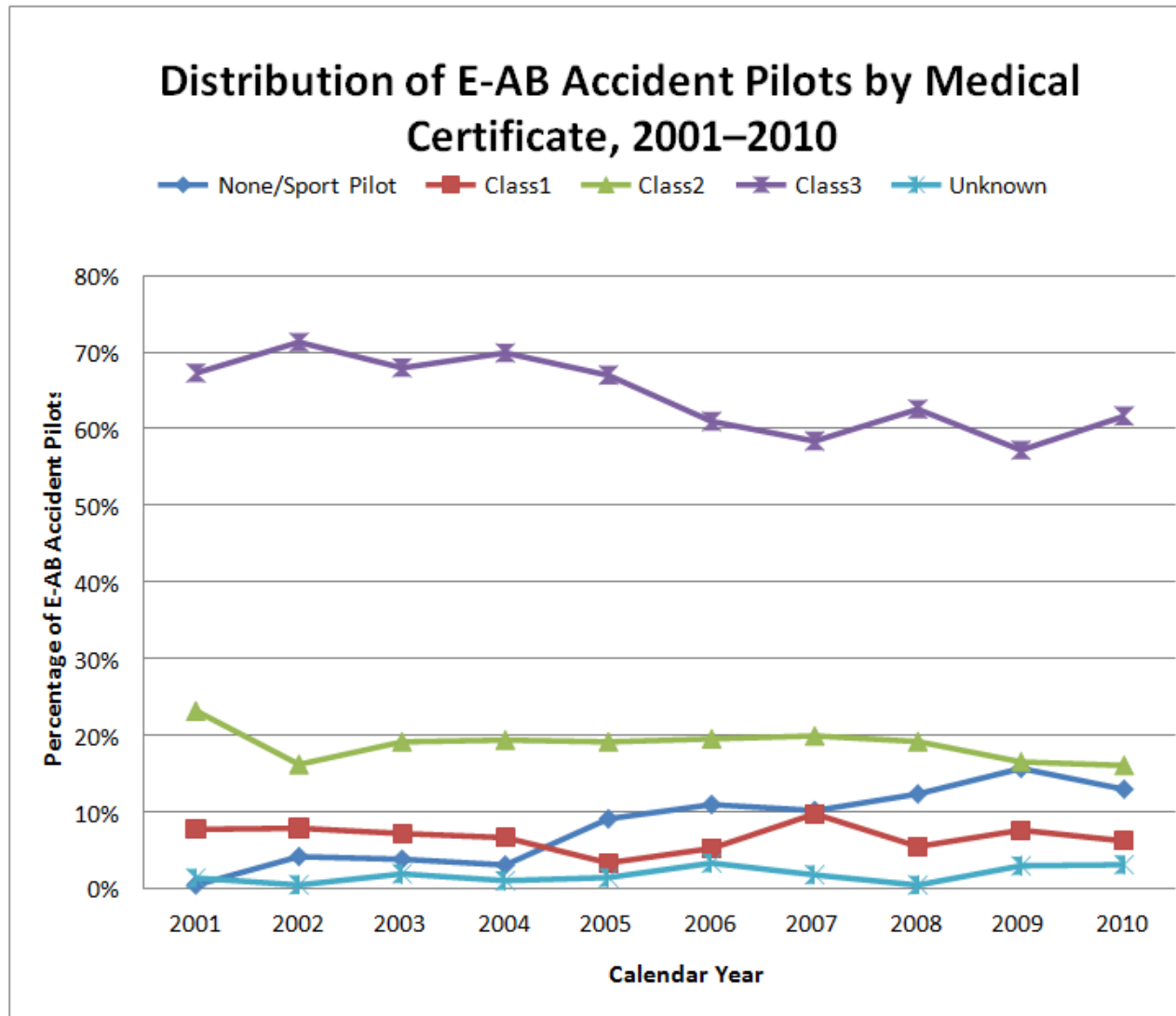
Flight Test Plan

- ▶ AC 90–89A provides extensive guidance.
- ▶ No requirement for test plan to be reviewed by FAA.
- ▶ Survey: 79% of builders made 1st flight.
12% of builders hired test pilot.
9% of builders asked friend to fly.

