

AVIATION ENGINES

How to care for them, how to maintain them, how to increase chances of reaching TBO

YOUR PRESENTER

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2012–2019

Commercial/IR pilot, 3,500 hours total, on 124 types

Owner of a Cessna 182 — Manages continued Airworthiness

WE HAVE LITTLE TIME AND LOTS TO COVER

So hang on to your hats! I will be available after the presentation to answer questions still open...

ENGINES: WHAT REALLY MATTERS?

There are many factors that influence the life of your engine:

- Initial state of your engine (was it installed new, installed on an aircraft you purchased second-hand, etc.).
- The way it is installed in your aircraft (baffling, hoses, modifications).
- Its age (probably more important than the number of hours it was flown).
- The regularity at which it has been consistently flown.
- Do you really know your mechanic?
- You and the other pilots that fly the engine.

READ THE SCRIPTURES!

Bill Ross, wrote a book called “Engine Management 101”

- Consider it as the aircraft engine bible.
- It is fun to read.
- It is not a practical and detailed maintenance guide, but it will give you an insight to all the industry best practices and the list of questions you have to ask your mechanic.
- It is free and downloadable at:
- <https://superiorairparts.com/>



INITIAL STATE

When purchasing an aircraft, the pre-buy inspection is the cheapest insurance you can buy. There are parts of the inspection that cannot be overlooked:

- Bore scoping the cylinders (examine valves and cylinder walls. If possible, take a look at the lifters and the camshaft).
- Request all oil analysis reports if they exist.
- Have a trusted, independant mechanic perform a complete review of the engine and its installation.
- Request all data engine analyzer data files when available.
- Cross-check all data against aircraft and engine logs.
- Cross check engine logs with work orders and invoices.
- Don't believe or trust anything you can't verify for yourself.

Even if we are talking about the plane you have owned for the last ten years, doing an initial state review can answer a lot of questions and avoid future bills.

INITIAL STATE

- Determine if the engine is first run from factory or has been overhauled:
 - Factory Reman
 - Field overhaul
 - Top overhaul
- Check if the engine has been overhauled more than once (how many times? If two overhauls already, chances are that you could easily encounter problems with engine case, crankshaft, camshaft or other parts that are taken in consideration in the core value determination).
- Make sure that this engine passes manufacturer's engine core value requirements.

INITIAL STATE

Allow me to present Exhibit 1 your honor!

