The National FAA Safety Team Presents

Federal Aviation Administration

Topic of the Month - December

Engine Maintenance and Flight Data Monitoring

Presented to: WAFC and Friends

By: Stephen Bateman, CFI

Date: December 13th, 2021

Produced by AFS-850
The FAA Safety Team (FAASTeam)

Welcome

- **Steve Bateman, CFI, AOPA Director of Flying Clubs**
  - Treasurer, maintenance and safety officer – Westminster Aerobats Flying Club
  - FAASTeam lead representative, Baltimore FSDO
- **Our monthly in-and-out safety meeting using the FAASTeam Topic of the Month**
- **Sponsor Acknowledgment – WAFC, AOPA, FAASTeam, Baltimore FSDO**
- **WINGS Credit: Yes…but give me a day or two…**
- **Probably no time for questions, but send email: steve.bateman@aopa.org**

Check NOTAMS!

VIP TFR OVER WILIMINGTON, DE BEGINNING
TODAY SATURDAY, MARCH 6, 2021

Guess who's on the naughty list…!

VIP TFR OVER HAGERSTOWN/THURMONT, MD
BEGINNING FRIDAY, APRIL 2, 2021
(((CHANGE IN DEPARTURE TIME)))

Overview

- *GAJSC System/Component Failure Study
- Best Practices for Engine Maintenance
- Best Practices for Engine Operation
- Safety Benefits of Flight Data Monitoring
- Present & Future FDM Technologies
- How GA pilots can use FDM today

*General Aviation Joint Steering Committee

FAASTeam
Safer Skies Through Education

FAA Aviation Safety

Aircraft Performance Monitoring

The General Aviation Steering Committee (GAJSC) System/Component Failure Working Group asserts that pilots continue to hold unreasonable expectations of their personal performance, and the performance of their aircraft, which has contributed to fatal GA accidents. Reasonable performance expectations, based on realistic data from flight data monitors, can help to forecast system/component problems before they reach the point of failure, resulting in safer flight operations.

Flight Data Monitoring

Flight Data Monitoring (FDM) has been around since before the jet age and commercial airplanes make extensive use of the technology. Systems comprised of sensors, computer hardware, and software acquire and archive flight data for use in trend analysis and investigations of accidents and incidents. While it's true that most general aviation (GA) aircraft don't have dedicated automatic flight data recording devices now, we will be able to enjoy the benefits of equipage in the future. In the meantime, it's often surprising to see what we already have.

Tools You Can Use Now

Changes in aircraft performance can be a sign of developing mechanical issues. Your Pilots Operating Handbook (POH) will help you to predict your aircraft's performance, but only by monitoring your personal performance can you know what to expect. Comparing your performance with the POH will enable you to develop accurate performance predictions and reasonable performance expectations.

Many data monitoring operations involve no automation at all. Basic instrumentation such as airspeed indicators, attitude indicators, angle of attack indicators, manifold pressure, RPM, and G indicators give immediate feedback as to whether design limitations have or are about to be exceeded. Pilots can track engine power, fuel flow, oil temperature and pressure. Panel mounted GPS systems and many hand held units are already capable of recording position, heading, speed, and altitude. Some engine monitors have recording capability and many aircraft owners participate in oil analysis programs — a tool for gauging engine health and heading off expensive or, in some cases, disastrous problems.

Continued on Next Page

The Future is Here

Manufacturers are already offering self-contained flight data and visual data recorders for GA airplanes and helicopters. We're seeing multi-sensor analysis programs on high-end GA aircraft with integrated performance, navigation, and route information. Auto landing systems are making their way into some GA aircraft now and, over time, they'll become available in lower-priced platforms.

It's true that modern avionics have made the collection of flight data and flight performance analysis much more accessible to GA, but the question is how do GA pilots access and use that information? Unlike in the commercial world where you have a structured system like Flight Operations Quality Assurance (FOQA) that can be easily used to tap the data from operators, the GA community has more limited options, despite its much greater footprint on NAS operations.

To provide a solution to that problem, the FAA partnered with academia and industry to create a portal that could collect data from the wide variety of GA operations. The end result was the National General Aviation Flight Information Database (NGAFID).

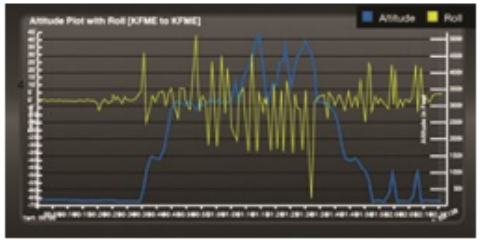


Image from NGAFID that allows users to view flight data.

The NGAFID allows GA pilots to analyze and share their flight data in two ways. First, operators equipped with avionics capable of recording flight data can upload flight and engine data anonymously into NGAFID. Devices that record flight data offer an easy, and free way for pilots to visually analyze flight performance for trends and changes over time to improve their flying. Second, pilots can share their data with NGAFID from a smart phone/tablet using the General Aviation Airborne Recording Device, or GAARD™, mobile app. Depending on your method of logging data, you can even use the NGAFID to monitor for airworthiness/maintenance concerns. All data collected from onboard avionics, an FDM recorder, or the GAARD app is anonymous and de-identified so pilots can share their data without any fear of reporting or reprisal. The NGAFID is managed by GA community members and associations.

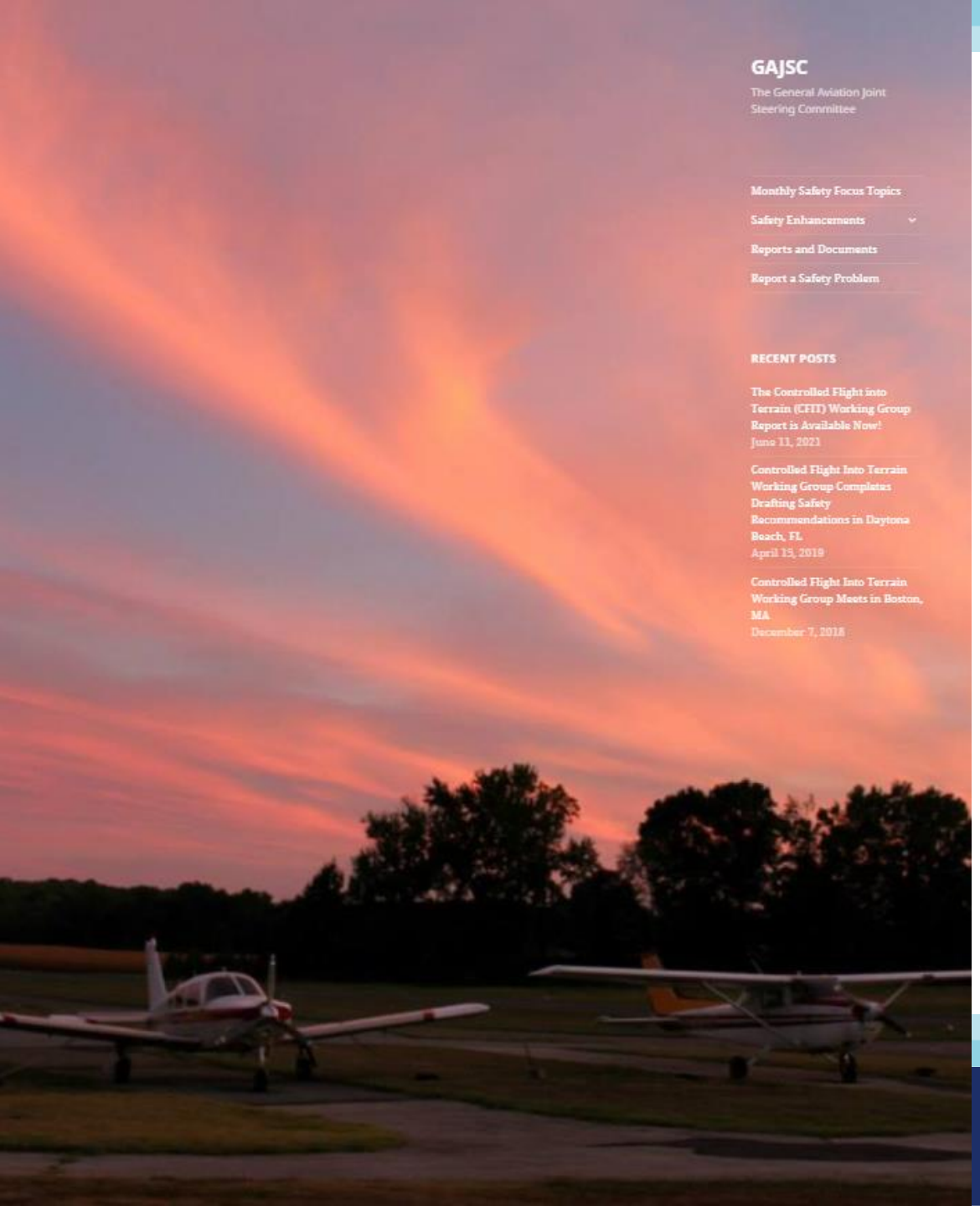
Thanks to GA data sharing and analysis programs, more safety issues can be detected, resulting in more interventions, leading to fewer accidents, and fewer lives lost. As more data is shared and analyzed, groups like the GAJSC develop safety enhancements and raise awareness in the community through targeted outreach efforts like the #FlySafe Campaign. FAASafety.gov and the FAA Safety Team's (FAASTeam) WINGS/AMT airmen proficiency programs are great resources for pilots and mechanics to help improve their skills and knowledge. More developments are on the way, including a complete redesign of FAASafety.gov with artificial intelligence capability that will use data to suggest customized training and flight activities.

