


# Safe Engine Management

Peter Cassidy

2011



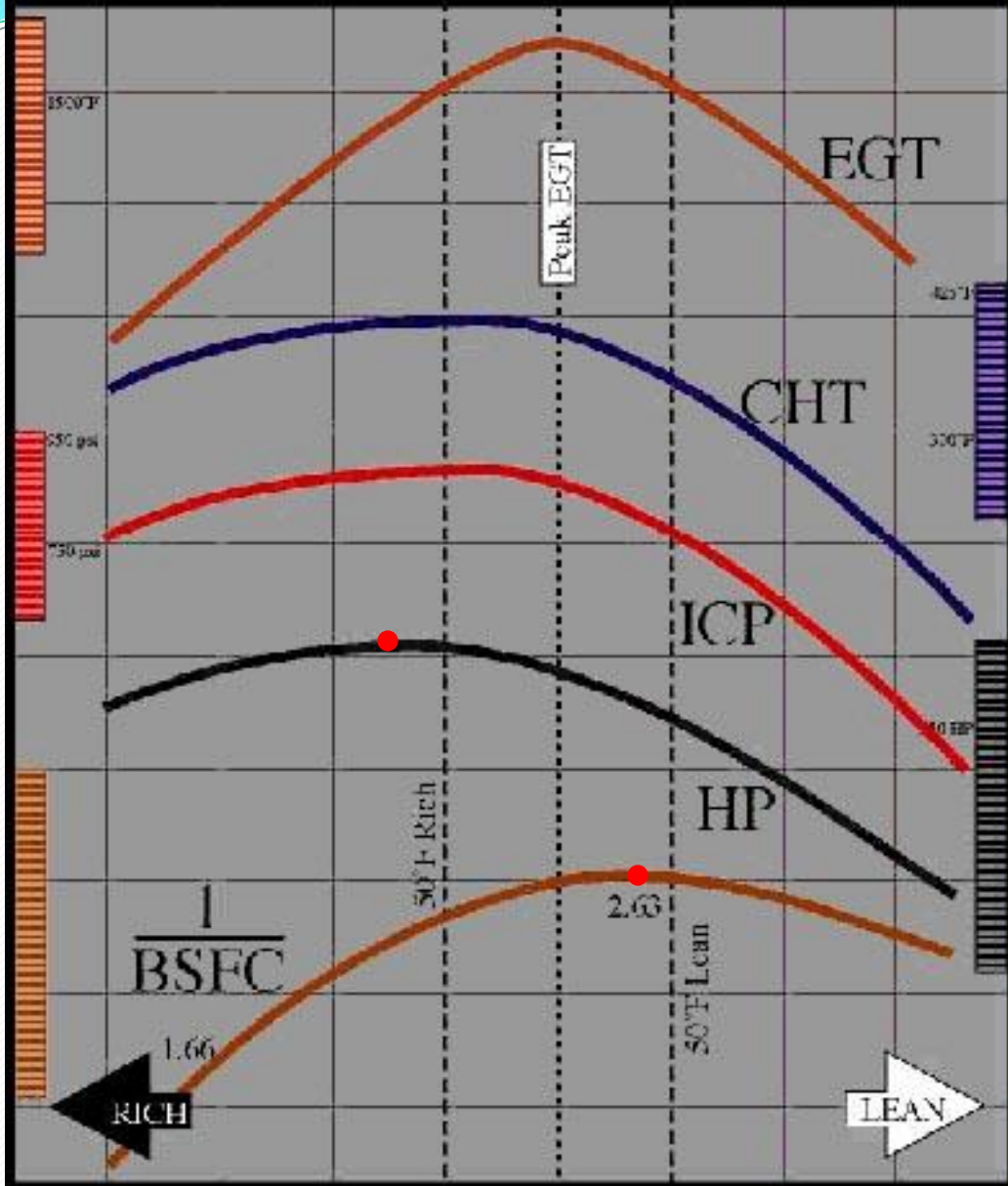
It's not how hard you run your engine,  
it's how you run your engine hard.

