GA Aircraft Glide Performance Testing

(With an appetizer of Bad Judgment)

Marc J. Zeitlin

August 30th, 2025

~2:00 PM

Kanab, UT Fly-In

What Will I Talk About?

- ***My Background / Introduction (2 minutes)***
- ***Bad Judgment (15 - 20 minutes)***
  - ***Travel Days***
  - ***Oshkosh***
  - ***Last Travel Day***
  - ***Learnings/Conclusion***
- ***COZY MKIV Glide Testing (30 - 40 minutes)***
  - ***Introduction***
  - ***Previous Canard Aircraft Glide Testing***
    - ***Ken Brimmer/Newsletter***
    - ***Nat Puffer/Newsletter***
    - ***Vance Atkinson/Newsletter***
    - ***Tom Staggs (COBA writeup)***
    - ***Klaus Savier (unpublished)***
  - ***Testing Requirements***
    - ***Safety***
    - ***IAS → CAS Calibration Map***
    - ***Autopilot Tuning***
    - ***EFIS***
    - ***Pilot***
    - ***Airspace***
    - ***Air Mass***
  - ***Test Procedure***
  - ***Test Data***
  - ***Test Results***
    - ***Lightweight, Fwd CG***
    - ***Lightweight, Aft CG***
    - ***Fwd CG L/D_{max} Curve Shape***
  - ***Methodological Differences***
  - ***Conclusions***
- ***References***
- ***Questions and Answer – until done (ANY topic - and I do mean ANY)***

My Background

- Biography / Resume'
  - http://www.mdzeitlin.com/Marc/bio.html
  - https://www.burnsideaerospace.com/resume/

- BS/MS Aeronautical Engineering from M.I.T.
- Built Quickie Q2 (1980 – 1985)
- Built COZY MKIV #386, N83MZ – >2090 flying hours
- Scaled Composites - SS2/WK2/RM2 Project Engineer/Engineering Manager
- ICON Aircraft - A5 Systems Engineering Manager

- As **Burnside Aerospace**, provided:
  - E-AB / canard A&P services (Pre-Buy, Pre-Sale, Condition Inspection, Sale Assistance, etc.)
  - Consulting to multiple commercial clients re: canard composite aircraft, Design Reviews, etc.

- I provide **UNOFFICIAL** technical support for **COZY** aircraft (and other canards) to all builders, flyers and prospective builders

- Start Syracuse Law School (online) in August, 2025

- Enough of that

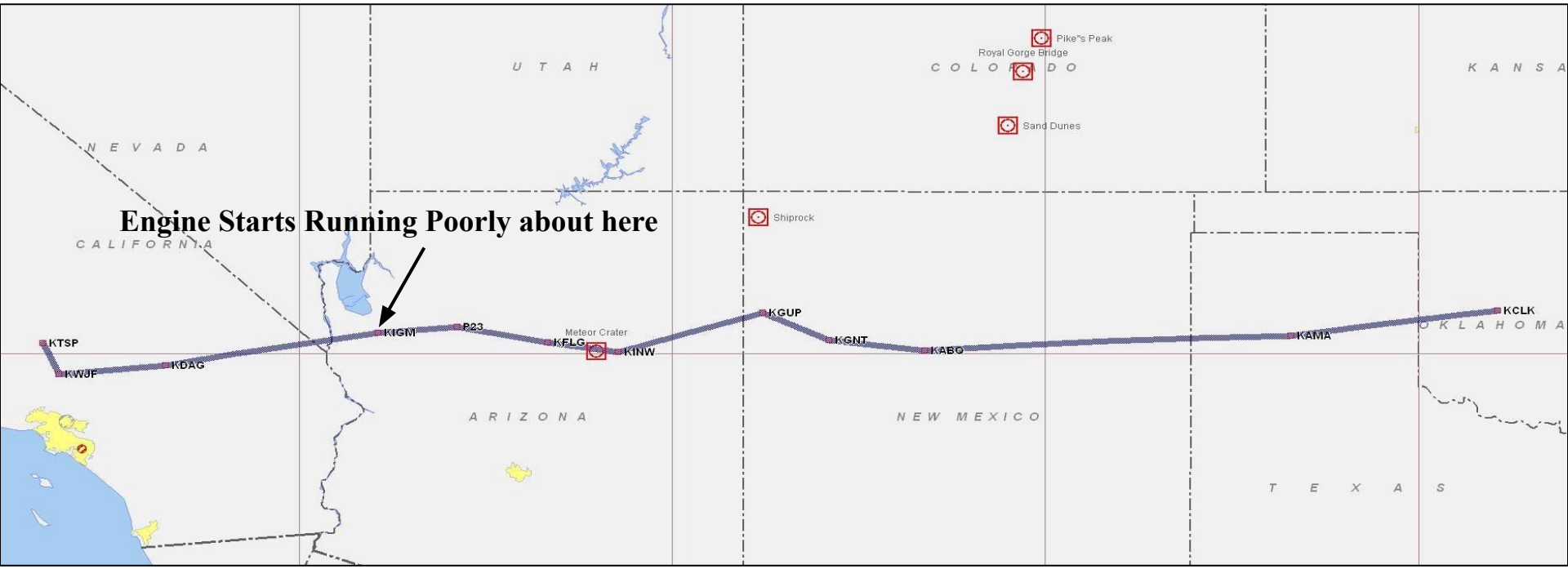
Introduction

- Not a flying story (at least not only) – human story
- I **guarantee** you'll think I'm an idiot
- I **guarantee** you'll think that **"I'd never do that"**
- You will laugh with embarrassment and feelings of superiority
- You'll think this is just as stupid as **"Watch This"** or **"Here, Hold My Beer"**

- 2008 Trip Description:
  - Tehachapi, CA to Cape Cod, MA / New Jersey for vacation
  - To **OSH** for vacation and Fora (COZY and Canard)
  - Come Home

- Previous Flights:
  - Test flight after replacing broken magneto with new Pmag – had **two** electronic ignitions (Pmag from "Emagair")
  - Five flights, including sightseeing for friends over Antelope Valley