We are certainly in an age of innovation where information, technology, and pilot performance combine to make flying safer than ever before.

Resources

- National General Aviation Flight Information Database and GAARD™ App
  www.ngafid.org
- *FAA Safety Briefing* Sep/Oct 2020, "The Missing Link Contributing to the Future by Examining Your Past," p. 13
  medium.com/faa/the-missing-link-abdc1fda5de6

GAARD App on iTunes Store
(Android/Google Play Store version coming soon . . .)



GAJSC

General Aviation Joint Steering Committee

https://www.gajsc.org/

Download and read these…

Federal A
Administ

GAJSC

General Aviation Joint Steering Committee

The General Aviation Joint Steering Committee (GAJSC) was launched in 1997 as part of the industry-government Safer Skies Initiative to improve aviation safety. Revitalized in 2011, the GAJSC works to improve general aviation safety through data-driven risk reduction efforts focused on education, training, and enabling new equipment in general aviation aircraft.

The GAJSC analyzes aviation safety data to identify emerging issues and develop mitigation strategies to address and prioritize safety issues. GAJSC participants include the Federal Aviation Administration and industry stakeholders, including pilot organizations, flight instructors, mechanics, builders, and manufacturers. More information about the purpose, objectives, and composition of the committee is available in the GAJSC's Charter.

The General Aviation Joint Steering Committee (GAJSC) is a public-private partnership working to improve general aviation safety. The GAJSC uses a data-driven, consensus-based approach to analyze aviation safety data and develop risk reduction efforts. The GAJSC's goal is to reduce the GA fatal accident rate.

The GAJSC analyzes GA safety data to develop intervention strategies to prevent or mitigate problems associated with accident causes, called Safety Enhancements. Safety Enhancements may include procedures, training, and equipment installations that, when implemented, may reduce the likelihood of accidents in the future. Read more about the GAJSC's safety enhancements:

Loss of Control Safety Enhancements

System Component Failure – Powerplant Safety Enhancements

CFIT Safety Enhancements

FAA also maintains a complete list of the **Safety Enhancement Topic of the Month** on FAA's Safety Briefing website.

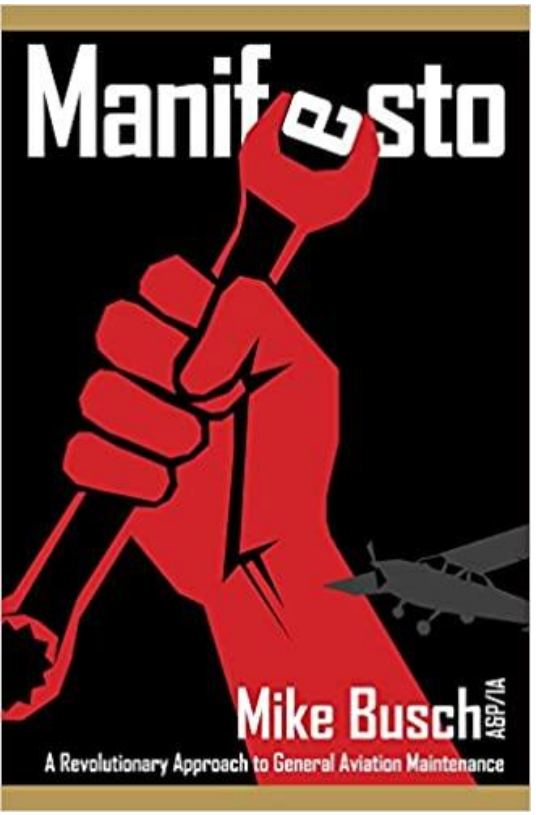
To Know What is Going On, You Must Know What Should Be Normal

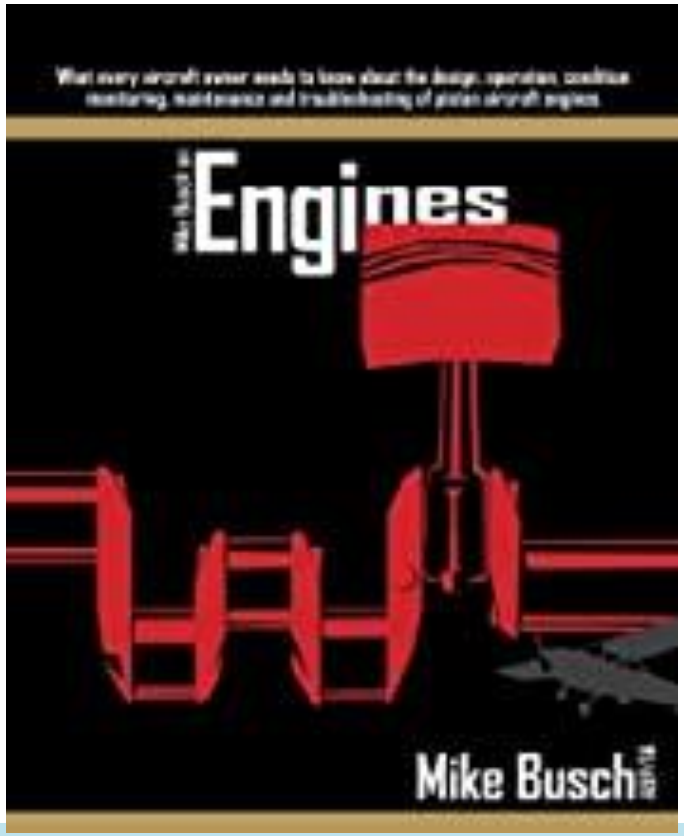
Become educated on maintenance

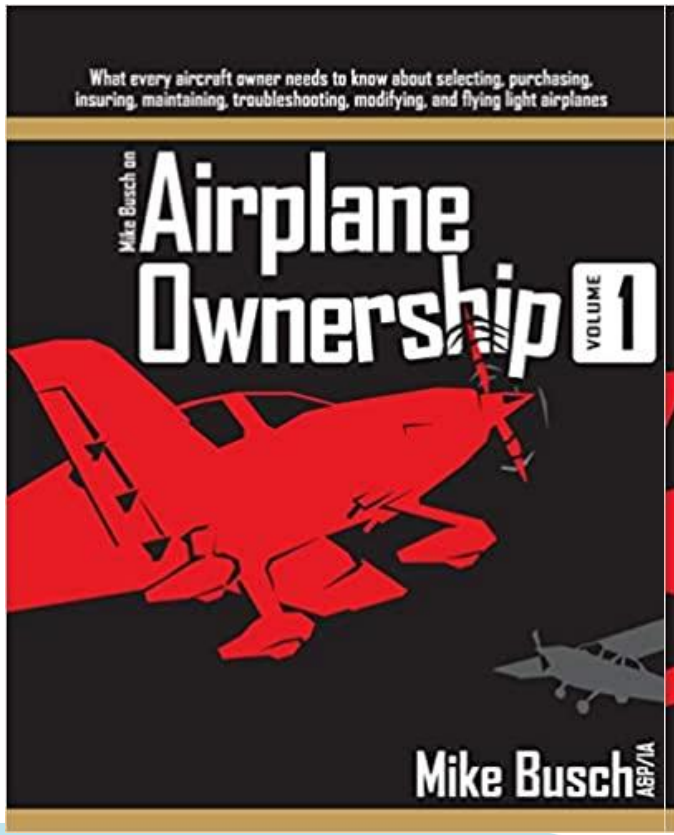
- Who can/must do what?
- What can you do?
- Read around the subject!