George Braley

# It's About Heat Management

- Heat Management = CHT Management
  - Cylinders can only take so much heat
  - Goal <380F      400F max
  - No detonation
- Efficiency and speed are secondary goals
  - Faster      = More GPG
  - Further      = Less GPH = Slower

# Landmarks On The Way to Understanding Piston Engine Powerplant Management



- EGT Exhaust Gas Temp  
Easy to measure  
Responds quickly to fuel flow changes
- CHT Cylinder Head Temp  
Changes slowly to fuel flow changes  
Good surrogate for ICP
- ICP Internal Cylinder Pressure  
Most important parameter  
Hard to measure
- HP Horse Power
- 1/BSFC Operating Efficiency  
HP / Pounds Fuel per hr.  
BSFC = Brake Specific Fuel Consumption

Max HP ~ 80F ROP  
Max Eff. ~ 40F LOP

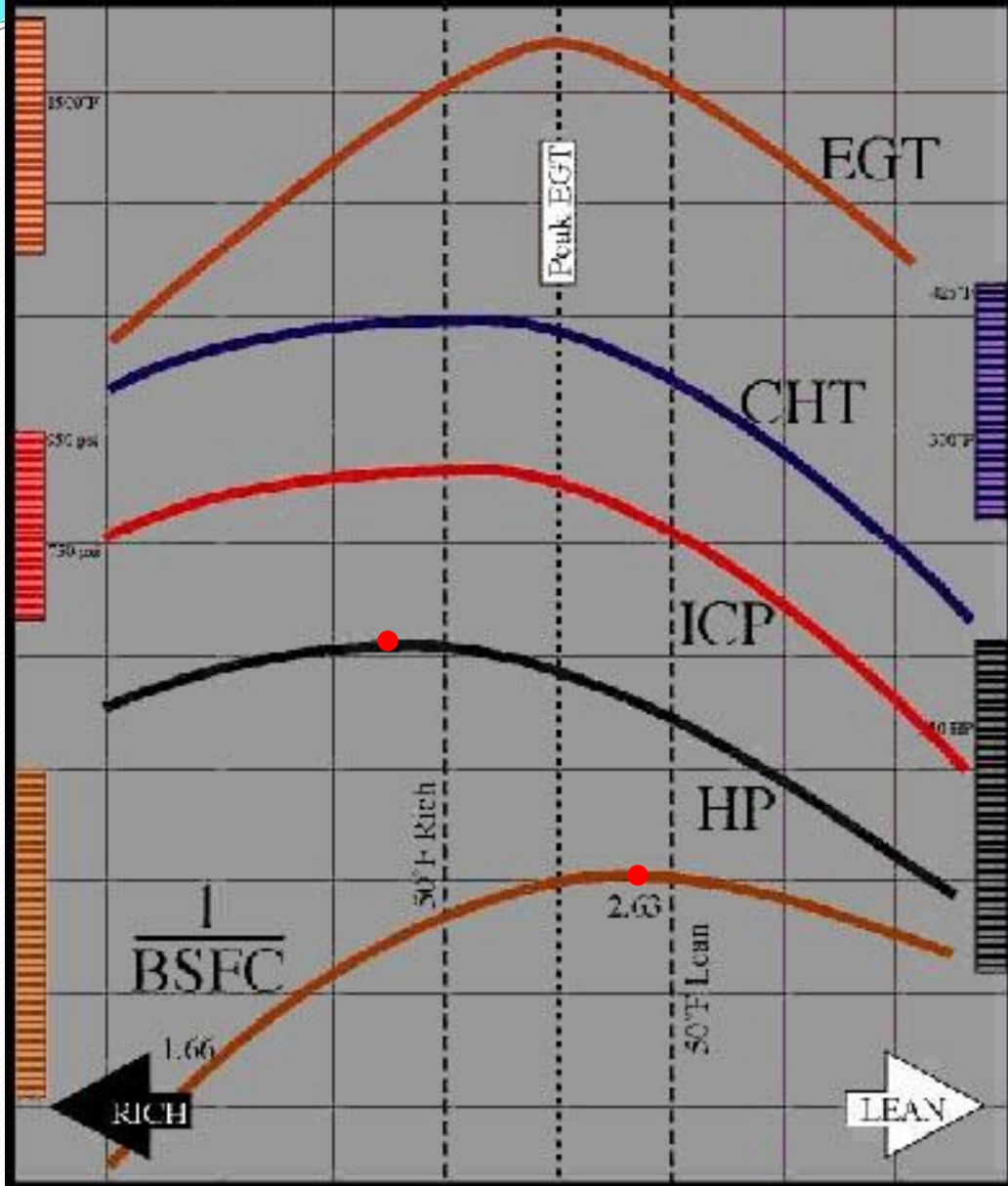
# Detonation

- The explosive burning of a part of the fuel-air charge as a result of auto-ignition of the end gas in the combustion chamber at some point after the spark plug firing event.
- Causes of detonation include
  - Insufficient Octane rating
  - Improper, advanced timing
  - Runaway, excessive CHTs

# Detonation (cont.)

- Rapidly rising internal cylinder pressures (ICP)
- Rapidly increasing temperatures
- Medium detonation
  - Is not catastrophic
  - Over time rod, bearing, ring, valve, spark plug damage
- Heavy detonation
  - CHTs may rise at more than  $1^{\circ}\text{F}/\text{sec}$
  - Can ruin a cylinder in 15-30 sec