Flight Test Plans

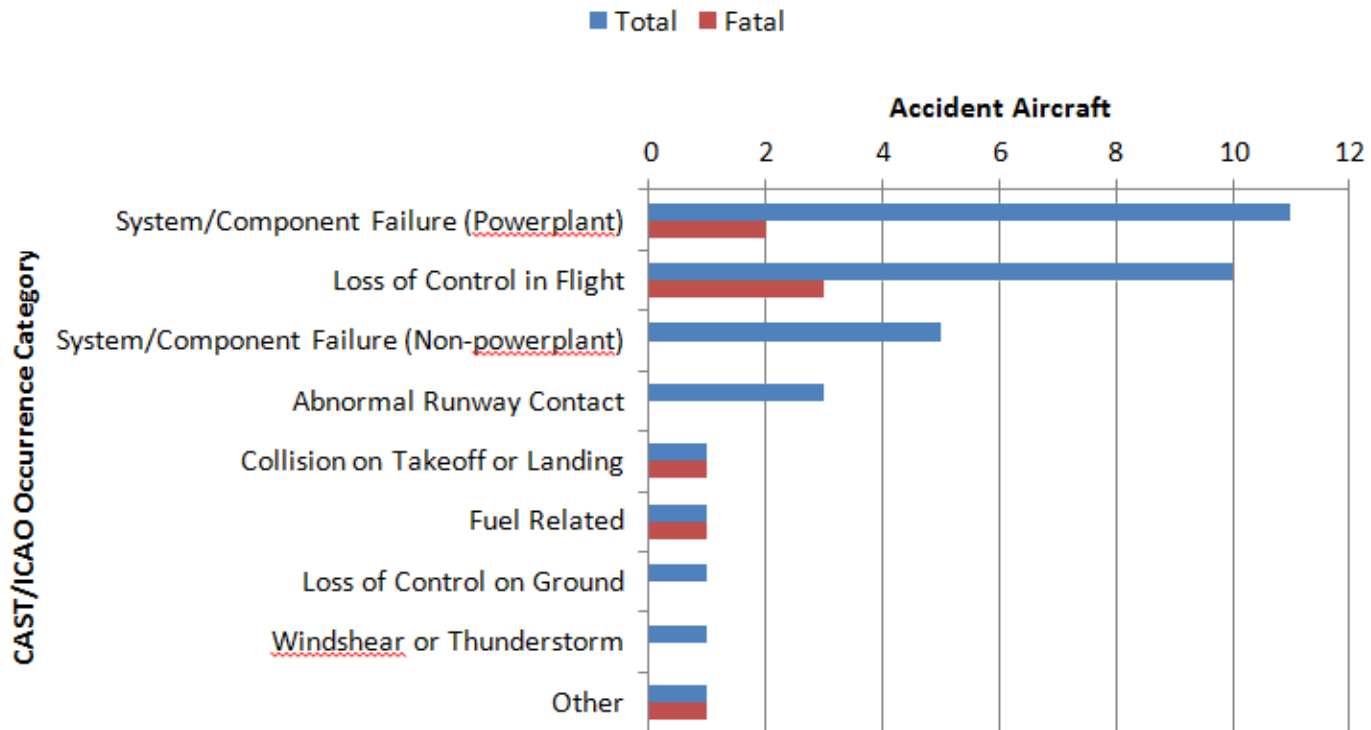


Who?