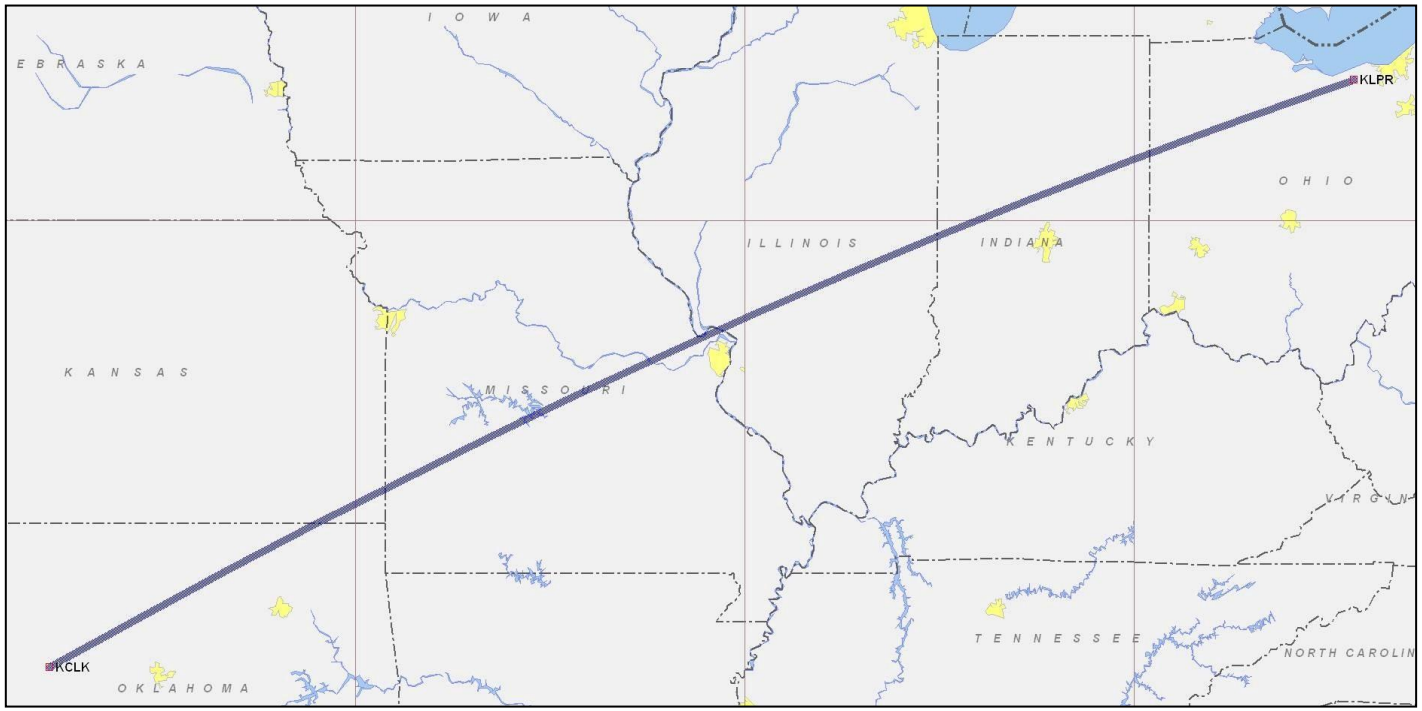
July 18th, 2008: KTSP - KCLK



- 987 NM Non-Stop
  - ~6.2 hrs
  - ~800 NM with EI Issue
- Lost ~100 RPM
- CHT's up ~50F
- Fuel Flow up ~1/2 gph
- Played with:
  - Throttle
  - Mixture
  - Ignition Cutoff

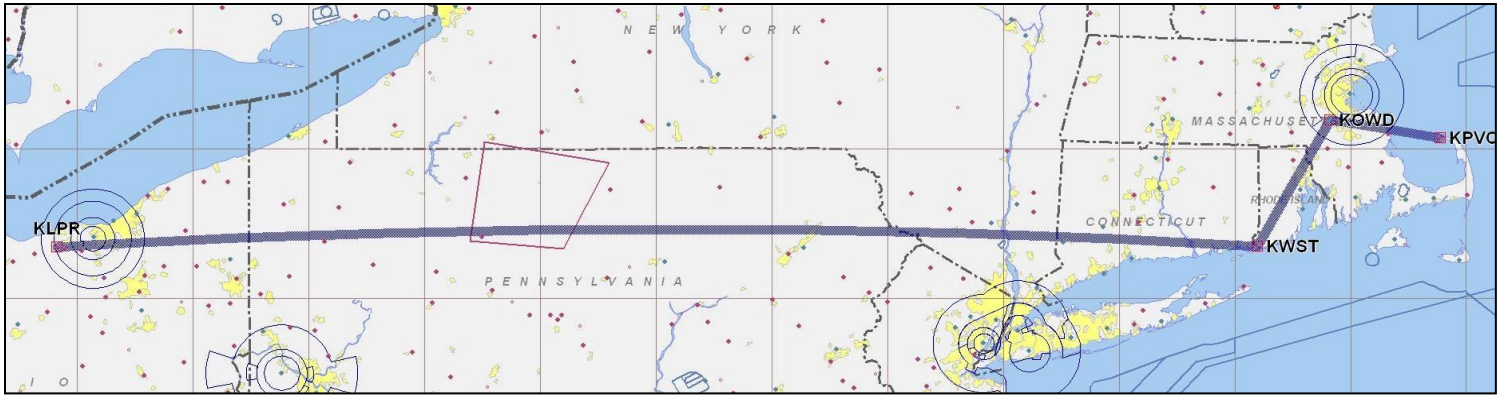
- First Stupid Decision – continue flight with known issue – obvious that **SOMETHING** is wrong
- Land in Clinton, OK (gas, oil, bathroom)
- No A&P on field – won't be back for 3 days
- Add oil, takeoff cowl – no obvious problems
- Run-up crappy – one EI not working – go back and check under cowl again
- Don't want to be stuck somewhere in AZ, NM or in KCLK – have friend in OH – "need" to get there