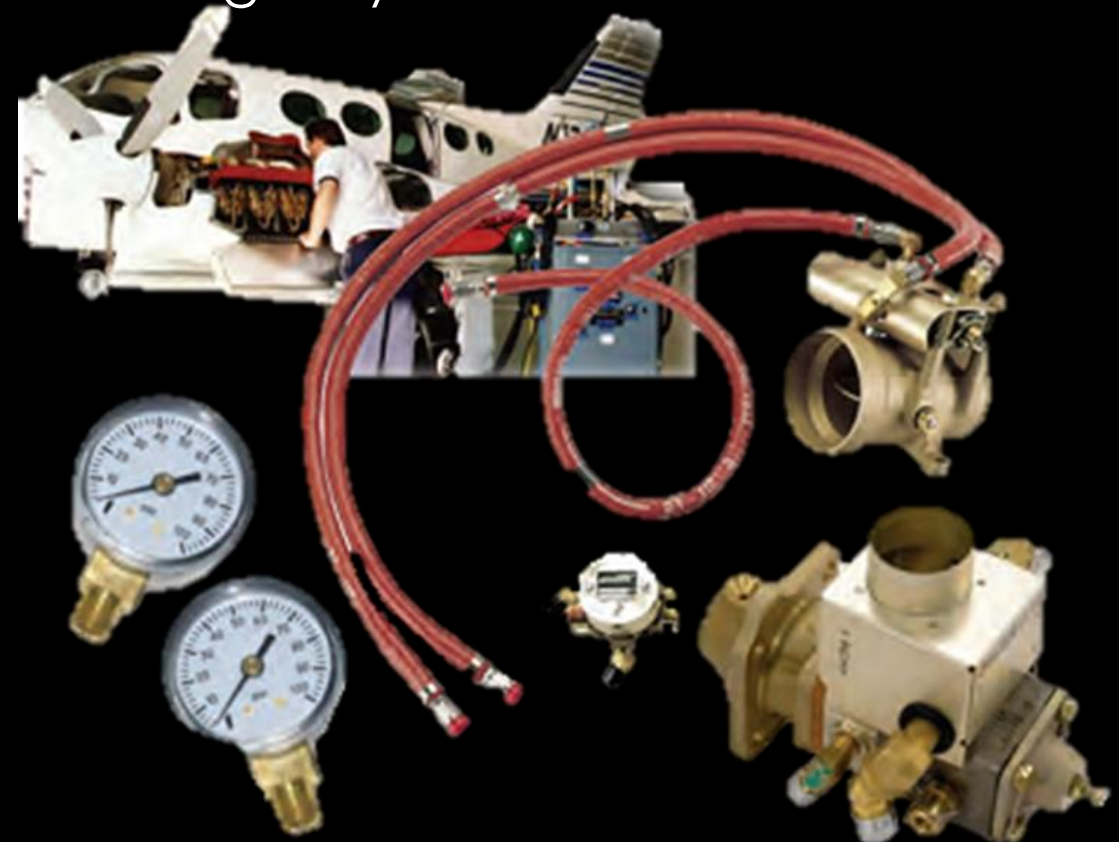
- Lycoming®* Service Letter N° L250A regarding acceptability of core engines
- And Exhibit 2, the same thing by Continental Aerospace Technologies...

Clearly, talk to your engine vendor before committing to anything! A serious amount of \$ is involved!

AIRCRAFT INSTALL

The way the engine is installed in the aircraft is one of the major factors involved to obtain performance, reliability and longevity:

- Baffling (both hard and soft baffling)
- Hoses
- Instrument and gauges calibration
- Propeller balancing
- Fuel system adjustment (critical)



AIRCRAFT INSTALL

Baffle seal not conforming to upper cowling

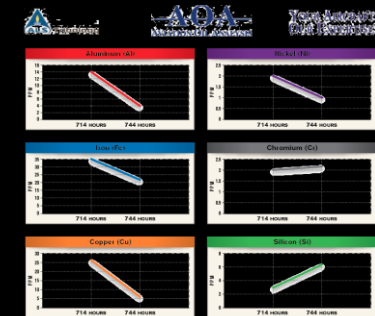
Typical cracks in metal baffles

Baffle seal making minimal contact with upper cowling

Baffle seal collapsed and not contacting upper cowling



CRITICAL ROUTINE MAINTENANCE TASKS



Oil changes

50 hours or six months, whichever comes first. This is nonnegotiable!

Water and oil don't mix.

Don't perform ground runups, it is worse than sitting.

Oil filter inspection

Cut open the oil filter at each oil change and examine it **with a magnifying glass** at **each occurrence**.

Use the proper tool to remove oil filter and cut it open.

Regular oil analysis

Oil analysis is **cheap** compared to **repairs**. But only useful if done at each oil change.

You are looking for **trends** not exact numbers.

CRITICAL ROUTINE MAINTENANCE TASKS



Fuel System setup

Critical to all engines.

Check proper setup at **100 hours or annual whichever comes first.**

Check the carburetor.

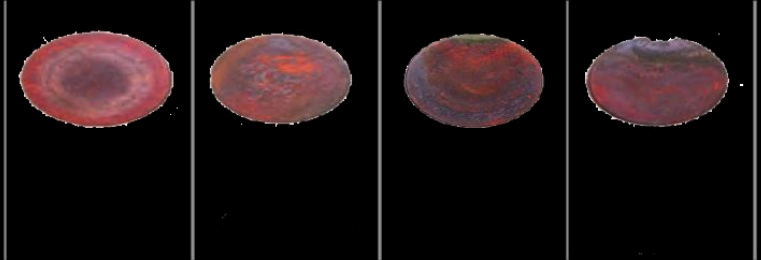
Check carb heat.