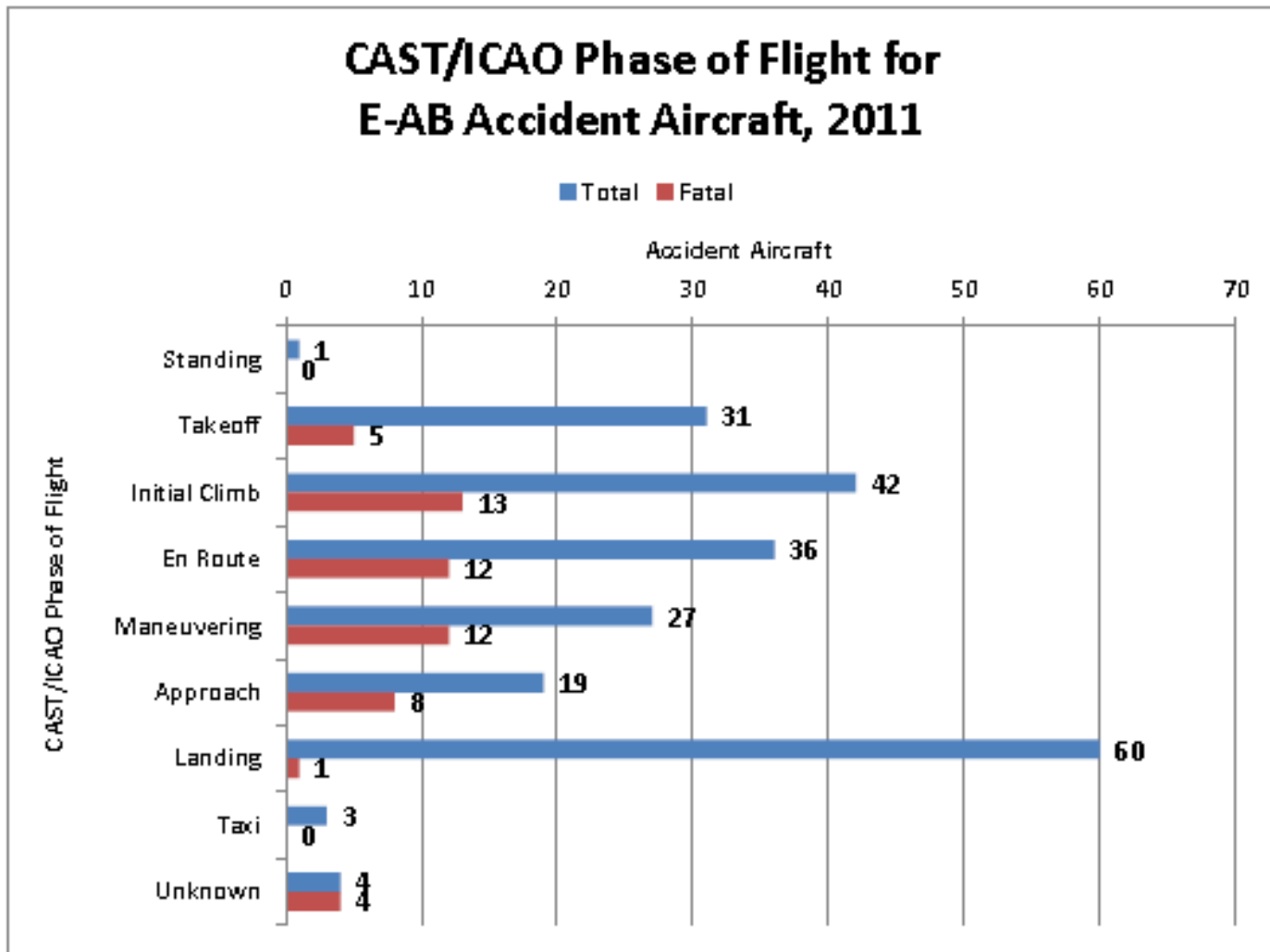


Why?

CAST/ICAO Occurrence Categories of E-AB Aircraft Accidents During Phase I Flight testing, 2011



When?



What's out there?

- ▶ Maverick Jet



Maverickjets.com

- ▶ Aerochia LT-1



Aerochia-lt1.com

What's out there?

- ▶ LP-1



Prototype – one of a kind.
Never flown – yet!

Woodward-aerospace.com

- ▶ Van's RV

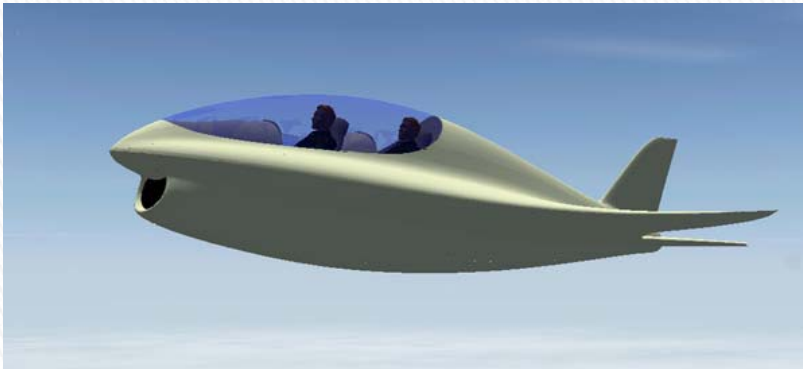


Completed kits = 8112

vansaircraft.com

What's out there?

- ▶ Smartfish



Concept design

- ▶ Waix



Kits sold \approx 1900
Kits flown = 430

Smartfish.ch

Sonexaircraft.com

FAA Guidance

- ▶ AC 20–27F, Certification and Operation of Amateur–Built Aircraft
- ▶ AC 90–89A, Amateur–Built Aircraft and Ultralight Flight Testing Handbook
- ▶ Order 8130.2G, Airworthiness Certification of Aircraft and Related Products

FAA Guidance

- ▶ 91.319: No person may operate an aircraft that has an experimental certificate ---
 - (b) until it is shown that ---
 - The aircraft is controllable throughout its normal range of speeds and ... all the maneuvers to be executed.
 - The aircraft has no hazardous operating characteristics or design features.

Industry Help

▶ EAA



www.eaa.org

Presented by Ron McElroy at SETP
Flight Test Safety Workshop 2013



FLIGHT TESTING HOMEBUILT AIRCRAFT



Effective tools for testing your creation safely with professional results,
greatly increasing your knowledge of the aircraft and its capabilities

Vaughan Askue

Test Flying Your Project

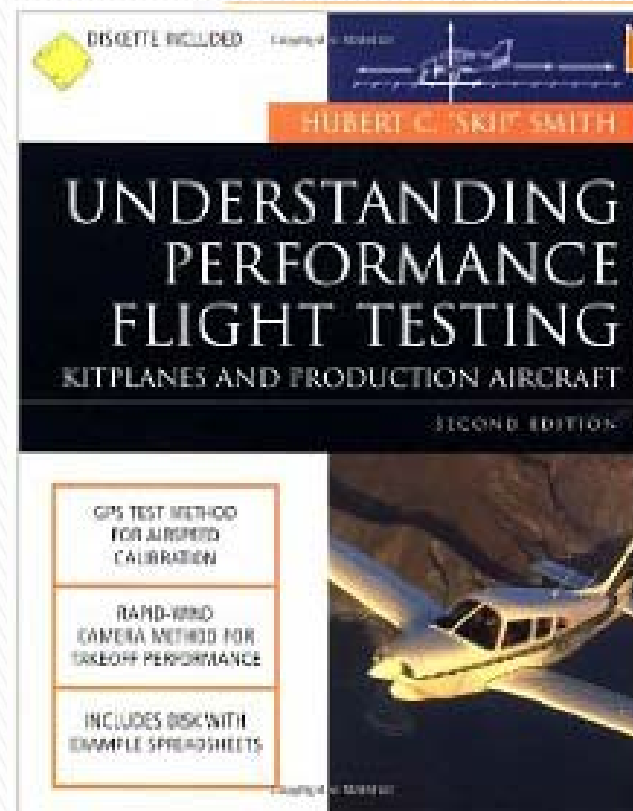


EAA
SPORTAIR
WORKSHOPS



For Information about other Workshops
Call 800-967-5746
Or Visit us at www.sportair.com