July 18th, 2008: KCLK - KLPR



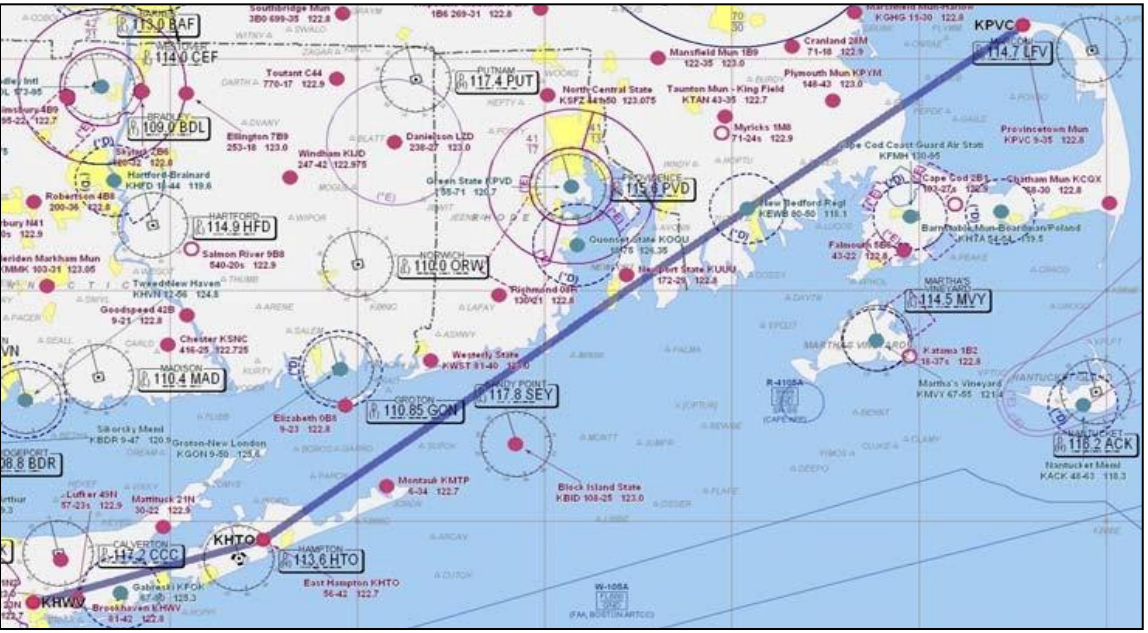
- Second Stupid Decision – rationalize takeoff from **KCLK** to get to **KLPR** in OH
- 859 NM - ~5.5 hrs
- Engine running poorly from the start – take off on one EI
- Second EI kicks in after 10 minutes (warm-up, presumably) – runs as before on 1.5 EI's – Land at **KLPR** in OH
- Look under cowl again – nothing obvious – add oil
- Spend night with friend in OH

July 19th, 2008:
KLPR – KWST – KOWD - KPVC



- Don't want to be stuck in OH – already paid for vacation in Cape Cod with family
- Third Stupid Decision – take off on one EI again – second kicks in after 10 minutes during climb – runs medium crappy again
- 568 NM with two stops planned for friend visits
- ~4.5 hrs total
- Fly over scattered/broken decks at 13.5K ft.
- Instead of going straight to final destination – land in Westerly to visit friend (who's not there – eat lunch and have phone conference with EI vendor)
- Fourth Stupid Decision – take off on one EI and fly to Norwood, MA to visit another friend (at least he's there)
- Fifth Stupid Decision – take off on one EI and fly to Provincetown for week vacation (Normalization of Deviance)
- Call EI vendor and have new unit Fedex'ed to **KPVC**

July 25th, 2008:
KPVC – KHWV – KHTO - KPVC



- Replaced defective EI at **KPVC** – engine runs well (but **no RTS flight**)
- Sixth Stupid Decision – take off on two EI's, knowing that I've already had a failure with no known cause
- But "need" to bring nephew home to Long Island – son comes with us
- ~140 NM each way
- ~50 min each way
- Engine/both EI's run fine to **KHWV**
- Major problem 7 minutes after takeoff on return – son in right seat
- CHT's through the roof – can only maintain 2000 RPM
- Make Emergency landing at **KHTO** – disconnect **OTHER** EI – **NOT** the new one
- Seventh stupid Decision – take off on one EI
- Fly back to **KPVC** on new EI
- Deanie (wife) very upset (big surprise) – everyone OK
- **First epiphany – I almost killed my son**

July 26th, 2008: KPVC - KCDW

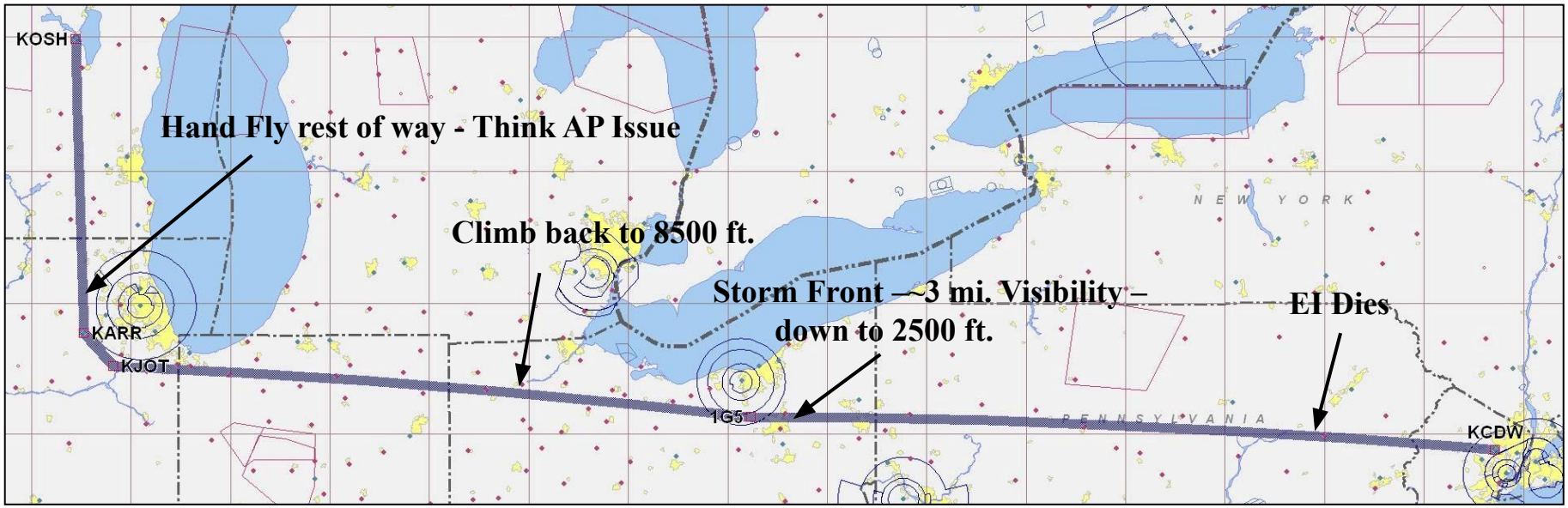
- No passengers for rest of trip – woohoo – at least **ONE** good decision