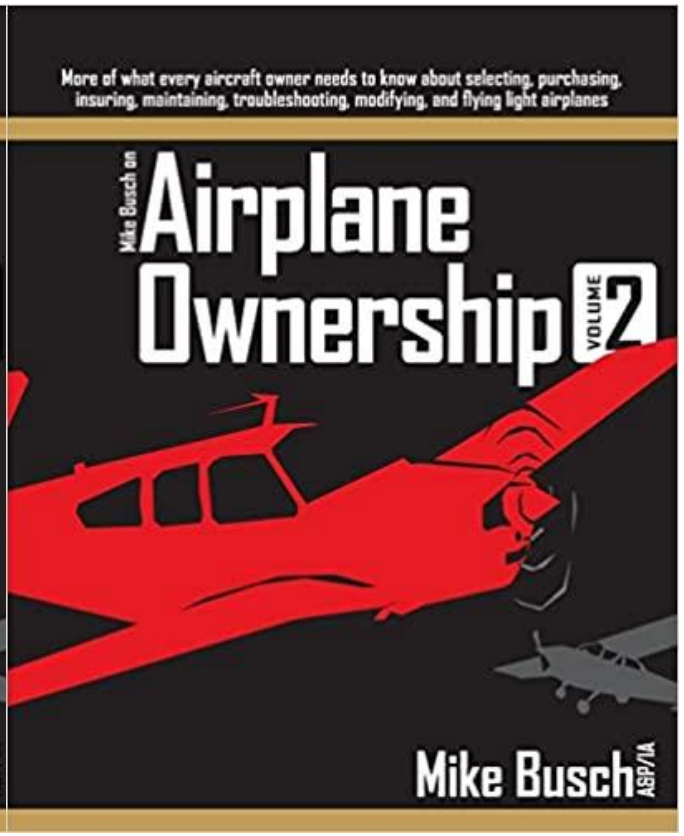
Become Educated:

- Mike Bush's books (and articles):



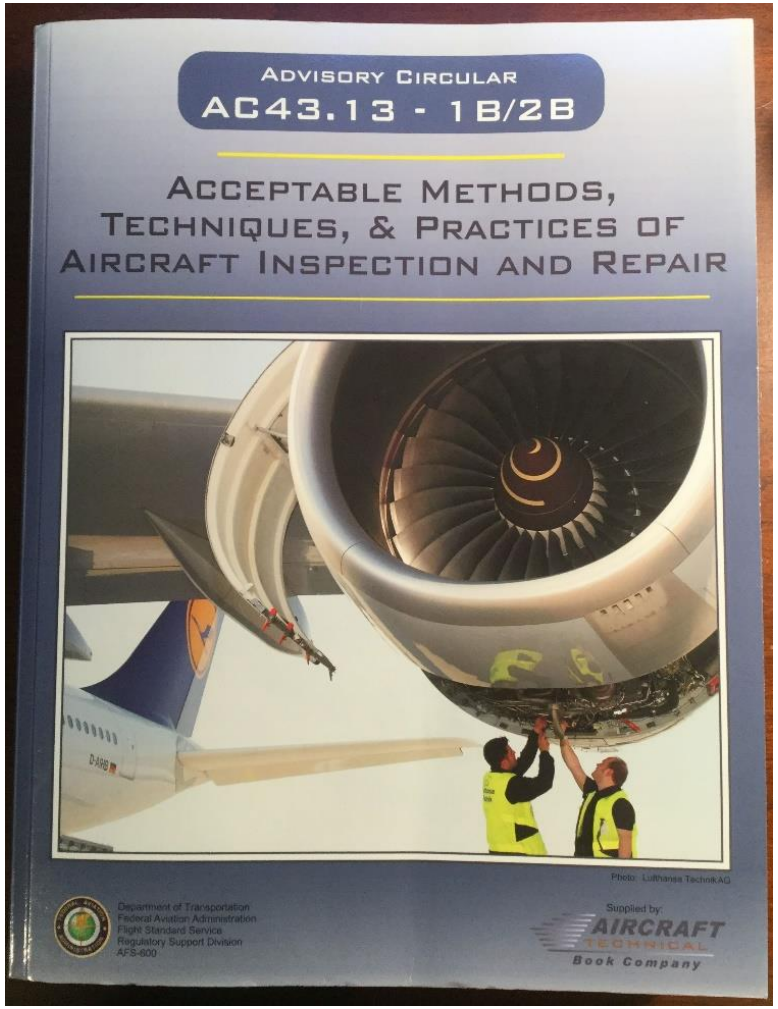




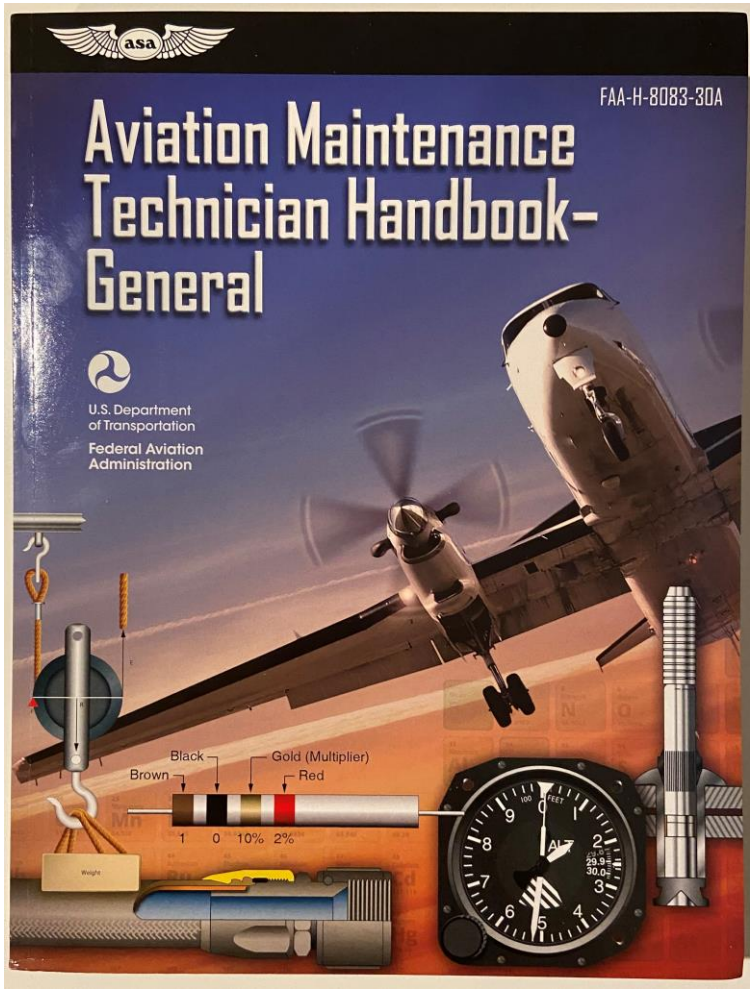


Become Educated:

- AC 43.13 1B/2B
- A “must” for your aviation library
- Curl up on the sofa and give it a solid read
- You WILL learn a lot!
- When is a washer not a washer?
  - When it is not an AN960



Become Educated: Want More…?



Know your machine

- **Take an active role**
  - No blank checks
  - Question
  - Learn
- **Review inspection results**
  - An inspection looks at things
  - Maintenance fixes things
- **Review ADs and Service Bulletins**
  - Keep a list and check it twice
- **Assist with inspections**
- **Ensure all a/c logbooks entries are correct**
  - Keep a logbook with time you spend on maintenance activities

14 CFR Part 1

- **Definition of Operate:**

> ***Operate***, with respect to aircraft, means **use, cause to use, or authorize to use** aircraft**, for the purpose** (except as provided in § 91.13 of this chapter) **of air navigation** including the piloting of aircraft, with or without the right of legal control (as owner, lessee, or otherwise).

But I don’t own the aircraft…I just fly it...