2-Day Schedule TBD \$349.00



Amazon.com \$499.00


Great gouge for anyone!

www.sportair.com

1-800-967-5746

Presented by Ron McElroy at SETP
Flight Test Safety Workshop 2013

Flight Test Philosophy

- ▶ Refer to AC 90-89 for planning events. 
- ▶ Start early and don't rush – get to know your airplane!
- ▶ Start conservatively in the heart of the envelope and incrementally open it up.
- ▶ What does the design support?
 - C_L vs α
 - Thrust / Weight Ratio
 - Max AOA for takeoff and landing
- ▶ Be aware of slow flight & stall surprises!

Phase I Flight Testing

▶ Flight Test Hours

- With type-cert engine/prop 25 Hours
- With non type-cert engine/prop 40 Hours
- Gliders, balloons, etc. 10 Hours

▶ Flight Test Area

- 91.305: over open water or sparsely populated areas.
- You may request otherwise, but should be within 25 sm radius.
- Stay within gliding range of suitable landing spots.

▶ No Passengers

- Additional crewmembers must be authorized.

▶ Recommend video/audio.

Ground Testing

- ▶ Preflight & checklists, test card preparation
- ▶ Engine runs & systems testing
- ▶ Low speed taxi
 - ▶ Engine ops, displays, steering & brakes
- ▶ High speed taxi
 - ▶ Vibration, flight control authority, steering & brakes
- ▶ Flight #0 – **Brief for unintended first flight!**