Gauges calibration

Check the correctness of gauges indication: RPM, temperatures, pressure, flow.

Often overlooked!



Check your valves

Check valves with bore scope, you might be able to come a valve rescuer!

At annual or during a leak compression test.

CRITICAL ROUTINE MAINTENANCE TASKS

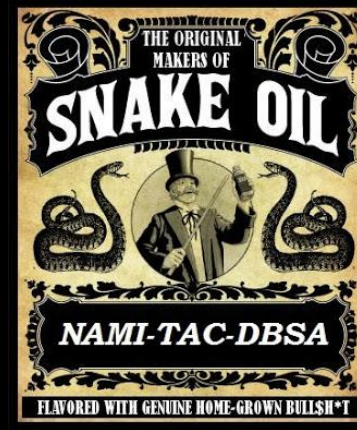


Compression test

Lycoming ≠ Continental, different set of values.

Don't change cylinders because of compression test. Fly the engine hard and try again!

Bore scope before pulling jug.



No snake oil!

Do not use additives in your oil.

Camguard is the only one that is considered as beneficial.



Don't forget the other filters

Air Filter should be inspected and changed when necessary, **not cleaned!**

It is usually impregnated with oil...

Don't forget secondary filters (fuel, avionics).

When possible check fuel tanks for debris and contamination.

CRITICAL ROUTINE MAINTENANCE TASKS



Get to know your mechanic

Factory training?
Recurrent training?
Current documentation?
Experience on type?



Get to know your mechanic

Proper tooling?
Proper procedures?
Open discussion?



Getting to know your mechanic.

It is essential for the health of your engine and your wallet's health...

Communication is essential. If your mechanic cannot accept discussion, it is time for a change. Same if he refuses to change his ways. "I have 30 years of experience, I'm not going to do it differently..."

ANOTHER GREAT MYTH

Cylinder Compression tests

CYLINDER COMPRESSION TESTS

It's only a test to learn if a leak is present:

- Doesn't tell you what the cause is...
- Is not a death sentence when numbers drop.
- Compression numbers vary from one manufacturer to another (42/80 for Continental...).

Make sure your mechanic:

- Understands the procedure.
- Has the right tools to perform the procedure.
- Has the proper documentation.
- Requests that you fly the plane hard for at least an hour and redo the test immediately after landing (when its hot).
- Looks for the cause of the lack of compression using a bore scope and any other investigation mean.

LET'S LOOK AT THOSE VALVES



LEAN OR RICH OF PEAK OPERATIONS

The greatest general aviation controversy

RICH OR LEAN, THAT'S YOUR PICK...

One essential choice

Has to be made before take off or during the flight if conditions change

- Do I need speed or range?

There are no miracles in aviation:

Either go fast with high fuel flow (Rich)

Or

Go slower, but with greater range (lean)

Can't have both

The legends

Lean of peak will kill my engine.

Lean of peak halves the life of cylinders.

I can adjust mixture by ear to run lean of peak.

Lean of peak is for every engine.

Can't do lean of peak with a carbureted engine.

Reality

Absolutely not! It will run differently!

Not if done properly and following manufacturer's recommendations.