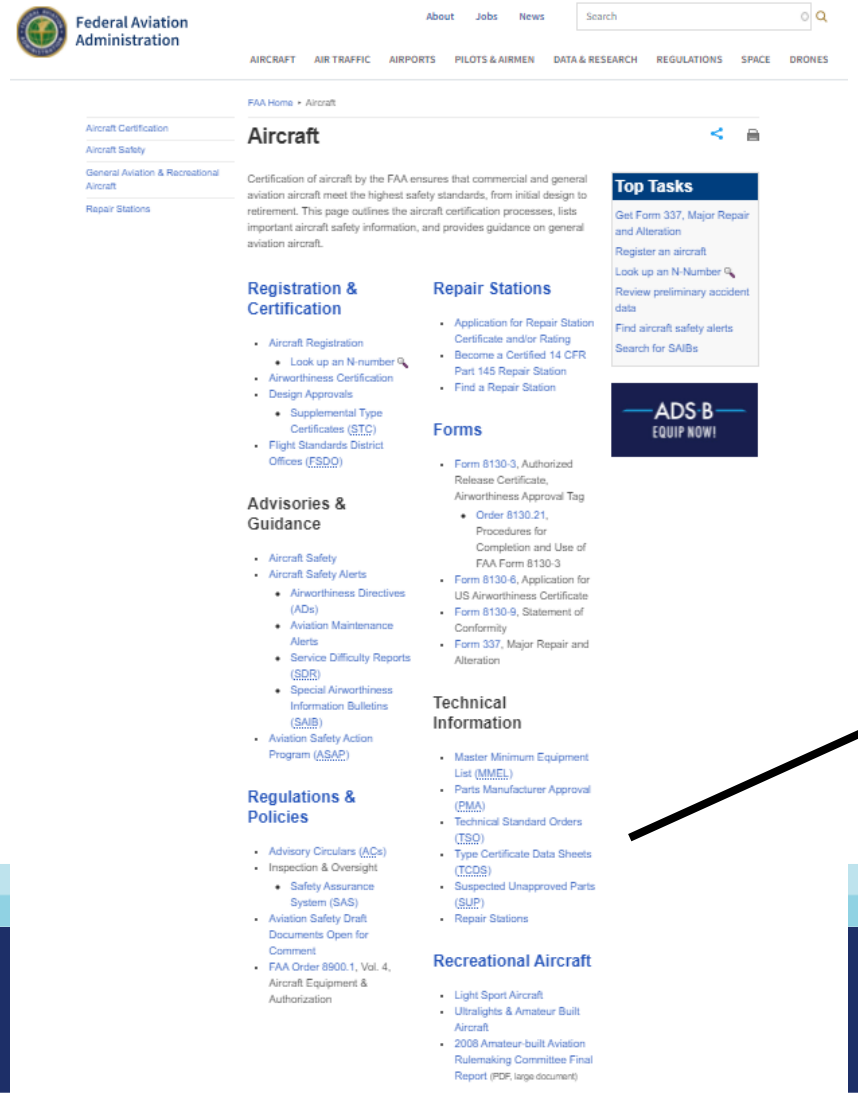
- **14 CFR 91.3 Responsibility & authority of the pilot in command.**
  - PIC is “directly responsible” and “final authority”
- **14 CFR 91.7 Civil aircraft airworthiness**
  - PIC is responsible for:
    - Determining aircraft condition and
    - Discontinuing flight when unairworthy conditions occur.

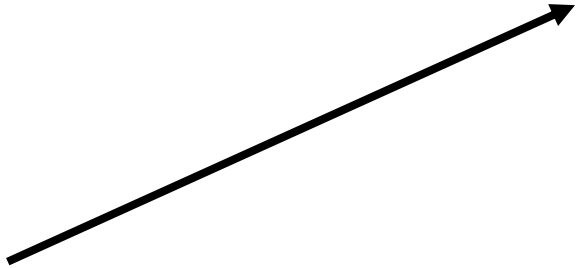
So, what does airworthy mean?

1. **Must conform to type design**
   - As manufactured
     - Type Certificate (TC)
   - As modified
     - Supplemental Type Certificate (STC)
     - Other approved alterations
2. **Must be in condition for safe operation**

Get your TCDS (Type Certificate Data Sheet)

- **https://www.faa.gov/aircraft/**





Technical Information

- Master Minimum Equipment List (MMEL)
- Parts Manufacturer Approval (PMA)
- Technical Standard Orders (TSO)
- Type Certificate Data Sheets (TCDS)
- Suspected Unapproved Parts (SUP)
- Repair Stations

Get your TCDS (Type Certificate Data Sheet)

Federal Aviation Administration

A152 Go

Advanced Search

- Type Certificate Data Sheets
  - New TCDS (Last 45 Days)
  - Current Models
    - By Make (TC Holder)
    - By TCDS Number
    - By Product Type
    - By Responsible Office
    - By Regulatory Basis
  - Revision History for TCDS
    - By Make (TC Holder)
    - By Number
    - By Product Type
    - Former TC Holders
- Related Links
- Help

Type Certificate Data Sheets (Make Model)

The Type Certificate Data Sheets (TCDS) database is a repository of Make and M
certification including airspeed limits, weight limits, thrust limitations, etc.

TCDS documents are available from the initial implementation of this database (A
will be retained as additional documents and revisions to documents are incorpora

Revision History refers to those documents that have been revised through a TCD
Revision History views, the checkmark indicates the current documents.

TCDS-related Documents

Basic Glider Criteria Handbook.pdf

Microsoft Access Database

We provide a MS Access database containing all TCDSs and Models data from ou

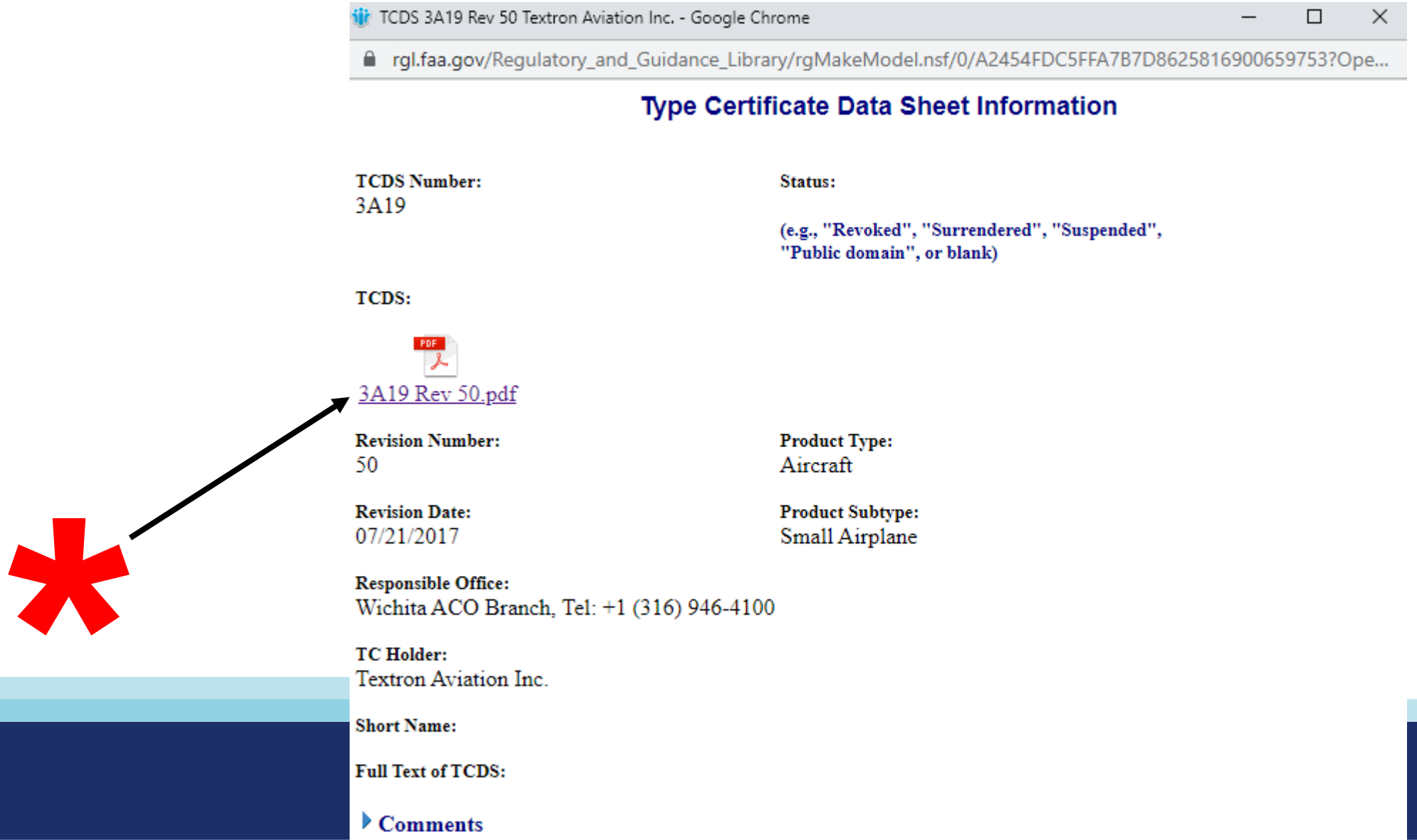
NOTE: We will update this file as needed until the decommission of RGL. After tha