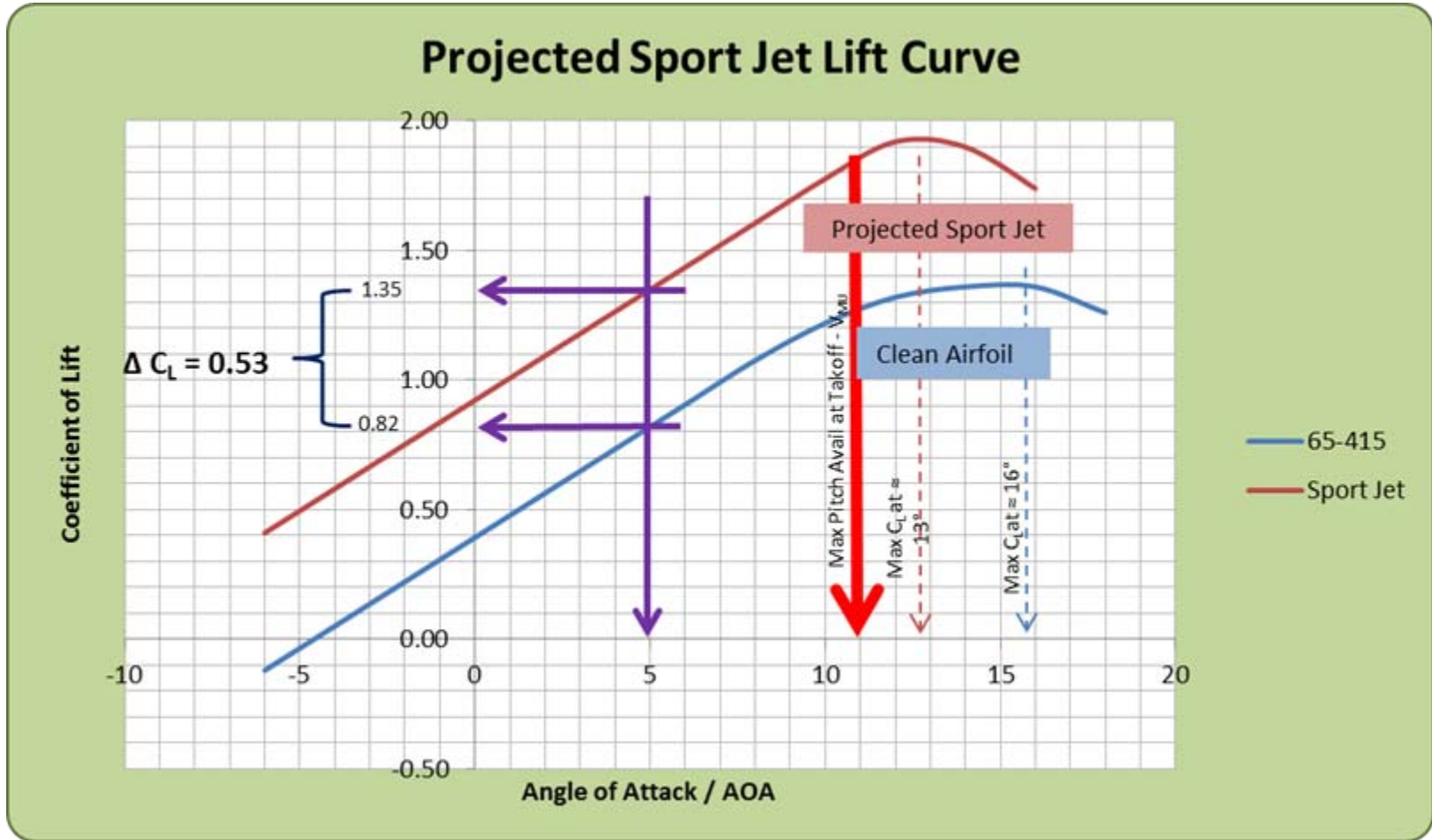
First Flight – X Amateur Built



▶ N350SJ, KCOS, May 2006



Design Expectations



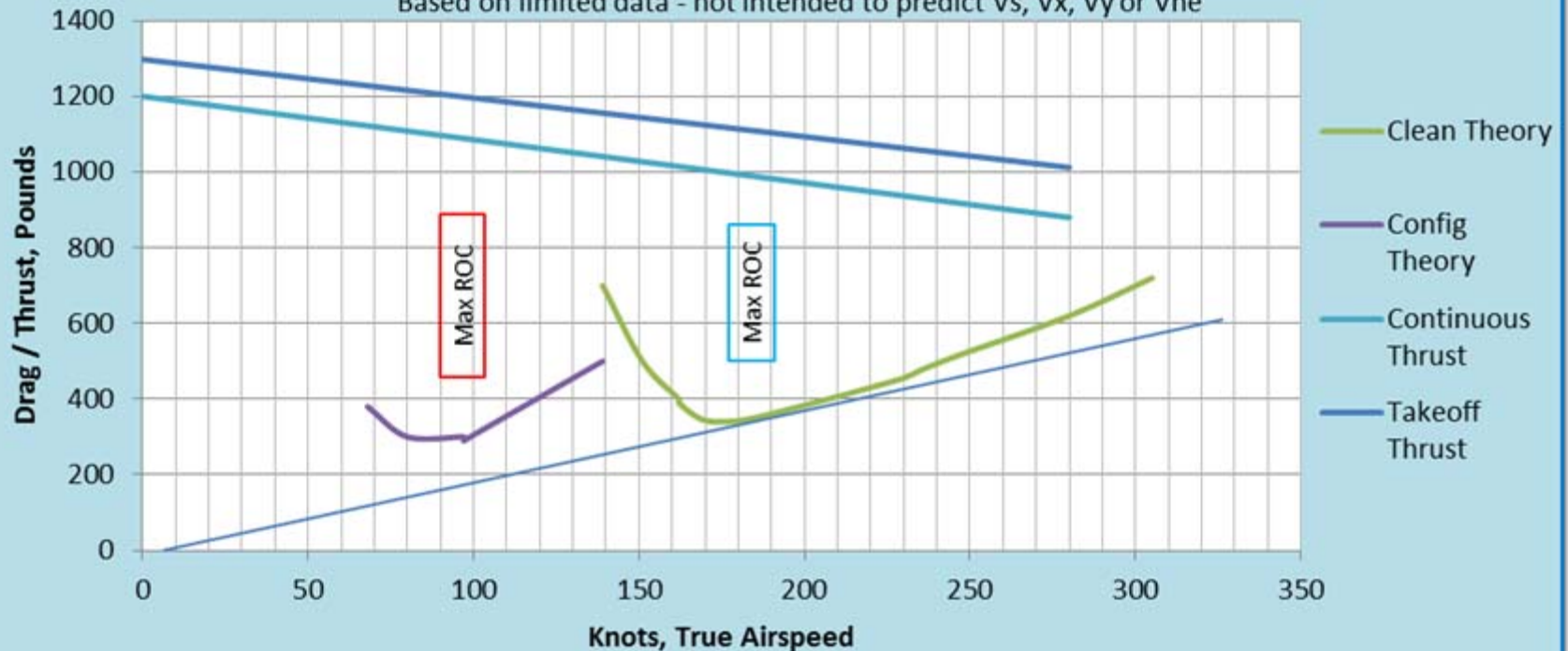
Knee Board Data

Flight #	MSL Altitude	Configuration				KIAS	KTAS	RPM		Rate of Climb		Est. Weight	Calculated Drag *	Theory Drag	Takeoff Thrust	Takeoff Thrust																													
		Gear	T/O Flaps	Full Flaps	AirBrakes			N1	Thrust	ROC	ROC						Drag	Climb Angle *																											
						knots	knots	%	lbs	ft/min	lbs	lbs	lbs	FPA = degrees	lbs																														
4	8000	X				120	139	95	950	1800	3520	500	500	10.4	1135																														
4	7000	X	X		X	85	97	48	135	-500	3300	303	290	15.6	1180																														
5	7000	X	X		X	85	97	47	120	-500	3300	288	290	15.6	1180																														
7	8000	X		X		85	97	50	145	-500	3100	303	300	16.5	1180																														
	7000	X		X		70	80				3100		300	16.9	1200																														
	7000	X		X		60	68				3100		380	15.5	1210																														
	8000					120	139	98 **	1000	2000 **	3300	531	700																																
	8000					130	151	98 **	980	2200 **	3300	505	500																																
5	8000					140	162	95	945	2500	3520	409	400																																
7	8000					140	162	96	980	3000	3250	386	390																																
12	8000					145	168	98	1040	3700	3270	329	350																																
7	8000					150	174	96	970	2500	3250	509	340																																
8	8000				unstable data -->	160	185	96	955	1500	3380	684	350																																
7	13800					176	228	81	400	0	3100	400	450																																
7	13800					185	236	85	470	0	3100	470	480																																
7	13800					194	248	88	530	0	3100	530	520																																
	13800					220	280	92 **	620	0	3100	620	620																																
	13800					240	305	95 **	705	0	3100	705	720																																
* Extrapolated from other data point																																													
8000 ft MSL	Thrust data interpolated from Williams International FJ33-4A-15 engine thrust charts	Maximum		0	0	Knots --->	1200	lbs thrust																																					
8000 ft MSL		Continuous Thrust		240	280	Knots --->	880	lbs thrust																																					