# Landmarks On The Way to Understanding Piston Engine Powerplant Management

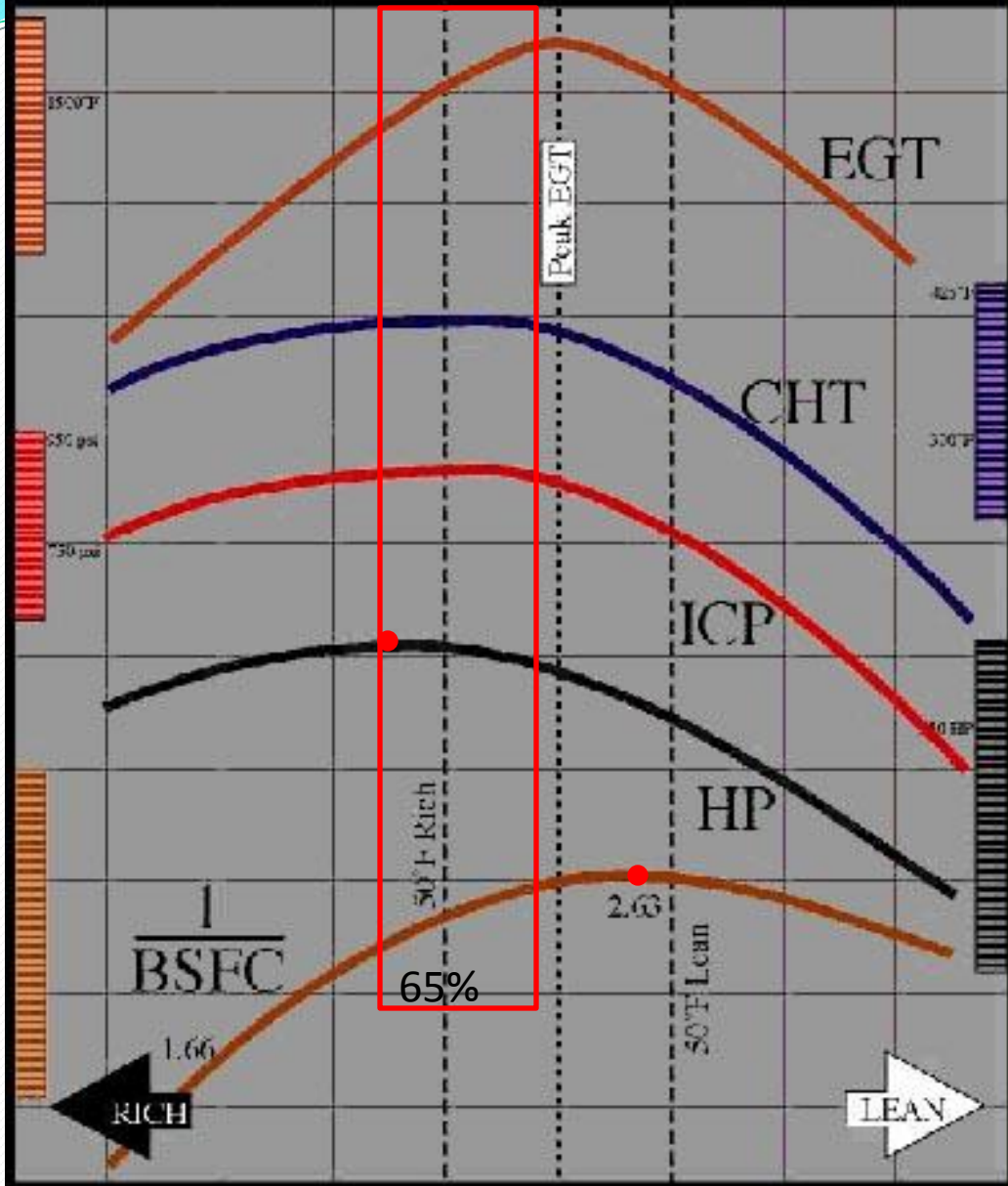


## Safe Areas

- Stay outside the **Red Box**
- 60% Any setting is safe

Max HP ~ 80F ROP  
Max Eff. ~ 40F LOP

# Landmarks On The Way to Understanding Piston Engine Powerplant Management



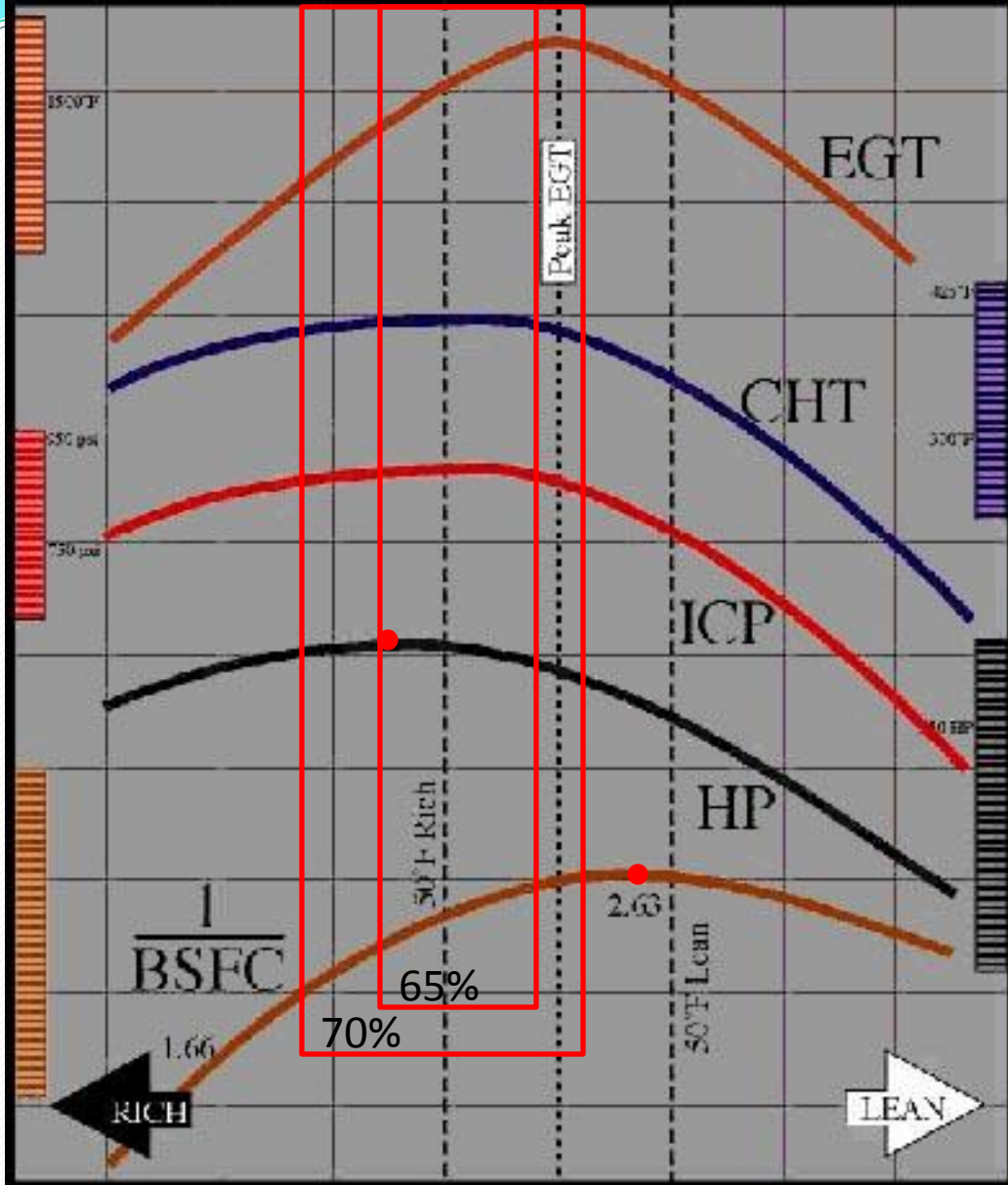
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- Stay outside the **Red Box**
- 60% Any setting is safe
- 65% 75F ROP – 10F ROP

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# Landmarks On The Way to Understanding Piston Engine Powerplant Management