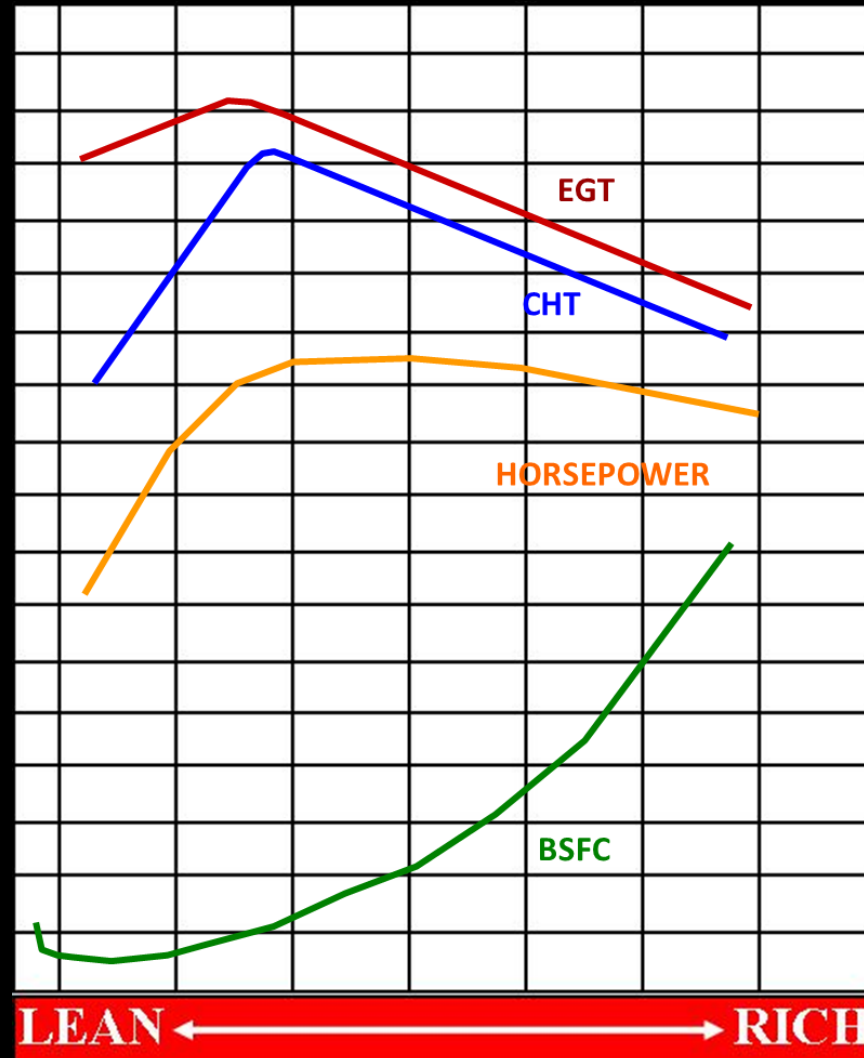
You might... I prefer to rely on an engine analyzer...

No. Some manufacturers prohibit lean of peak.

Some carbureted engines can't cope...

RICH OR LEAN, THAT'S YOUR PICK...

This is the relation between different engine parameters:
Exhaust gas temperatures: EGT
Cylinder head Temps.: CHT
Horsepower: engine power
BSFC: measures quantity of fuel in relation with power



RICH OR LEAN, THAT'S YOUR PICK...