8000 ft MSL		Takeoff Rated Thrust		0	0	Knots --->	1298	lbs thrust																																					
8000 ft MSL				240	280	Knots --->	1012	lbs thrust																																					
<table border="1"> <thead> <tr> <th colspan="2">Acceleration Calculations</th> </tr> </thead> <tbody> <tr> <td>F = m a</td> <td>1200 = (3450/32.2) x a a = 11.2 fps² a = 6.64 kps²</td> </tr> </tbody> </table>																Acceleration Calculations		F = m a	1200 = (3450/32.2) x a a = 11.2 fps ² a = 6.64 kps ²																										
Acceleration Calculations																																													
F = m a	1200 = (3450/32.2) x a a = 11.2 fps ² a = 6.64 kps ²																																												
<table border="1"> <tbody> <tr> <td>* Equations:</td> <td>ROC = 101.3(V)((T - D) / W)</td> <td>ROC</td> <td>Rate of Climb</td> <td>feet per minute</td> <td></td> </tr> <tr> <td></td> <td></td> <td>V</td> <td>True Airspeed</td> <td>knots</td> <td>[Note: 101.3 is factor converting knots to fpm]</td> </tr> <tr> <td></td> <td></td> <td>T - D</td> <td>Thrust - Drag</td> <td>pounds</td> <td></td> </tr> <tr> <td></td> <td></td> <td>W</td> <td>Weight</td> <td>pounds</td> <td></td> </tr> <tr> <td></td> <td>FPA = arcsin ((T - D) / W)</td> <td>FPA</td> <td>Flight Path Angle</td> <td>degrees</td> <td>[Note: FPA = radians; multiply x 57.3 = degrees]</td> </tr> </tbody> </table>																* Equations:	ROC = 101.3(V)((T - D) / W)	ROC	Rate of Climb	feet per minute				V	True Airspeed	knots	[Note: 101.3 is factor converting knots to fpm]			T - D	Thrust - Drag	pounds				W	Weight	pounds			FPA = arcsin ((T - D) / W)	FPA	Flight Path Angle	degrees	[Note: FPA = radians; multiply x 57.3 = degrees]
* Equations:	ROC = 101.3(V)((T - D) / W)	ROC	Rate of Climb	feet per minute																																									
		V	True Airspeed	knots	[Note: 101.3 is factor converting knots to fpm]																																								
		T - D	Thrust - Drag	pounds																																									
		W	Weight	pounds																																									
	FPA = arcsin ((T - D) / W)	FPA	Flight Path Angle	degrees	[Note: FPA = radians; multiply x 57.3 = degrees]																																								

Knee Board Data

Figure 3A. Extrapolated Sport Jet Drag Data

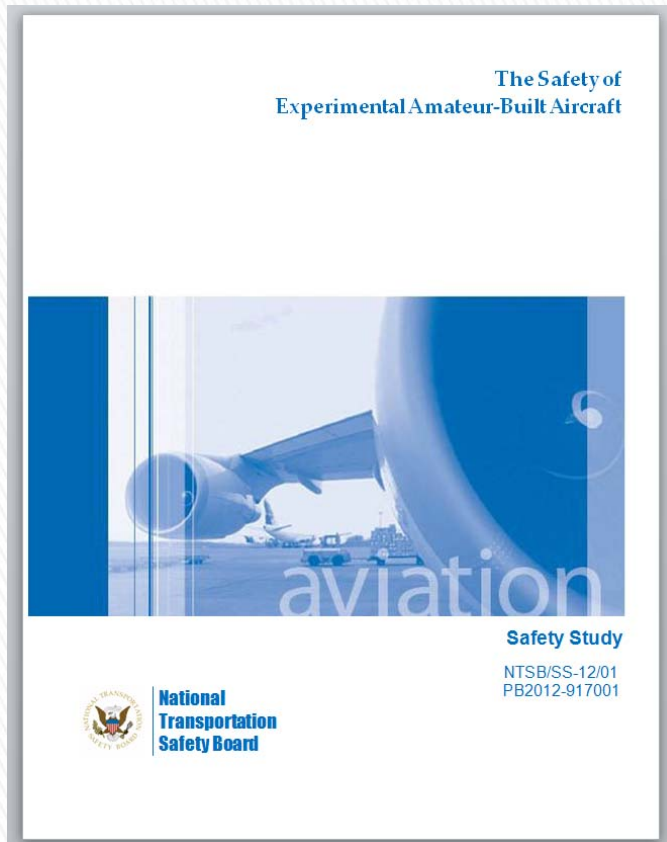
Based on limited data - not intended to predict V_s , V_x , V_y or V_{ne}



What Happened?