The ZIP file was updated November 15th, 2021. The database is created with Mic

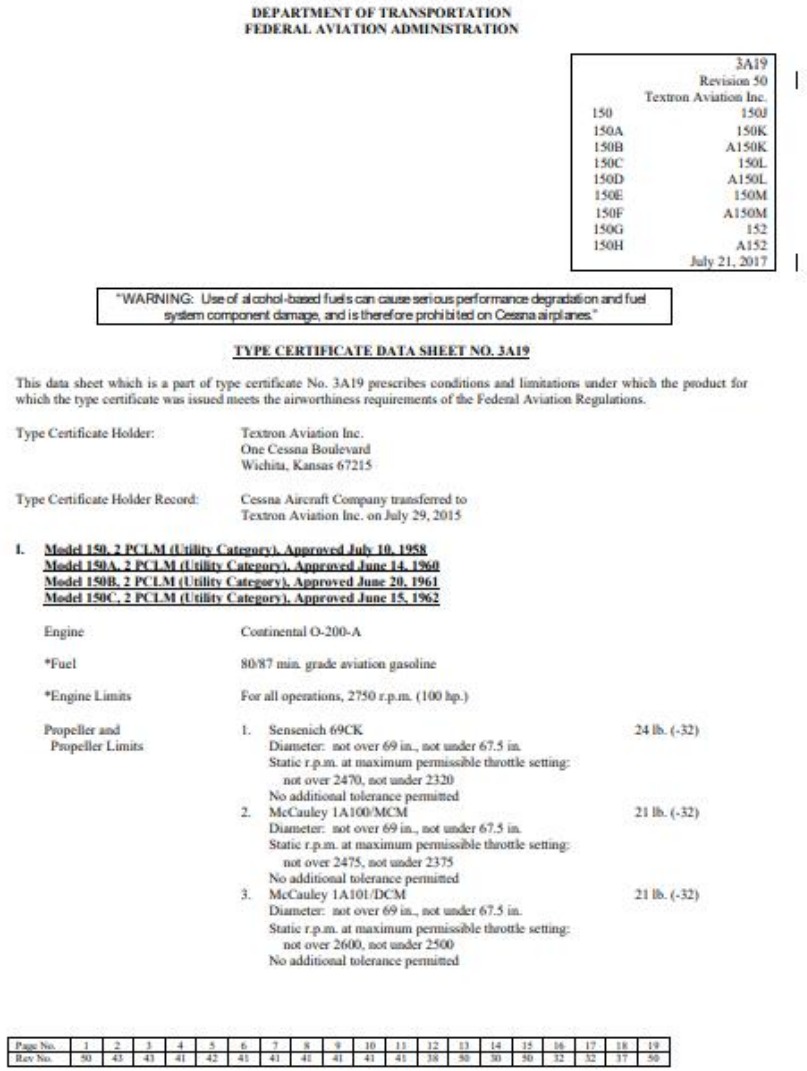
TCDS.zip

For questions, contact rgl@faa.gov.

Get your TCDS (Type Certificate Data Sheet)



Get your TCDS (Type Certificate Data Sheet)



DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

	3A19 Revision 50 Textron Aviation Inc.
150	150J
150A	150K
150B	A150K
150C	150L
150D	A150L
150E	150M
150F	A150M
150G	152
150H	A152
	July 21, 2017

"WARNING: Use of alcohol-based fuels can cause serious performance degradation and fuel system component damage, and is therefore prohibited on Cessna airplanes."

TYPE CERTIFICATE DATA SHEET NO. 3A19

This data sheet which is a part of type certificate No. 3A19 prescribes conditions and limitations under which the product for which the type certificate was issued meets the airworthiness requirements of the Federal Aviation Regulations.

Type Certificate Holder: Textron Aviation Inc.
One Cessna Boulevard
Wichita, Kansas 67215

Type Certificate Holder Record: Cessna Aircraft Company transferred to Textron Aviation Inc. on July 29, 2015

I. **Model 150, 2 PCLM (Utility Category), Approved July 10, 1958**
Model 150A, 2 PCLM (Utility Category), Approved June 14, 1960
Model 150B, 2 PCLM (Utility Category), Approved June 20, 1961
Model 150C, 2 PCLM (Utility Category), Approved June 15, 1962

Engine: Continental O-200-A

*Fuel: 80/87 min. grade aviation gasoline

*Engine Limits: For all operations, 2750 r.p.m. (100 hp.)

Propeller and Propeller Limits:

1. Sensenich 69CK — 24 lb. (-32)
Diameter: not over 69 in., not under 67.5 in.
Static r.p.m. at maximum permissible throttle setting: not over 2470, not under 2320
No additional tolerance permitted
2. McCauley 1A100/MCM — 21 lb. (-32)
Diameter: not over 69 in., not under 67.5 in.
Static r.p.m. at maximum permissible throttle setting: not over 2475, not under 2375
No additional tolerance permitted
3. McCauley 1A101/DCM — 21 lb. (-32)
Diameter: not over 69 in., not under 67.5 in.
Static r.p.m. at maximum permissible throttle setting: not over 2600, not under 2500
No additional tolerance permitted

Page No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Rev No.	50	43	43	41	42	41	41	41	41	41	41	38	50	30	50	32	32	37	50

What About STCs and 337s?

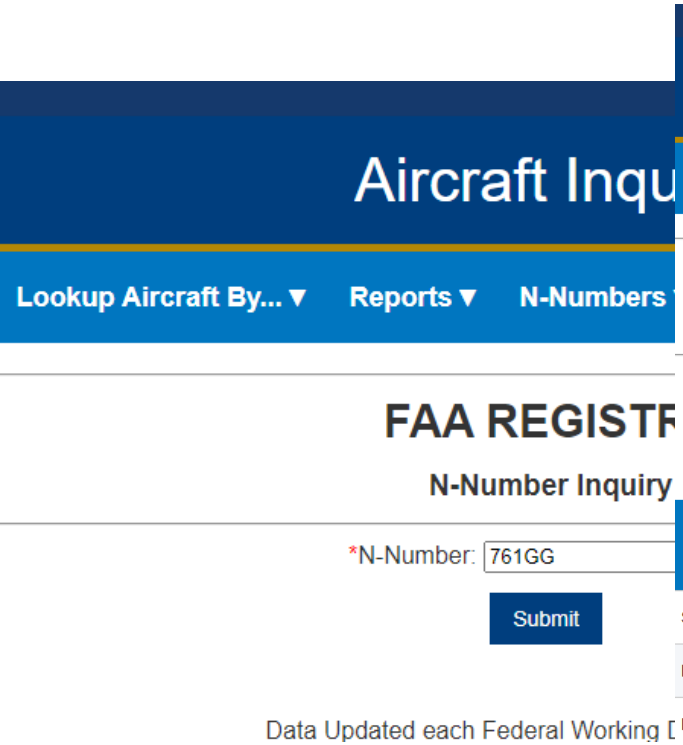
Should **be in the a/c PoH under supplements**

Should **be in the a/c logbooks and/or maintenance records**

Instructions for FAA Form 337: AC 43.9-1G

Little known way to get all info on file with the FAA…

Aircraft Registry…



United States Department of Transportation

About

FAA

Aircraft Inquiry

Search

Lookup Aircraft By... ▼ Reports ▼ N-Numbers ▼ Other Aircraft Resources ▼

FAA REGISTRY

N-Number Inquiry Results

Data Updated Each Federal Working Day At Midnight

N761GG is Assigned

N-NUMBER ENTERED: 761GG

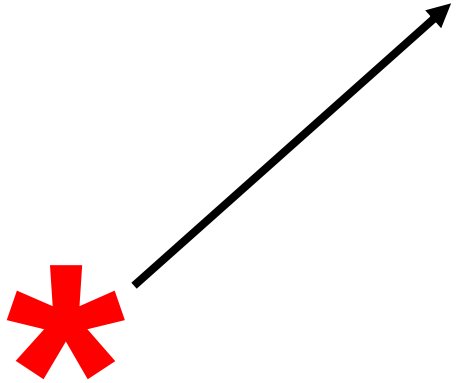
AIRCRAFT DESCRIPTION

Serial Number	A1520951	Status	Valid
Manufacturer Name	CESSNA	Certificate Issue Date	07/24/2018
Model	A152	Expiration Date	07/31/2024
Type Aircraft	Fixed Wing Single-Engine	Type Engine	Reciprocating
Pending Number Change	None	Dealer	No
Date Change Authorized	None	Mode S Code (base 8 / Oct)	52442734
MFR Year	1980	Mode S Code (Base 16 / Hex)	AA45DC
Type Registration	LLC	Fractional Owner	NO