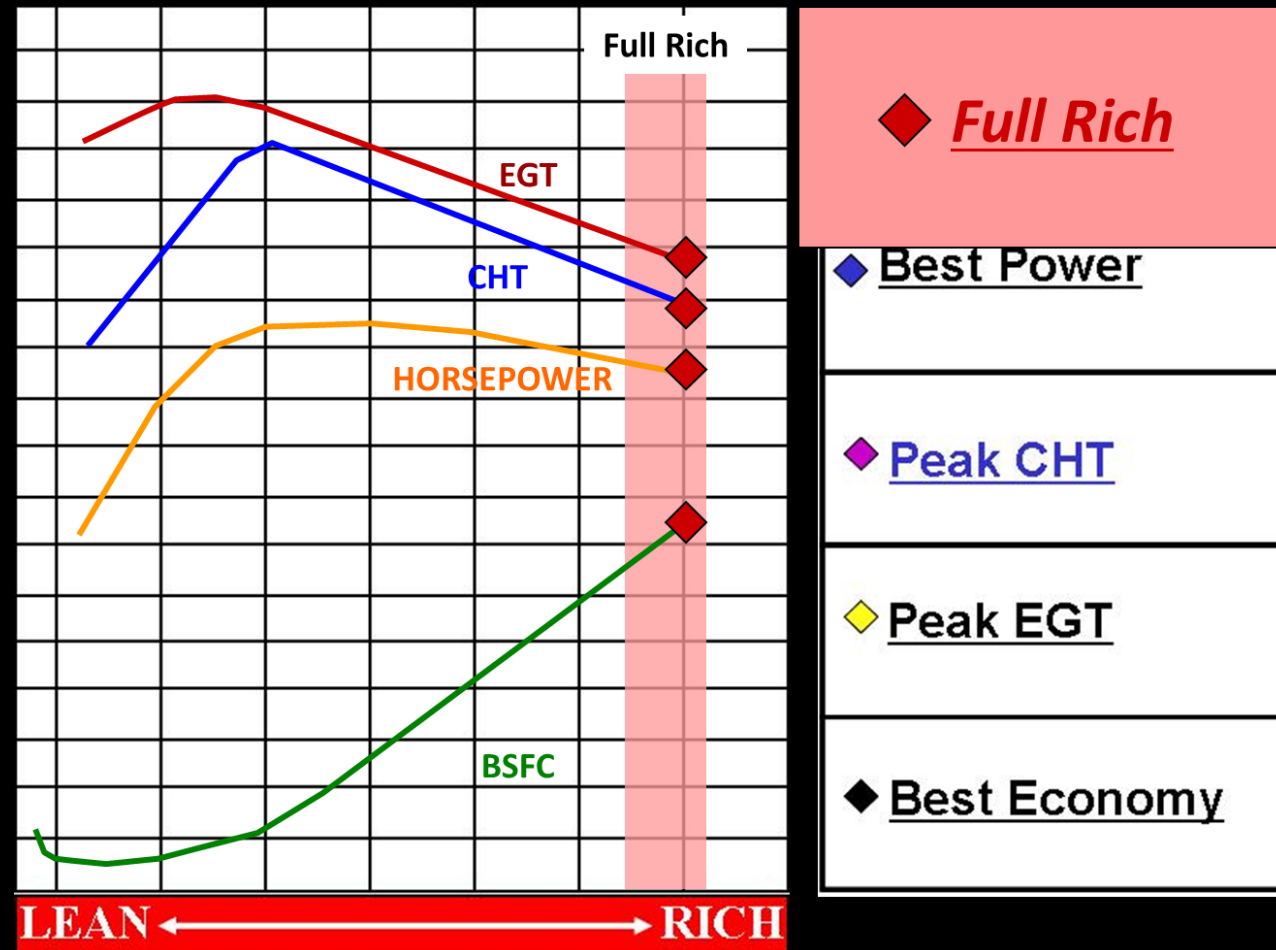
Full Rich operations:

Low EGT

Low Cylinder head (CHT) temperatures

Not à peak power (far away from possible detonation zone)