- Eighth Stupid Decision – take off on one EI, having had **TWO** failures of **DIFFERENT** EI's
- But "need" to get to NY to visit mom
- ~200 NM
- ~1.5 hrs into 20 kt. headwind

- 45 minutes above broken deck
- **DON'T TELL MY MOTHER ANYTHING**
- Have new EI Fedexed to NJ
- Install – now have two replaced EI's
- Get flight for Deanie from NY to **OSH**

- Notice – **NOT** getting substantially smarter (can laugh now, but doesn't change facts)

July 30th, 2008: KCDW - KOSH

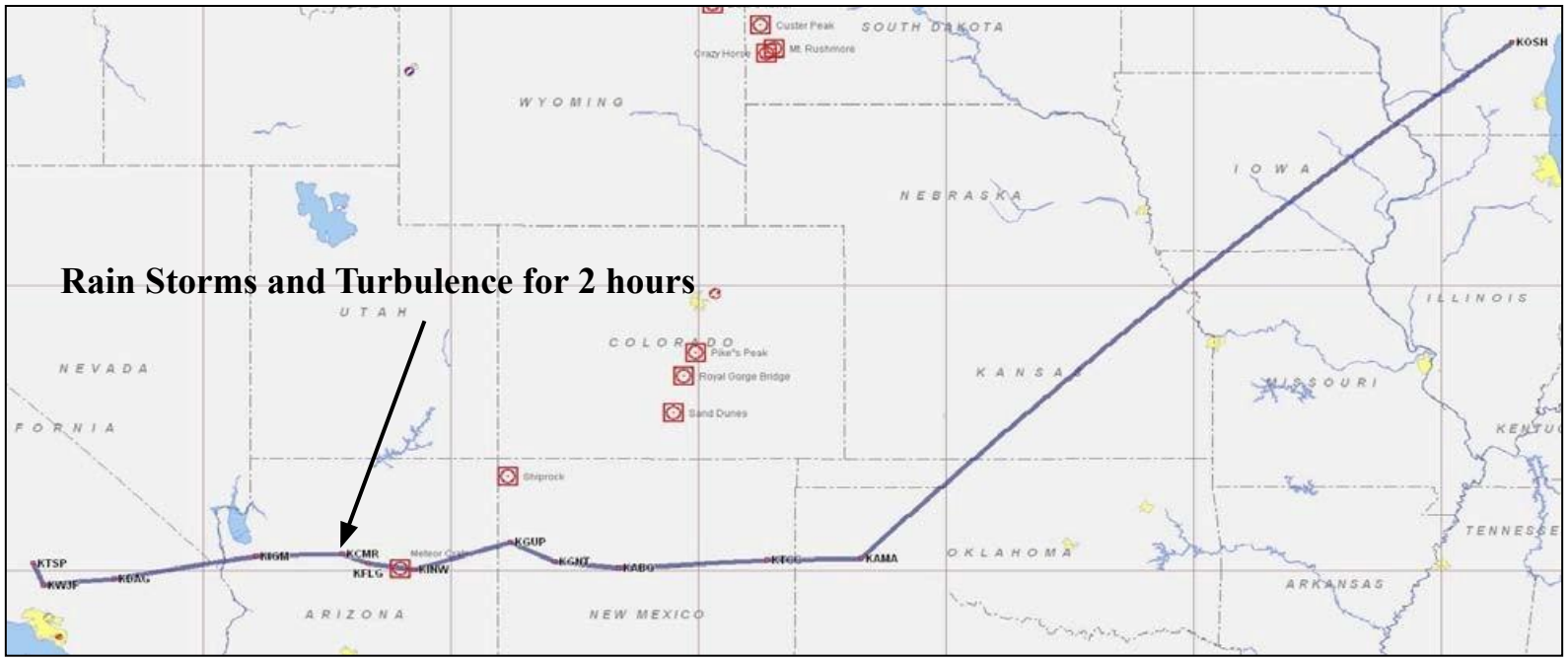


- Thought process (such as it was) – get to **OSH**, deal with vendor directly, then get home
- Ninth Stupid Decision – take off with two possibly bad EI's
- ~780 NM
- ~4.5 hrs. planned - ~5.5 hrs actual (winds / diversion)
- New (NJ install) EI dies after 1.5 hours over eastern PA
- Tenth Stupid Decision – continue flight
- From 10.5K ft, attempt to climb over front near Cleveland – can't get over the top – double back and descend from 13.5K Ft. to 2,500 ft. (**AWOS/ATC** indicate **VFR**, light showers underneath – no convective activity)
- Eleventh Stupid Decision – continue flight down low, through low visibility (~3 mile) on ONE EI
- Due to stress, accidentally switch AP to follow NAV radio rather than GPS and don't notice – think I've got an AP failure – hand fly rest of the way
- But, "have" to get to **OSH** to pick up Deanie at Appleton…
- **VERY** tired, **VERY** stressed, into **OSH** – borrow car, get Deanie

July 31st, 2008 – August 2nd, 2008 At OSH

- Spend three days taking apart EI's, diagnosing with Emagair (vendor), determining root cause of failures (lousy Mechanical Design)
- Give Canard Forum / COZY Forum
- Attend canard lunch, COZY dinner
- Argue with Vendor (Emagair) re: ignition issues
- Replace EI's with **two** new units – take spare as well
- Talk to friends about plan to get plane home – they recommend replacing with two Mags. I don't listen because….?