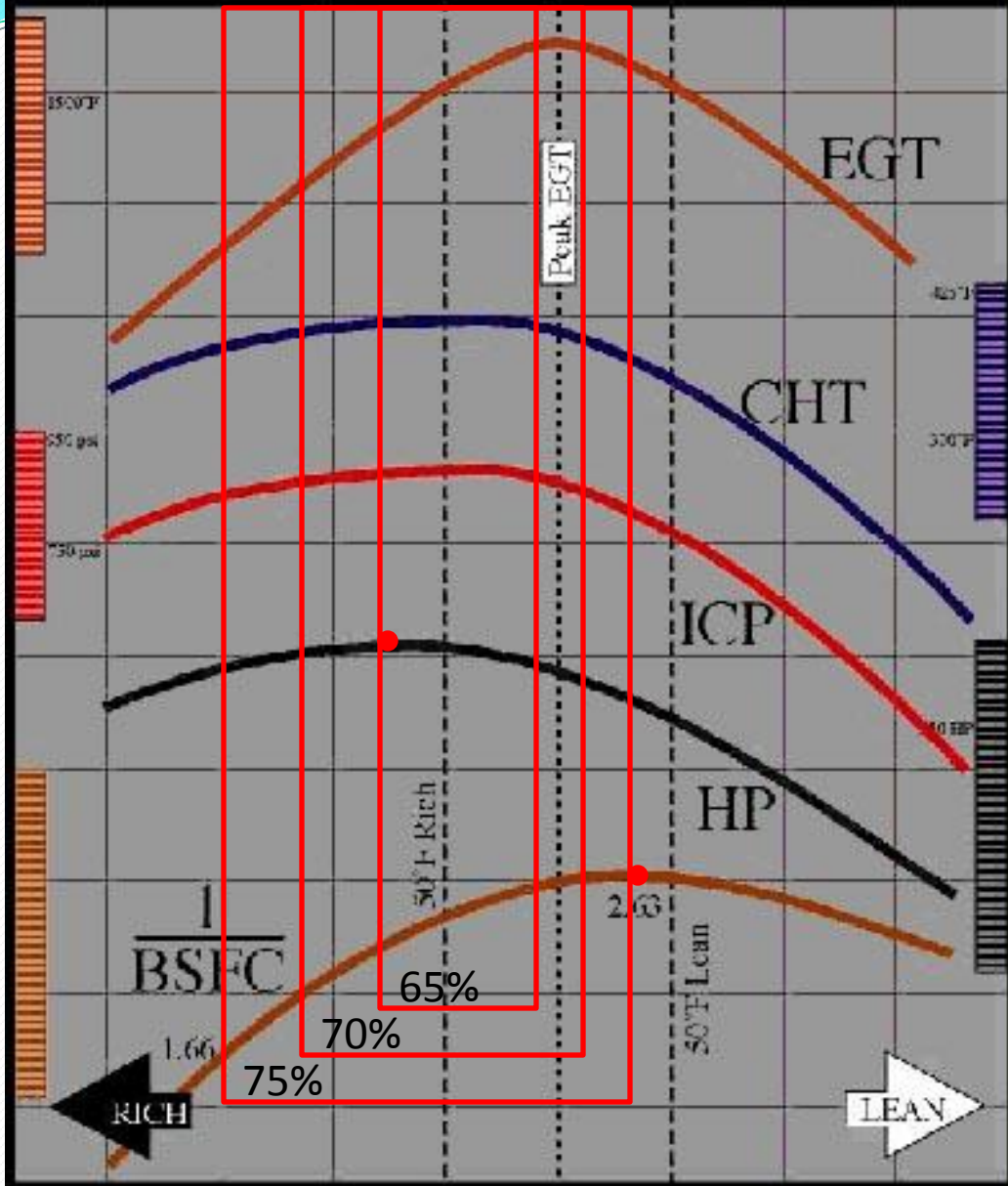


## Safe Areas

- Stay outside the **Red Box**
- 60% Any setting is safe
- 65% 75F ROP – 10F ROP
- 70% 100F ROP – 10F LOP