Investigation



- ▶ Wake Turbulence
 - Textbook worst conditions for vortices
- ▶ Complacent ATC
- ▶ Aircraft in perfect condition for flight
- ▶ Experienced pilot

NTSB Report

Accident Chain of Events

Lessons Learned

- ▶ Trust instincts – if it ain't right, it ain't right!
- ▶ Helmet and parachute.
- ▶ Install audio/video.
- ▶ Use AOA.
- ▶ Get familiar w/ aircraft.
- ▶ Get similarity training.
- ▶ Nobody else looking out for you.
- ▶ Build a flight test plan!
- ▶ Study aero predictions!
- ▶ Don't trust engineers!
- ▶ **Stop & Look** at data!
- ▶ Brief ATC/local Fire and Rescue teams!
- ▶ Use "*Experimental*" in Callsign.
- ▶ Don't let ATC rush you!
- ▶ FAA Advisory Circulars.

Flight Test Pilot

Project Details

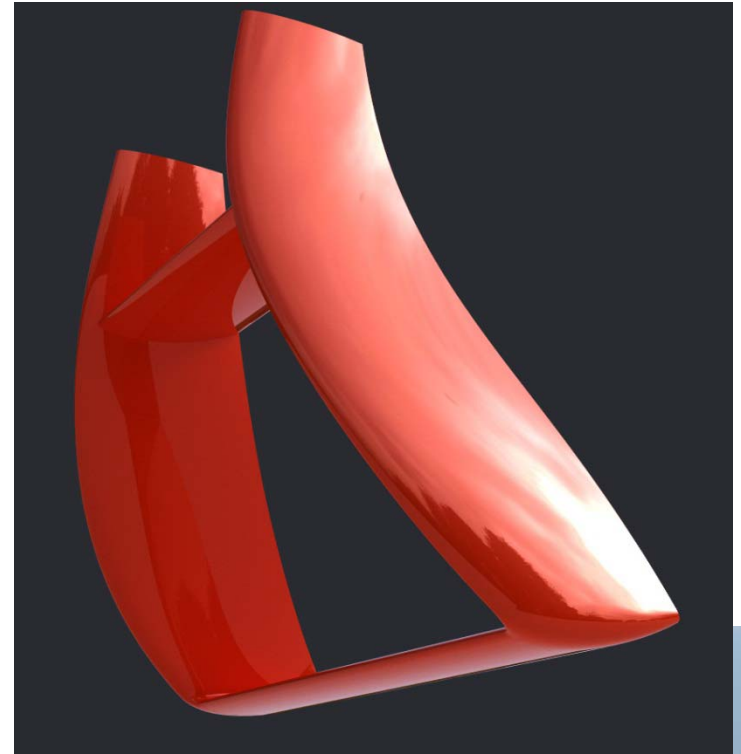




What's next?

"Are ya' feelin' lucky?"

What do I do now?



Are E-AB more unsafe in Flight Test?

- ▶ NTSB Study (2011):
 - 10 of 102 new E-AB aircraft accidents occurred during 1st flight.
 - 54 of 224 in all E-AB accidents had fatalities.
- ▶ EAA Study (1998 - 2007):
 - 1st Flight = 6% rate.
 - Phase 1 = 20% rate.
- ▶ Overall Risk?
 - 1st flight of new homebuilt has 1 in 133 chance of accident!
 - First 40 hrs rate of 1 in 43 chance of accident!
- ▶ Why?
 - Loss of control
 - Experimental engines

Statistics

Risk Management

NTSB & EAA Recommendations

- ▶ Define and conduct fuel system functional test and submit report for FAA approval.
- ▶ Submit flight test plan and flight test data for FAA acceptance plus EPs & flight manual.
- ▶ Require FAA review of Phase I test plan/data, performance, ops envelope prior to authorization of Phase II.
- ▶ Encourage “Test Flying and Developing POH” per EAA 2-day workshop (\$300).

NTSB & EAA Recommendations

- ▶ Allow 2nd qualified pilot for Phase I ops limits.
- ▶ Include guidance for use of recording flight test data....
- ▶ Include use of electronic data recordings from electronic displays to help support flight test and POH.
- ▶ LODA for transition training.
- ▶ Create coalition of kit builders, etc.
- ▶ Require review of ops limits and supporting documents as a condition of registration.

NTSB & EAA Recommendations

- ▶ Include provisions for modifying the ops limits of aircraft previously certificated as E-AB, to address safety concerns.
- ▶ Revise Civil Aircraft Registry database to better identify E-AB manufacturer, make, model, series, builder, etc.

LODA Website Database

ABOUT US :: AIRVENTURE OSHKOSH :: EAA STORE :: JOIN :: MEMBERS ONLY

EAA The Spirit of Aviation™

AVIATION INTERESTS | PROGRAMS | NEWS & EVENTS | MULTIMEDIA | SUPPORT EAA | MEMBER SERVICES | A TO Z

Search

Letter of Deviation Authority (LODA) Holders

These instructors hold Letters of Deviation Authority (LODA) from the FAA that authorize them to operate their experimental aircraft for hire for the purposes of type-specific training.