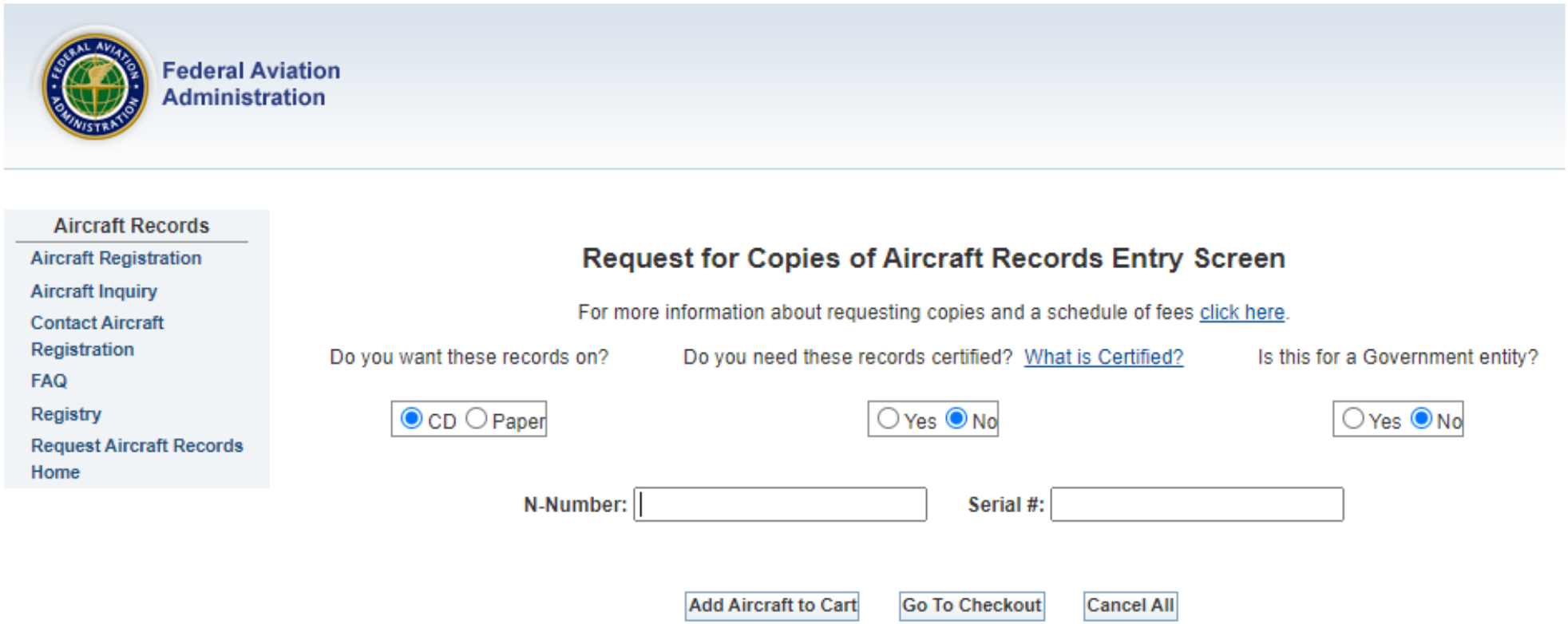
Aircraft Registry…

AIRWORTHINESS			
Type Certificate Data Sheet	None	Type Certificate Holder	None
Engine Manufacturer	LYCOMING	Classification	Standard
Engine Model	0-235 SERIES	Category	Acrobatic
A/W Date	09/05/1980	Exception Code	No

The information contained in this record should be the most current Airworthiness information available in the historical aircraft record. However, this data alone does not provide the basis for a determination regarding the airworthiness of an aircraft or the current aircraft configuration. For specific information, you may request a copy of the aircraft record at http://aircraft.faa.gov/e.gov/ND/



Aircraft Registry…



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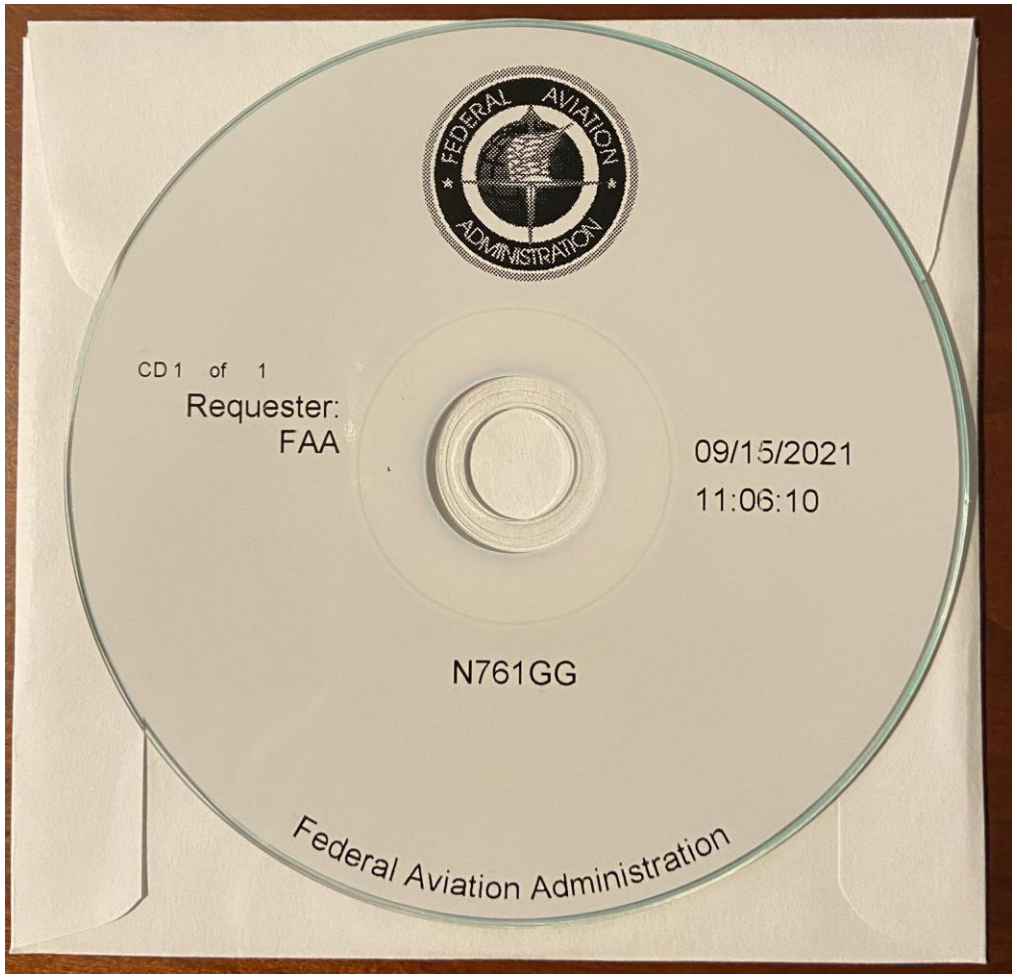


Engine and Flight Monitoring

You cannot track/change/improve anything unless you can first measure it…otherwise…

- How do you know what to look for?
- How do you know it anything changes?
- Need a baseline

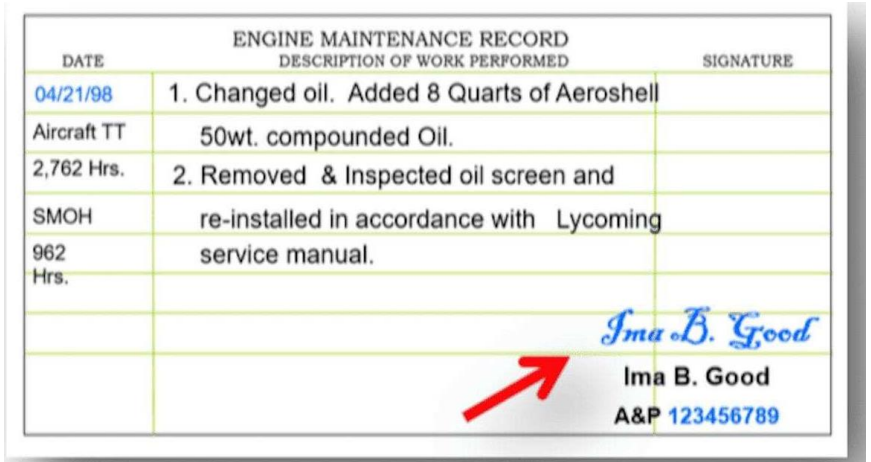
Aircraft Status

- **Online, paper, or wall chart**
- **Inspections – aircraft & equipment**
  - Time next inspection is due
- **ADs & Service Bulletins**
  - Keep status sheets
- **Out of service & Return to Service**
- **Use a modern management tool**

Caution! These are not permanent records. Trust but verify.