Max HP ~ 80F ROP  
 Max Eff. ~ 40F LOP

# Landmarks On The Way to Understanding Piston Engine Powerplant Management

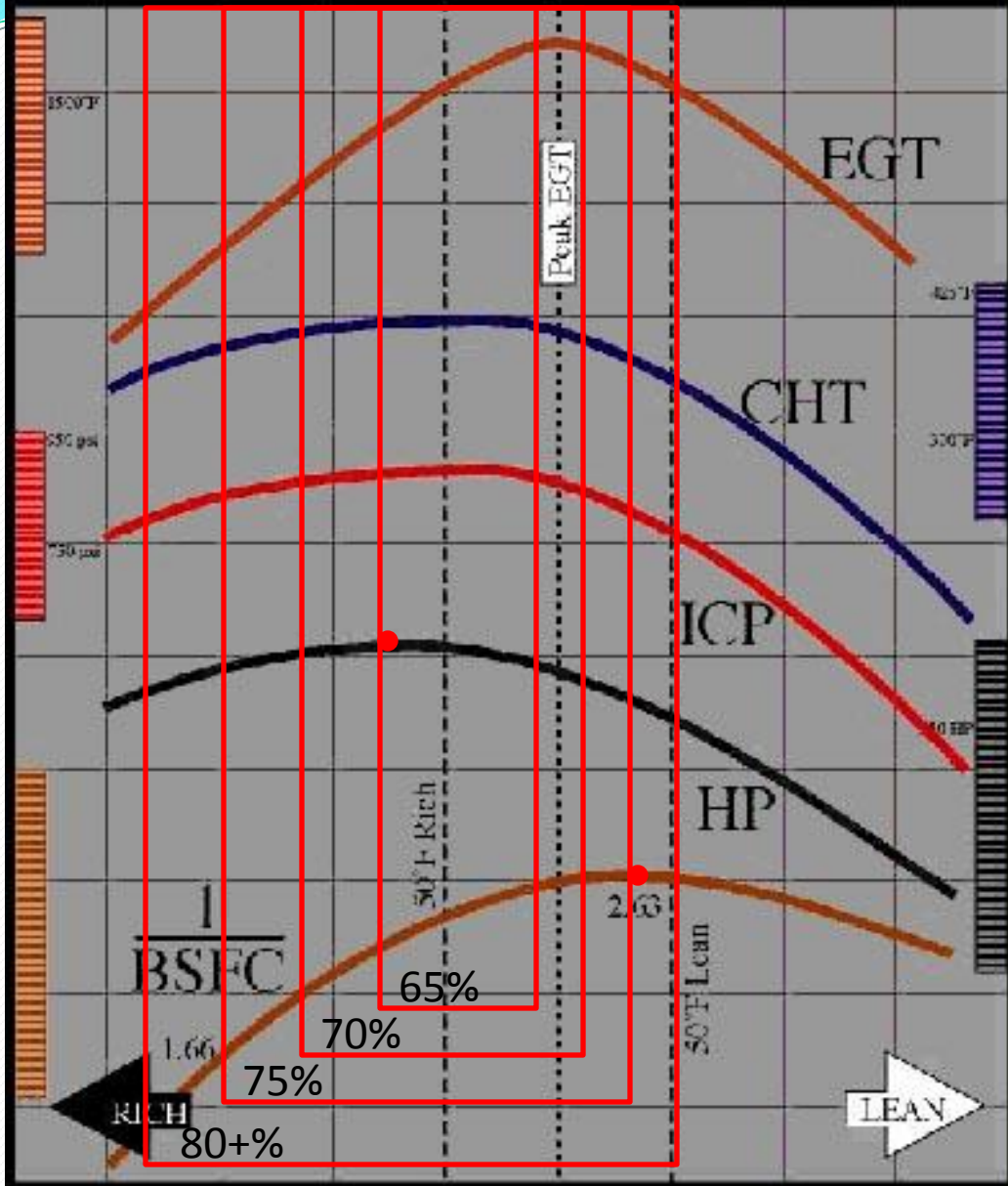


## Safe Areas

- Stay outside the **Red Box**
- 60% Any setting is safe
- 65% 75F ROP – 10F ROP
- 70% 100F ROP – 10F LOP
- 75% 125F ROP – 25F LOP

Max HP ~ 80F ROP  
 Max Eff. ~ 40F LOP

# Landmarks On The Way to Understanding Piston Engine Powerplant Management



## Safe Areas

- Stay outside the **Red Box**
- 60% Any setting is safe
- 65% 75F ROP – 10F ROP
- 70% 100F ROP – 10F LOP
- 75% 125F ROP – 25F LOP
- 80+% 175F ROP – 50F LOP