August 2nd, 2008:
KOSH – KTCC - KTSP



- Twelfth Stupid Decision (**MAYBE** slightly less stupid, since these EI's are supposedly "fixed") – take off, but at least this time, with a plan
- ~1650 NM
- ~12 hr. day
- Use "fixed" EI's – mechanical fix
- Plan:
  - Cruise at 2500 RPM
  - Never over 2600 RPM
  - Keep speed up for cooling – fast climb IAS
  - Have third "extra" EI in plane – just in case
- No problems first 5.5 hrs to **KTCC**
- Stop in **KTCC** for food/fuel/oil
- Thirteenth (and last) Stupid Decision (by this time, it's routine) – take off on last leg home
- Bumpy all the way with headwind – moderate turbulence through **AZ/CA**
- Engine runs fine the whole way
- **VERY** tired, nauseated, stressed – land just before dark at **KTSP**

- Removed EI's, returned for refund
- Took plane apart – **grounded airplane and self for 1.5 years**

Learnings / Conclusions

- **From this Experience:**
  - **Thirteen** Stupid Decisions – any of which could have killed me (or others) – odds relatively low, but **FAR** higher than normal - would you get in your car if it had a 1/1000 chance of killing you on any given day?
  - Don't focus on the **TECHNICAL** issues with the EI's / Engine – that's **NOT** the problem
  - No matter how smart you are, or think you are, you can still be a complete idiot
  - Anyone who thinks that because they have a degree from college and a good job or because they've been flying for 30 – 40 years that they're not capable of making mistakes that can and will kill them is in complete denial
  - You will sometimes do things that if your friends said they were going to do, you'd tie them up to the boiler in the basement to keep them from doing it
  - Reading NTSB reports and having a **"what was that moron thinking"** attitude is lying to yourself and can kill you
  - Get-there-itis can kill you
  - Having to be somewhere, or **THINKING** that you have to be somewhere, can kill you

  - **Sometimes, even recognition of all of these issues, and having them all running around in the back of your head, is INSUFFICIENT**

- **Other Personal Instances of Poor Judgment:**
  - 1978: Stuck finger in surface grinder
  - 1978: 75 mph motorcycle grounding
  - 1979: Caught hair in milling machine
  - 1981: Motorcycle case crack
  - 1985: Q2 nose-over
  - 2004: Shoelace nose gear collapse

- **Reference for Incompetence and Introspection:**
  - The Normalization of Deviance
  - "Unskilled and Unaware of It" - The Dunning-Kruger Effect

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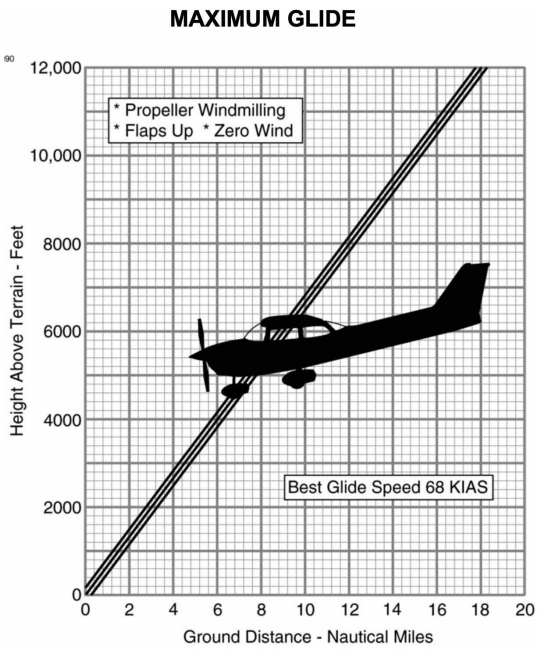
Glide Test Introduction

- Objectives:
  - Understand glide in general, but also prop stopped / prop windmilling differences
  - Provide test methodology to community
- Glider pilots understand meaning and importance of knowing glide ratio (L/D) of aircraft
- Power pilots far less familiar with idea, but important in case of an engine failure
  - Had personal experience with loss of propeller in 2006 flight



- Other configuration differences (landing gear, flaps, etc.)
- Verify previous test results with REAL scenario
- Magazine (COBA) which I edit had an article about Long-EZ glide testing - prompted my interest in performing my own testing

Previous Canard Glide Tests

- Ken Brimmer (COZY Pilot) - engine off, prop stopped, poor methodology, strange results
  COZY Newsletter #53 - January 1996
- Nat Puffer (COZY Designer) - unknown conditions, poor results in Prototype POH
  COZY Newsletter #61- April, 1998
- Vance Atkinson (ATP/COZY Pilot) - engine off, flawed methodology
  COZY Newsletter #74 - July, 2001
- Tom Staggs (Long-EZ Airshow Pilot) - engine off, prop stopped, methodological questions
  Canard Owners and Builders Association (COBA) Newsletter #149 - January, 2023
- Klaus Savier (Varieze/Long-EZ Pilot) - unknown conditions
  unpublished discussions

Testing Requirements

Safety Overview:

- Have glider rating since 1974 - not scared of deadstick flight (many power pilots are deathly afraid of engine failures)
- Safety is (or at least should be) first concern in **any** test
- Unlike previous discussion, goal was to avoid stupid decisions - no pressure for performance