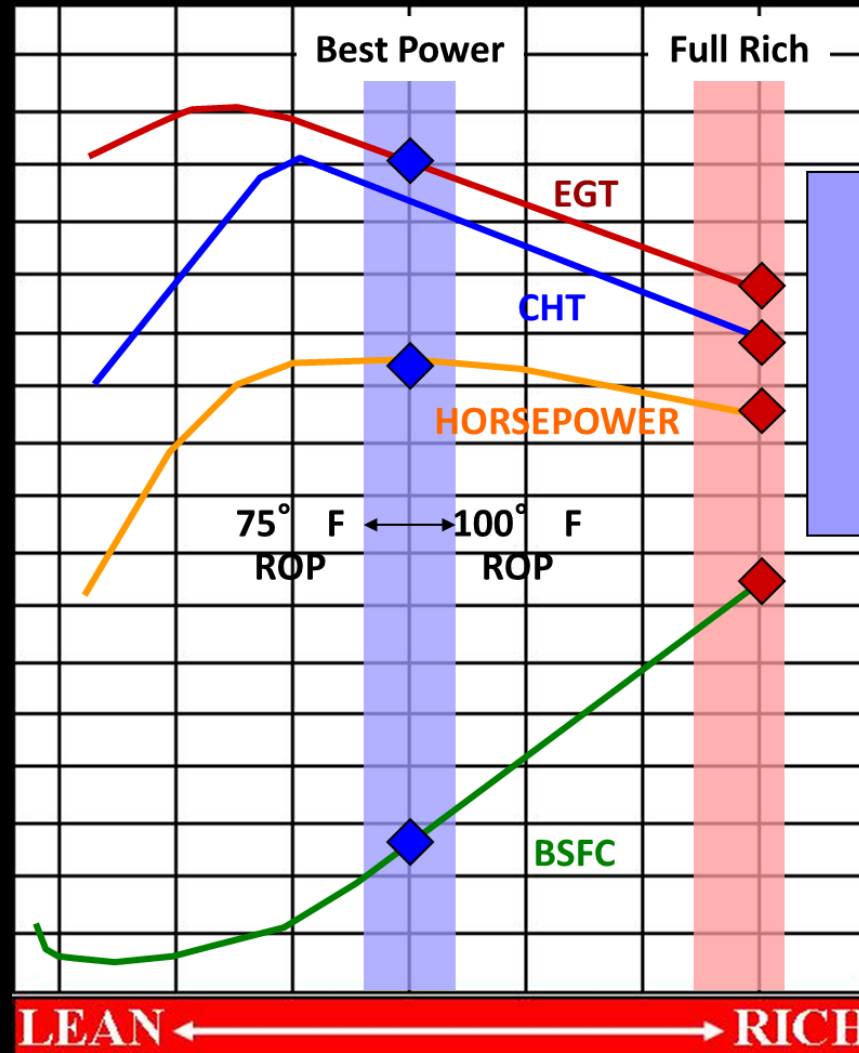
BSFC of a Saudi oil field owner



RICH OR LEAN, THAT'S YOUR PICK...

Best Power:
EGT below Peak
CHT below peak
Horsepower just below peak
BSFC greatly reduced
compared to full rich

Engine will not encounter
detonation



◆ Full Rich

◆ Best Power

75-100° F - Rich of
Peak (Peak Cylinder
Pressure)