EAA, as well as the FAA and NTSB, **strongly recommend** that all builders and new owners of experimental aircraft undertake a thorough transition training program before flying their own aircraft solo for the first time (during Phase I testing or otherwise). These instructors are an invaluable resource towards accomplishing that goal. Proper transition training is an essential first step toward safe operation of experimental aircraft and a key element in the continuing effort to improve aviation safety.

Arkansas

Ron's Gyroplane	E-mail	501-766-6456	Searcy	Gyroplanes
Bentley, Will	E-mail	254-718-3924	Fayetteville	RV-6A
Foster, Steve	E-mail	501-279-2759	Searcy	RAF 2000 GTX

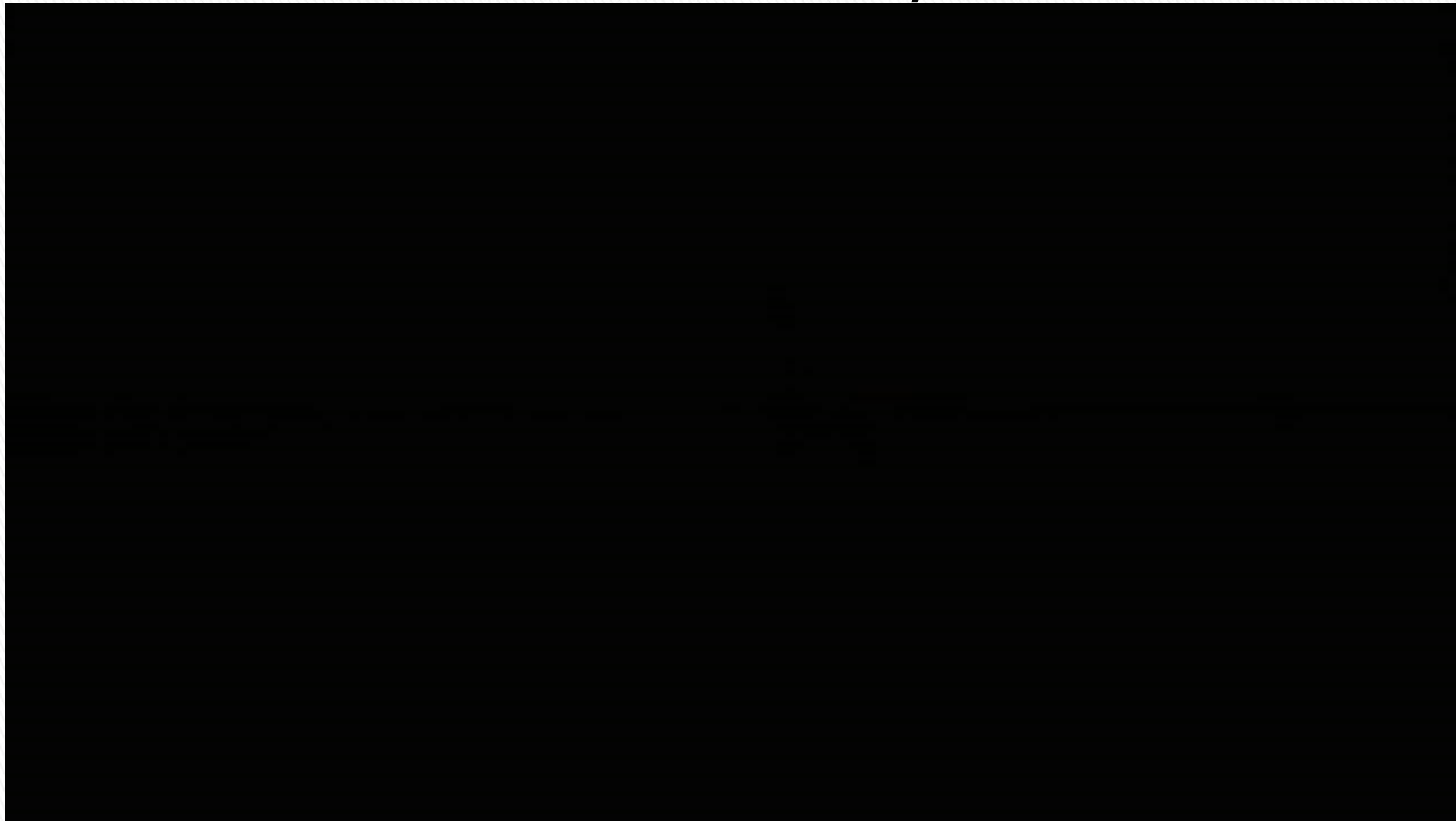
Arizona

Brandt, Terry	E-mail	602-739-0554	Avondale	RAF 2000
Dale, Andrew	E-mail	520-431-3114	Chandler	Rotorway Exec 162F Rotorway A600 Talon
Blumer, James	F-	623-930	Peoria	Challenger II Special

GOVERNMENT HOME
TYPE CLUB COALITION
LOCAL AIRPORTS
TSA and SECURITY
LIGHT-SPORT AIRCRAFT
FUEL and the ENVIRONMENT
AMATEUR-BUILT AIRCRAFT
USER FEES
GENERAL AVIATION (GA) CAUCUS
CONTACT CONGRESS

Courses are still

*“Those who don’t learn from history
are doomed to repeat it!”*





Fly Safe! Fly Smart! >>>

Capt Ron