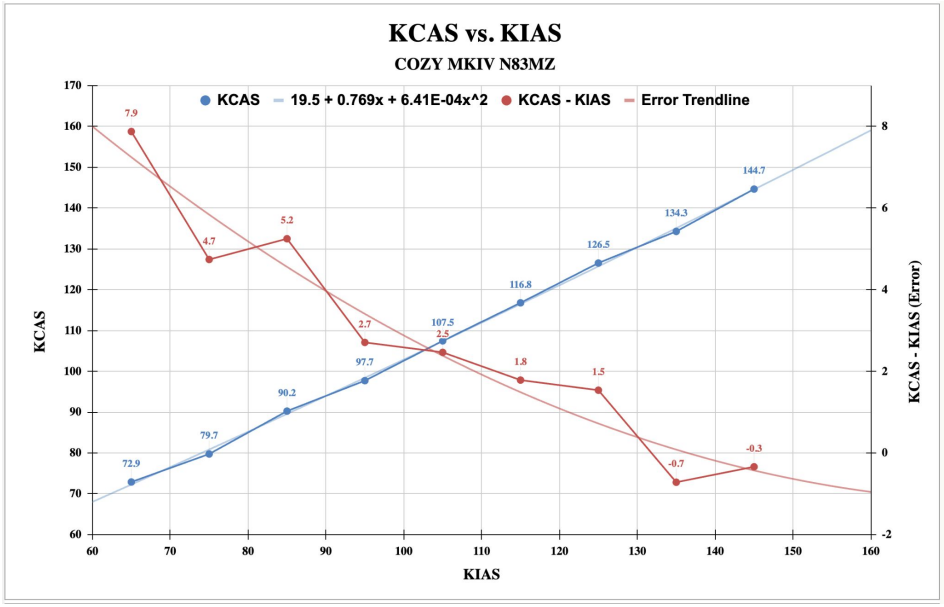
Safety Plan:

- Stay within **easy** glide distance of airport (**KTSP** or **L94**)
- Hard deck of 2,200 ft. AGL for attempting engine restart (why that?)
- If no engine restart by 1,500 ft. AGL, abort restart, configure and glide to landing. That's ~700 ft. altitude loss, or about **one** minute for a restart
- End each test run 1- 2 NM from airport runway approach end - (Need L/D of 8:1 for worst case scenario)

Testing Requirements

IAS → CAS Calibration Map:

- Methodology required accurate TAS knowledge
- Can't know TAS without knowing accurate CAS (at least within test range of 60 KIAS to 100 KIAS)
- This map from recent CAS testing (January, 2025)



- **With Dynon EFIS, can theoretically input this map to get accurate TAS reading in the data stream, rather than having to reduce/adjust data after the fact**

Testing Requirements

Autopilot Tuning:

- Need excellent speed control for accurate results - I'm a decent pilot, but the Dynon AP is better at IAS control
- AP must be tuned to hold IAS within +/- 1 KIAS in calm air
- +/- 2 KIAS can be acceptable, but suboptimal - errors are higher
- AP must be set to allow control down to just above aircraft's stall speed (for canards, canard bob speed)

Testing Requirements

Electronic Flight Information System (EFIS):

- Information required - IAS, TAS, Ground Speed (using GPS), Track, Time, Pressure Altitude, GPS altitude, VSI, RPM and OAT

- **May be** possible to keep track of via hand notes, but:
- Recording EFIS with 1/second recording and data output is far superior and far more accurate

Pilot

- Rested, not stressed
- Each test run takes ~1.5 hours - don't start unless time is available (multiple glide series for each run)

Testing Requirements

Airspace:

- Non-busy airspace
- Near non-busy airport(s) (untowered usually better, but not always)
- Need to be able to glide for ~2 - 4 minutes in straight line without having to avoid other aircraft

Airmass:

- Calmest possible air
- Turbulence or lift/sink leads to inaccurate results
- Wind **not** important - using TAS, not ground reference
- Early morning usually best

Test Procedure (eye chart)

1. Start at lightest possible weight and rearmost CG (102")
2. Note CG/GW for the test to be conducted (+/- 50 lb. and +/- 0.2" is fine)
3. Verify EFIS/Autopilot setup correct
4. Take off and climb to ~5.5K ft. AGL - pick some even altitude above 5.5K ft. AGL, to a distance 4 - 5 miles from the airport and level off at 70 KIAS
5. Point in an appropriate direction (reverse of the direction I climbed in, usually) so that at the end of the glide I'd be within a nautical mile or two of the airport
6. Turn off the engine via throttle ands mixture to hard idle - turn off ignitions as well, if required to stop the engine
7. Decelerate to below 65 KIAS to stop the propeller while holding altitude
8. Accelerate to approximately the test speed (start at 70 KIAS)
9. Activate the A/P in "Track" mode to hold that direction
10. Activate the A/P in IAS mode and adjust to 70 KIAS, with an altitude bug to descend to hard floor of 2.2K - 2.4K ft AGL
11. I would be at approximately 4.5K - 5.0K ft AGL when stabilized +/- 1 KIAS and on track
12. Descend in a stabilized glide for 2 - 4 minutes with the engine off and prop stopped until at 2.2K - 2.4K ft. AGL. This would be about 2.1K ft. - 2.8K ft. of altitude loss
13. Turn on ignitions and increase the mixture / throttle as required - start the engine using the starter
14. Reverse course, climb back up to 5.5K ft. AGL, and repeat the above #4 to #13 steps at 5 KIAS increments (75 KIAS, 80 KIAS, etc.) until at 100 KIAS
15. Land, download the data, and then reduce it
16. Repeat steps 2 - 15 at lightest weight and forwardmost CG (97.5")
17. Repeat steps 2 - 15 at mid-weight and rearmost CG (102")
18. Repeat steps 2 - 15 at mid-weight and forwardmost CG (97.5")
19. Repeat steps 2 - 15 at MGW and rearmost CG (102")
20. Repeat steps 2 - 15 at MGW and forwardmost CG (97.5")