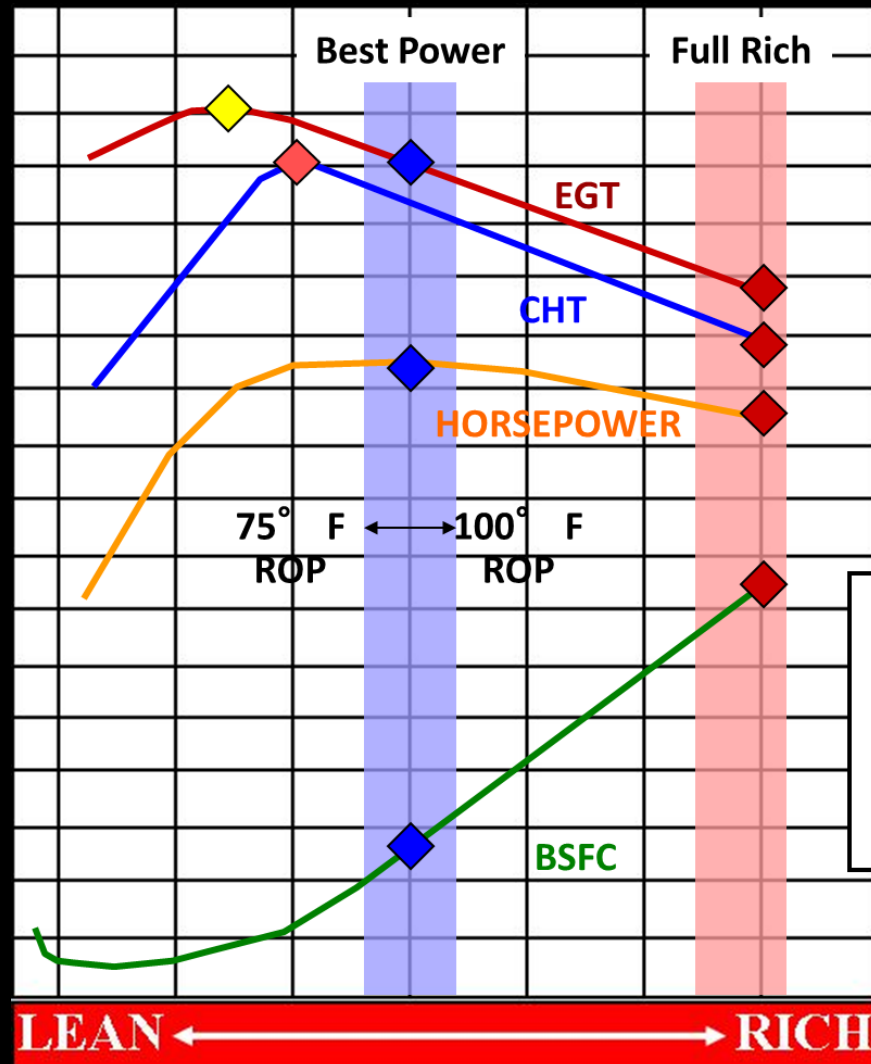
◆ Peak EGT

◆ Best Economy

RICH OR LEAN, THAT'S YOUR PICK...

To be avoided at all costs to avoid ... costs!

This is where detonation and pre-ignition lives...



◆ Full Rich

◆ Best Power
75-100° F - Rich of Peak
(Peak Cylinder Pressure)

◆ Peak CHT

◆ Peak EGT

◆ Best Economy
25-50° F - Lean of Peak

RICH OR LEAN, THAT'S YOUR PICK...

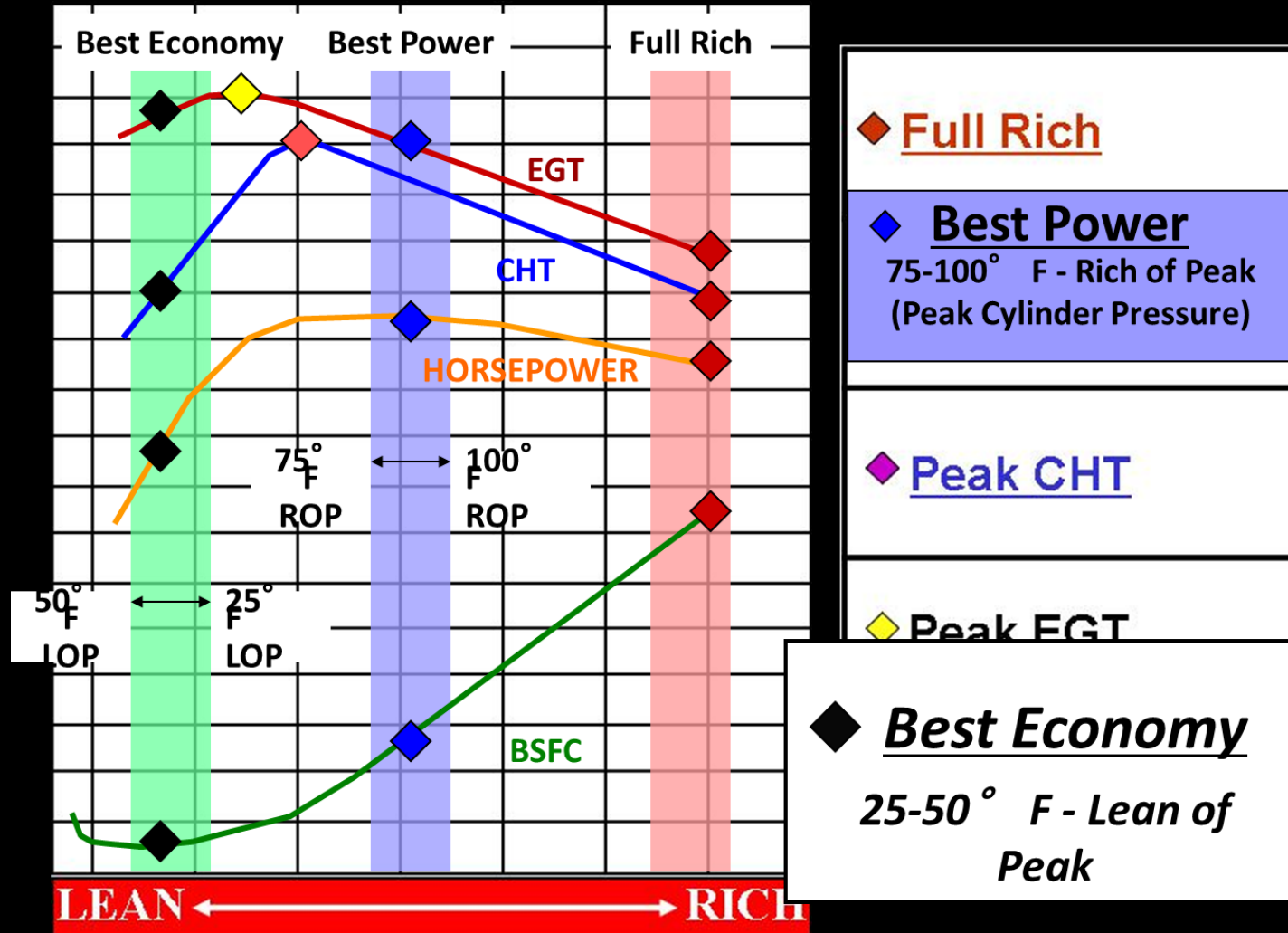
Lean of peak or best economy:
EGT are higher than with best power