United States Army Air Forces, Public Domain, via Wikimedia Commons

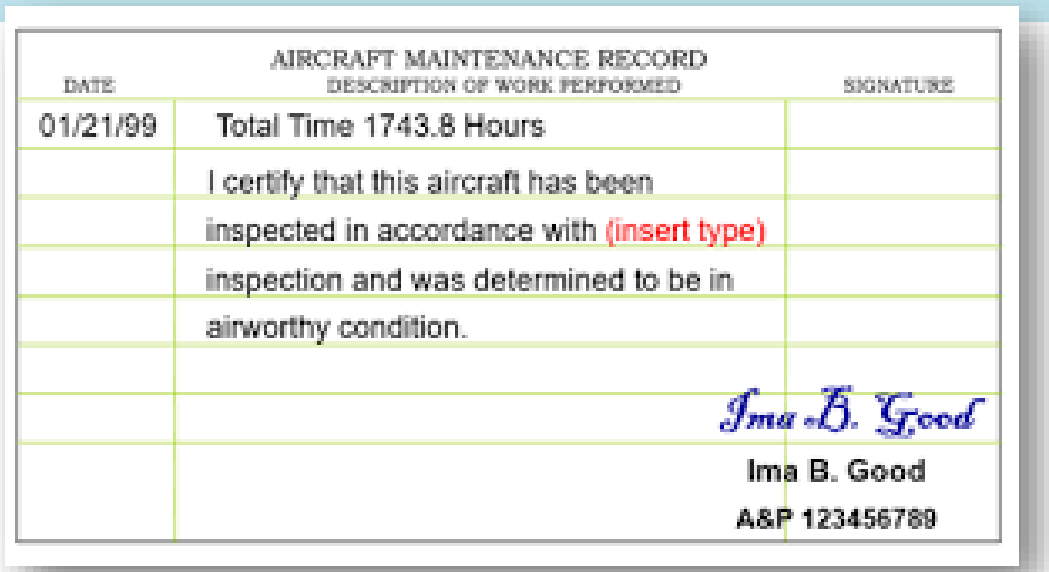
Return to service



ENGINE MAINTENANCE RECORD

DATE	DESCRIPTION OF WORK PERFORMED	SIGNATURE
04/21/98	1. Changed oil. Added 8 Quarts of Aeroshell	
Aircraft TT	50wt. compounded Oil.	
2,762 Hrs.	2. Removed & Inspected oil screen and	
SMOH	re-installed in accordance with Lycoming	
962 Hrs.	service manual.	
		Ima B. Good
		Ima B. Good
		A&P 123456789

The signature and certificate number make up the Approval for Return to Service.



AIRCRAFT MAINTENANCE RECORD

DATE	DESCRIPTION OF WORK PERFORMED	SIGNATURE
01/21/99	Total Time 1743.8 Hours	
	I certify that this aircraft has been	
	inspected in accordance with (insert type)	
	inspection and was determined to be in	
	airworthy condition.	
		Ima B. Good
		Ima B. Good
		A&P 123456789

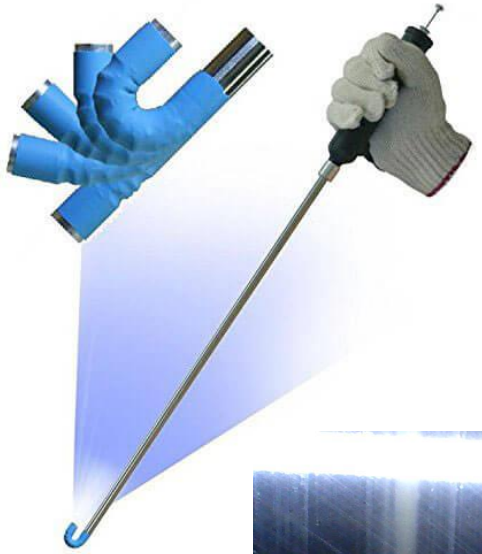
- First flight after maintenance = test pilot
- Know what was done
- Think about what was “disturbed” during the work
- Could it have changed the baseline of what you monitor?
- Thorough pre-flight…nothing to chance…you are flying the aircraft, not the mechanic

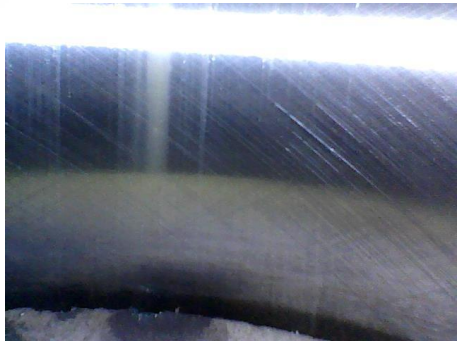
Service Intervals and Monitoring

- **Oil & Filter Change (Hobbs or Tach…?)**
  - 50 Hrs. (30 Hrs. for Turbos, 25 hours for Rotax running 100LL)
    - Filter Inspection – immediate results
    - Oil analysis – multiple results over time, for trending
  - 100 Hrs. add:
    - Compression check
    - Borescope…
    - Magneto timing
    - Spark plug inspection & maintenance
    - Exhaust system check
  - Does your a/c require a *100-hour inspection* as per 14 CFR 91.409? (Legal vs. safe…)
- **ADs & service bulletin check.**

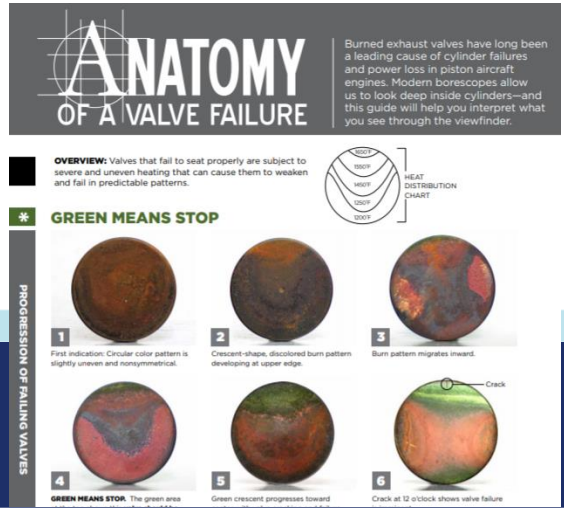
Borescope Monitoring

- **Really useful piece of kit – for around $250**
  - VIVIDIA ABLESCOPE VA-400 BOROSCOPE





- **Use for cylinders, airframe inspections, etc**
- **Adjustable light level**
- 180° articulated camera/light head
- **Connects via USB to laptop**
- **Takes stills and videos**
- **AOPA Anatomy of Value Failure**
  - The View Through a Borescope
  - https://www.aopa.org/training-and-safety/air-safety-institute/valve-safety
  - Handy poster



Not just an oil change…

- **Opportunity for inspection**
  - Leaks and stains
  - Missing, broken, or loose hardware
  - Tires
  - Brakes
  - Oleo struts
  - Lubrication

Pre-flight, Run-up and Ground roll

- **Things to monitor:**
  - Engine gauges in the green
  - Mag check
  - Carb heat check – at RPM and idle
  - Charging system
  - Vacuum pumps (sigh…)
  - Static RPM – look in the PoH!