RED = Not Done Yet

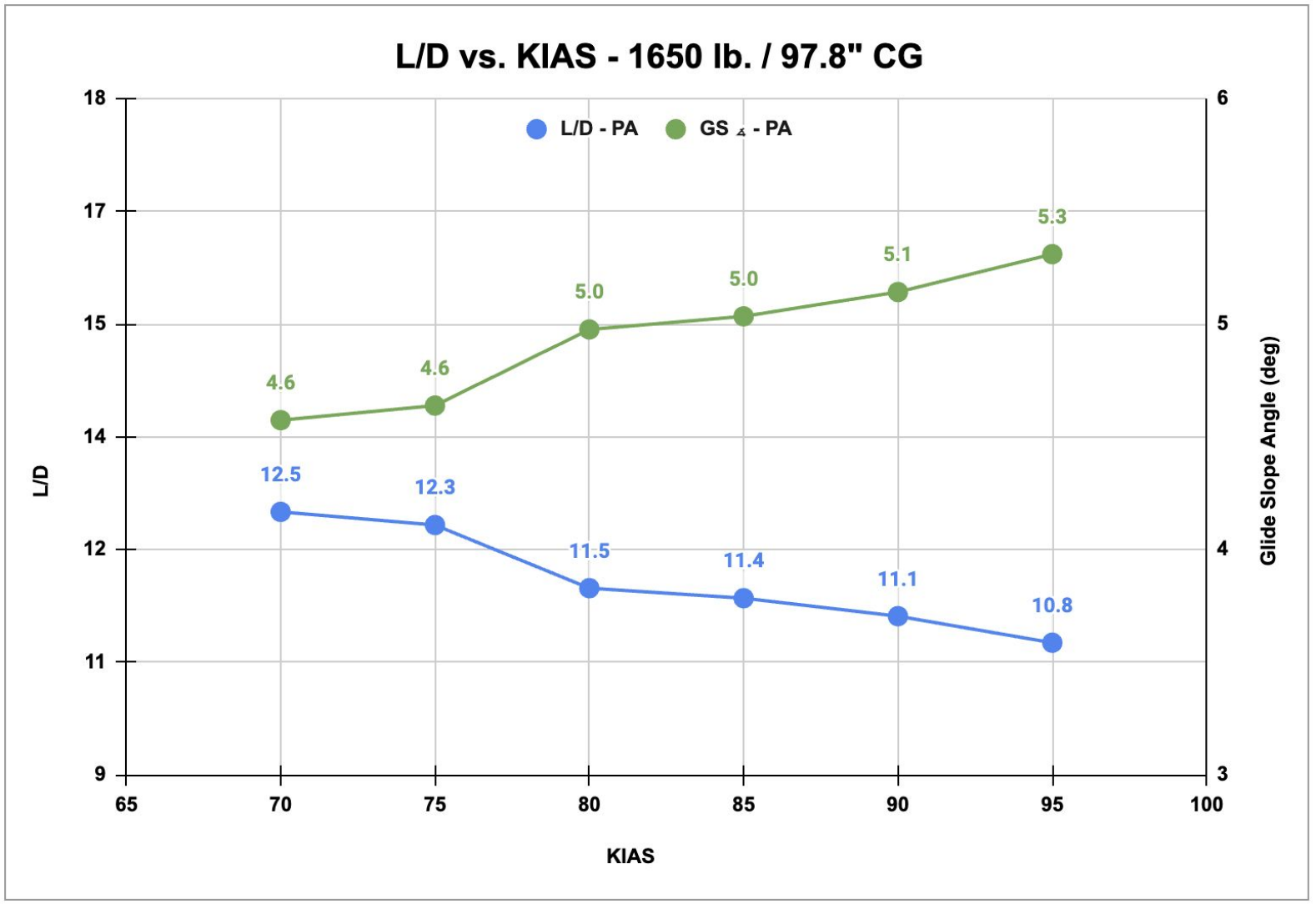
Test Data

- Download flight data - delete all data that isn't a glide run - over 75% of data in file
- Use IAS → CAS correction factors to adjust TAS output from EFIS
- Sample from data set →
- Note stopped engine, IAS bug, actual IAS, EFIS TAS, corrected TAS

GPS Zulu Date & Time	Session Time	Run Seconds	AS Bug (kt)	KIAS	KTAS	Corrected TAS (kt)	Alt. Bug (ft)	PA (ft)	DA (ft)	GPSA (ft)	VS (ft/min)	RPM
Engine OFF - 95 KIAS												
2023-01-03 19:30:27	773.06	0	95	94.9	107.6	109.0	9400	8401	8440	8499	-1414	0
2023-01-03 19:30:28	774.06	1	95	95.7	108.5	109.9	9400	8377	8420	8476	-1406	0
2023-01-03 19:30:29	775.06	2	95	95.9	108.7	110.1	9400	8356	8393	8455	-1360	0
2023-01-03 19:30:30	776.06	3	95	95.9	108.7	110.1	9400	8335	8378	8436	-1298	0
2023-01-03 19:30:31	777.06	4	95	96.2	109	110.4	9400	8319	8359	8420	-1176	0
2023-01-03 19:30:32	778.06	5	95	96.1	108.8	110.2	9400	8302	8345	8401	-1117	0
2023-01-03 19:30:33	779.06	6	95	96.2	108.9	110.3	9400	8285	8329	8384	-1082	0
2023-01-03 19:30:34	780.06	7	95	96.5	109.2	110.6	9400	8269	8313	8368	-1020	0
2023-01-03 19:30:35	781.06	8	95	95.9	108.5	109.9	9400	8252	8300	8352	-1013	0
2023-01-03 19:30:36	782.06	9	95	95.9	108.5	109.9	9400	8237	8282	8337	-957	0
2023-01-03 19:30:37	783.06	10	95	95.6	108.1	109.5	9400	8223	8276	8323	-909	0
2023-01-03 19:30:38	784.06	11	95	95.7	108.2	109.6	9400	8212	8262	8311	-826	0
2023-01-03 19:30:39	785.06	12	95	95.6	108.1	109.5	9400	8197	8255	8296	-852	0
2023-01-03 19:30:40	786.06	13	95	95.6	108	109.4	9400	8180	8234	8281	-910	0
2023-01-03 19:30:41	787.06	14	95	95.7	108.2	109.6	9400	8166	8226	8265	-894	0
2023-01-03 19:30:42	788.06	15	95	95.5	107.9	109.3	9400	8149	8208	8250	-927	0
2023-01-03 19:30:43	789.06	16	95	95.3	107.6	109.0	9400	8135	8191	8235	-885	0