CHT lower than at best power

Horsepower lower

BSFC at its lowest

This explains why you can't go fast!



THE MOST IMPORTANT RECOMMENDATIONS

THE MOST IMPORTANT RECOMMENDATIONS

Do not listen to self proclaimed gurus:

- They make a living out of you, not by fixing your plane.
- They don't have access to engineering data, certification data, test cells, metallurgy experts, manufacturing data.
- Sometimes they defy logic and common sense.
- But they will convince you and turn you into an advertisement for them!
- They don't pay your maintenance or repair bills.
- The reason you are facing repair bills is because you did not follow their principles in the past; therefore your engine is sick now... That's what they will make you believe.

THE MOST IMPORTANT RECOMMENDATIONS

Follow manufacturer's recommendations:

- POH
- Manufacturers' manuals
- When in doubt, contact the manufacturer's technical support and ask questions
- Do not improvise
- Do not test new recipes or miracle products
- It is only a question of common sense.

THE MOST IMPORTANT RECOMMENDATIONS

Example of conflicting information in the automotive world

- My car is a 2010 BMW 530ix with an automatic gear box.
- BMW says that the oil of the gearbox is good for the life of the engine and advises that no gearbox oil change is necessary. They “do not recommend” gear box oil changes.
- Common sense dictates that no oil keeps its lubrication properties for all eternity
- My car is over 150,000 km
- I do my research, I contact the technical support of the gearbox manufacturer: ZEF
- **Surprise!** They **clearly** state in **their manuals** that gearbox oil changes are **mandatory** every 80,000 to 100,000 km
- So who is right? A gearbox oil change, done properly and following manufacturers procedure, is not going to damage the gearbox...

THE MOST IMPORTANT RECOMMENDATIONS

Example of conflicting information in the aviation world:

- Cirrus aircraft, on the SR22 and Turbo SR22, used to recommend power settings by fuel flow only (set power and lean to obtain specific fuel flow)
- No reference to EGT, CHT or TIT temperatures
- Continental has a position that is different and its clearly stated in engine manuals
- Who is right?
 - Aircraft manufacturer that wants the max performance in the books?
 - Engine manufacturer that publishes data coming from tests?
- Use common sense, read the manuals, understand the relationship of power settings and decide for yourself when you have all the data.

QUESTIONS?

We might want to use the coffee break to avoid disturbing the schedule of other presenters...