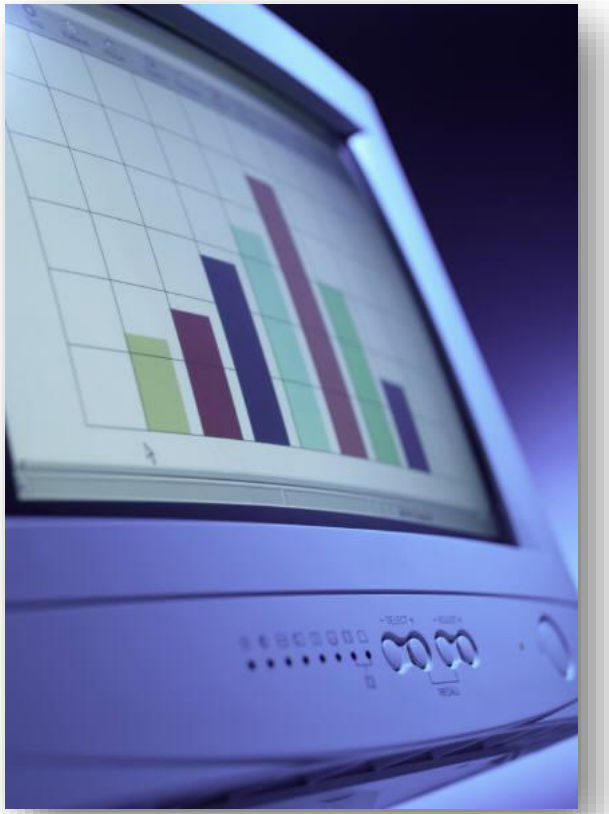
Take-off, Climb and Cruise

- **Things to monitor:**
  - RPM on roll— in the static RPM range
  - Initial climb rate
    - Engine gauges in the green—watch for high CHT
    - Expected RPM
    - Expected pitch (~ +10^{o} at V_y)
  - Cruise climb
    - Lean (how…?)
    - Engine gauges in the green
  - Cruise
    - RPM in range
    - Engine gauges (thermal management)

Engine Operation

- **Fly often**
- **Minimize thermal shock**
  - Pre-heat
  - Warm up before flying
  - Smooth power application and reduction
  - Be careful when operating lean of peak EGT
  - Plan descents to avoid shock cooling.
    - Especially important for Turbos
    - Important for anything in cold weather
- **Monitor performance**
  - Small changes can predict developing problems
  - Develop a “Spidey Sense” for subtle changes
  - Use all senses…noise, smell, sight, feel…ESP…

Flight Data Monitoring for GA



Flight Data Monitoring for GA

- Engine Data

- Flight Data + Visual

Flight Data Monitoring for GA

Sample of What's Available to the GA Community

ENGINE MONITORING SYSTEM

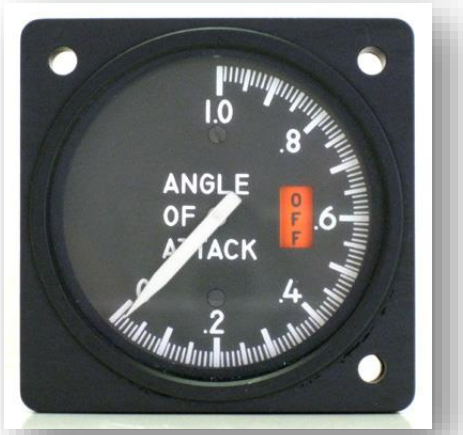
RPM
M.P.
EGT/CHT Bar Graph
Oil Pressure
Oil Temperature
TIT
Hyd Pressure
C.O.
OAT
Vac.

Fuel Pressure
Fuel Level
Fuel Flow
Fuel Remaining
Fuel Used
Fuel
GPS Related Data
Low Fuel Alarm
Recurring Fuel Alarm
Volts
Amps

Flight Timer
Tach Timer
Annunciators
Data Recording
USB Port
Caution Lights
…More

Flight Data Monitoring for GA

- Basic Instrumentation…not that basic if you think about it…



Flight Data Monitoring for GA

- Basic Instrumentation…not that basic if you think about it…

Flight Data Monitoring for GA

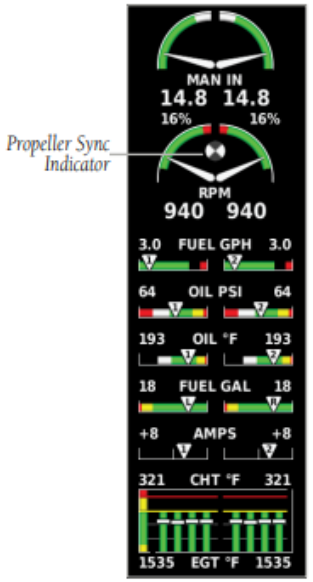
- Basic Instrumentation…not that basic if you think about it…
- Just a bit of hardware and software…

EIS GARMIN

3.2 MULTI-ENGINE INDICATIONS (OPTIONAL)

PROPELLER SYNC INDICATOR

In Multi-Engine installations, a Propeller Sync Indicator is displayed on the Tachometer. The indicator spins in the direction of the higher-speed propeller when the propellers are out of sync.



Example Engine Indication System (PFD) (Multi-Engine)

From Garmin G3X Touch Pilot's Guide

Flight Data Monitoring Using Your EFB

- For example, Foreflight
- Use Track log and play back for post flight review
- Export to Google Maps – 3D view
- Flight Data Review

Flight Data Monitoring Using Your EFB

- **Flight Data Review**
  - Speed and altitude
  - Pitch and bank

Flight Data Monitoring Using Other Apps

- **Example - CloudAhoy…**
- **Free app for data collection**
- **Subscription for analysis**
- **Can import from FF, Stratus, etc.**
- **If import from EFIS, get data for engine, comms, AHRS, etc.**
- **Take a look at the CloudAhoy videos…**

If it isn't broken…

- **Know all there is to know…**
- **Mike Busch's book on condition-based maintenance**
  - So, need to know the condition
  - …and then if anything has changed
- **Track tends to enable predictive maintenance**
  - www.aopa.org/news-and-media/all-news/2021/august/pilot/savvy-maintenance-machine-learning
  - EAA Webinar- Predictive Maintenance
  - EAA Webinar- Machine Learning
- **Savvy Maintenance**
  - Website, newsletter, case studies…

Have you earned your *WINGS*?

- **Proficient Pilots are:**
  - Confident
  - Capable
  - Safe
- ***WINGS*** will keep you on top of your game

Proficiency and Peace of Mind

- **Practice makes you better and might save your life!**
- **Fly often with a CFI**
- **Training is credited**
- **WINGS participation can save you money**
  - Insurance discounts
  - Less bent metal!

Thank you for attending!

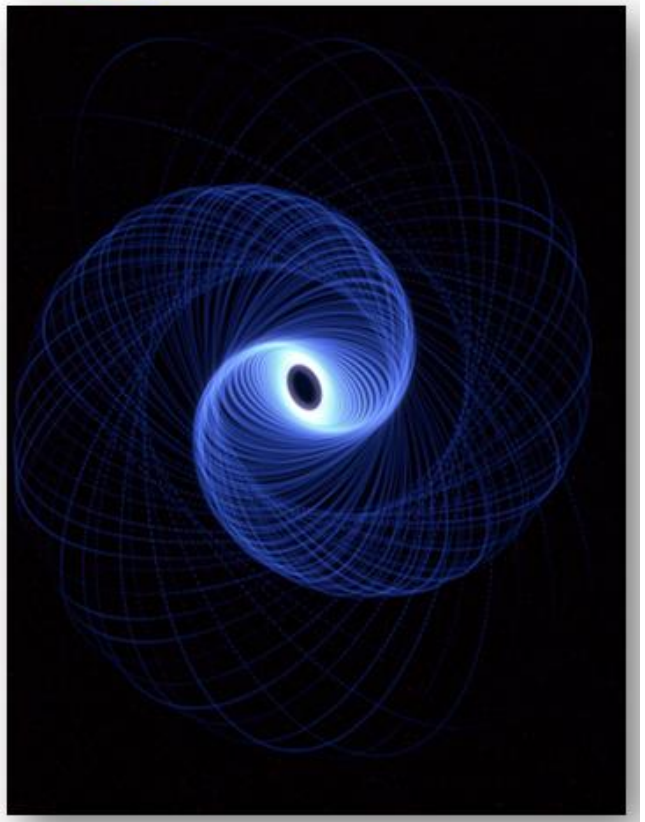
You are vital members of our GA safety community!

Next Month ToM:

The National FAA Safety Team Presents

The Startle Response

Federal Aviation Administration



Presented to: WAFC and Friends

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