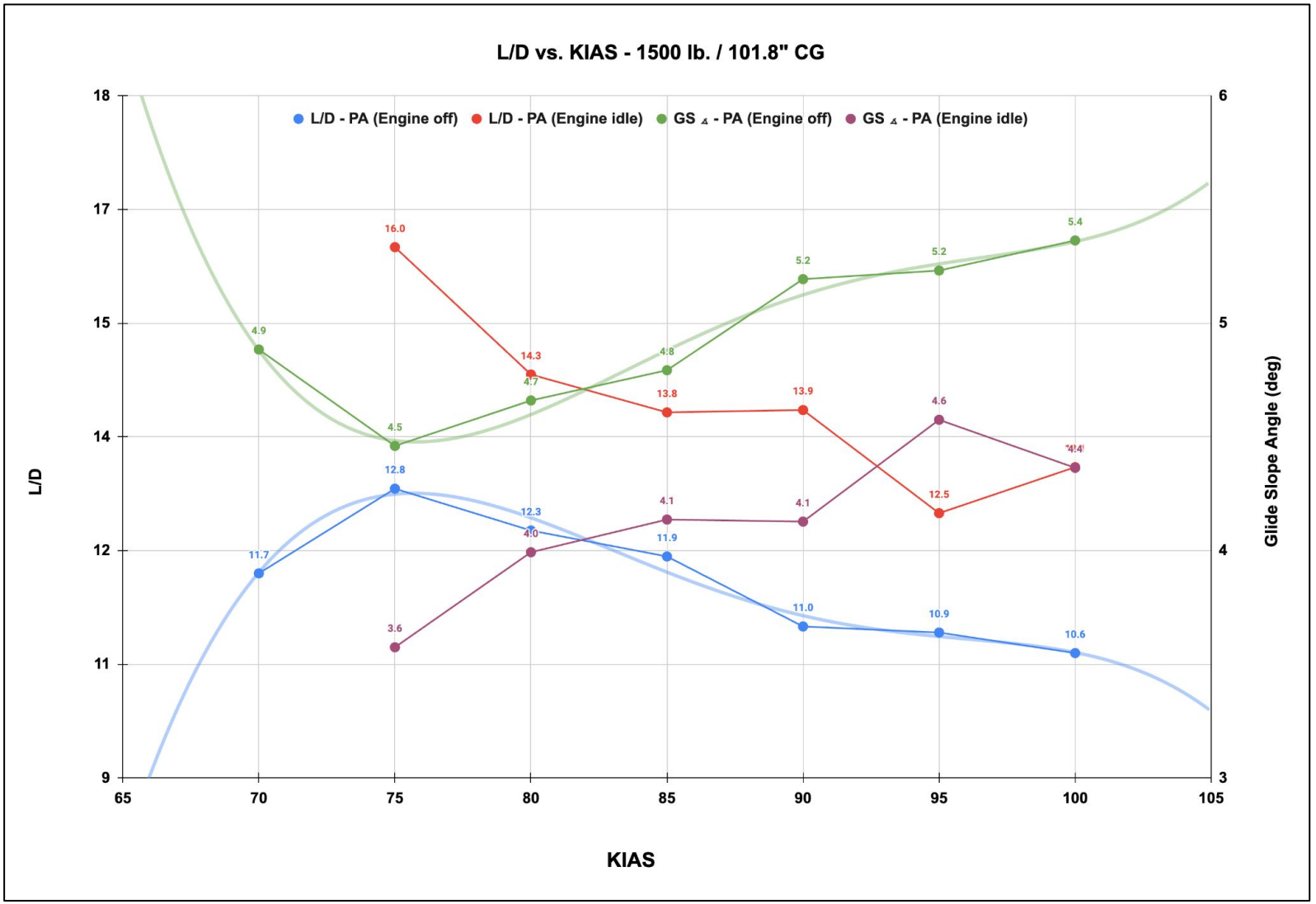
Test Results

Lightweight, Forward CG:



Test Results

Lightweight, Aft CG:



Test Results

- Fwd CG L/D_{max} Curve Shape

  If we examine a conventional aircraft's L/D curve, we see that the L/D increases as we increase IAS from the stall speed, and then falls off again, with an obvious L/D_{max} location. While we seem to see this in the aft CG test data, we do not see it in the forward CG data, even though the 70 KIAS test point is only a few kias above the COZY MKIV **canard** stall speed

  My hypothesis for this seeming anomaly from standard behavior relates to the fact that for our canards, the main wing never stalls. So we never reach the "stall" AOA of the main wing, or close to it. And when the CG is forward and the canard is heavily loaded, the main wing's AOA can only reach a lower angle. Therefore, we can never reach the low end of the L/D curve as a conventional aircraft can, when the CG is forward

Methodological Differences

- Tom Staggs findings: measured ~10:1 L/D for a Long-EZ - seemed very low - barely more than C-172 & way worse than POH value
  - Use of DA rather than PA - theoretical difference - not actual difference on Tom's test day
  - TAS errors
  - Wind errors
- I did not care about winds - only accurate TAS & altitude loss over time

- Reason for large discrepancy still unclear

Test Conclusions

- Just a start - no statistical significance - need multiple runs of multiple aircraft to get more accurate results
- Both Tom S. and I found that L/D_{max} occurred at IAS's substantially lower than POH indicated (possible that POH has mph/kt unit conversion issue)
- My COZY MKIV L/D_{max} matches Long-EZ POH value more closely given higher drag of COZY, but reasons for Tom's LE #'s being low are unclear

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References / Submitted Q's.

- **COZY Aircraft Newsletters**
  http://cozybuilders.org/newsletters/

- **Canard Owners and Builders Association (COBA) Newsletters**
  https://canardowners.com/

- **Submitted Question (Mike Z.):**
  - **Carson Speed Determination?**
    - **$V_{carson} = 1.32 * V_{best\ L/D}$**
    - **For N83MZ:**
      $V_{carson} = 75\ KIAS * 1.32 = 99\ KIAS$

      This is slow…

Any Other Damn Thing / Questions & Answers

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