Max HP ~ 80F ROP  
 Max Eff. ~ 40F LOP

# ROP or LOP

- ROP

- All engines can operate ROP
- Higher power

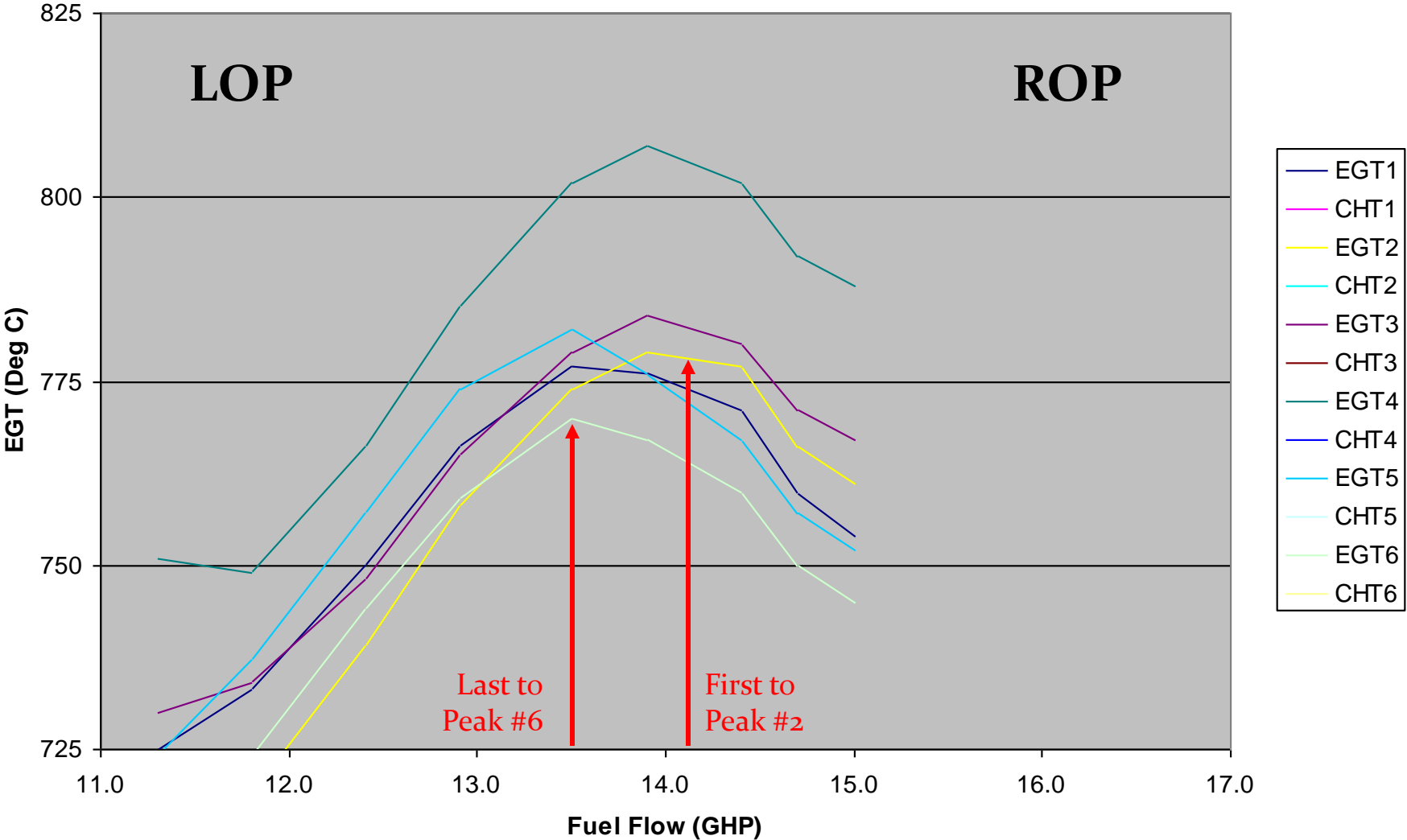
- LOP

- Requires Engine Monitor to lean properly
- Cooler CHTs
- Little or no carbon monoxide or carbon deposits

# Operating LOP

- First do a GAMI Lean Test
  - WOT, 8500 RPM, Normal Cruise RPM
  - Spread needs to be less than 0.5 GPH

# N395SA GAMI Test 1/7/04 8500'



Shelby RV7 GAMI Lean Test 7/8/10  
8500' WOT 2300 RPM 15C

- EGT 1
- EGT 2
- EGT 3
- EGT 4

**ROP**

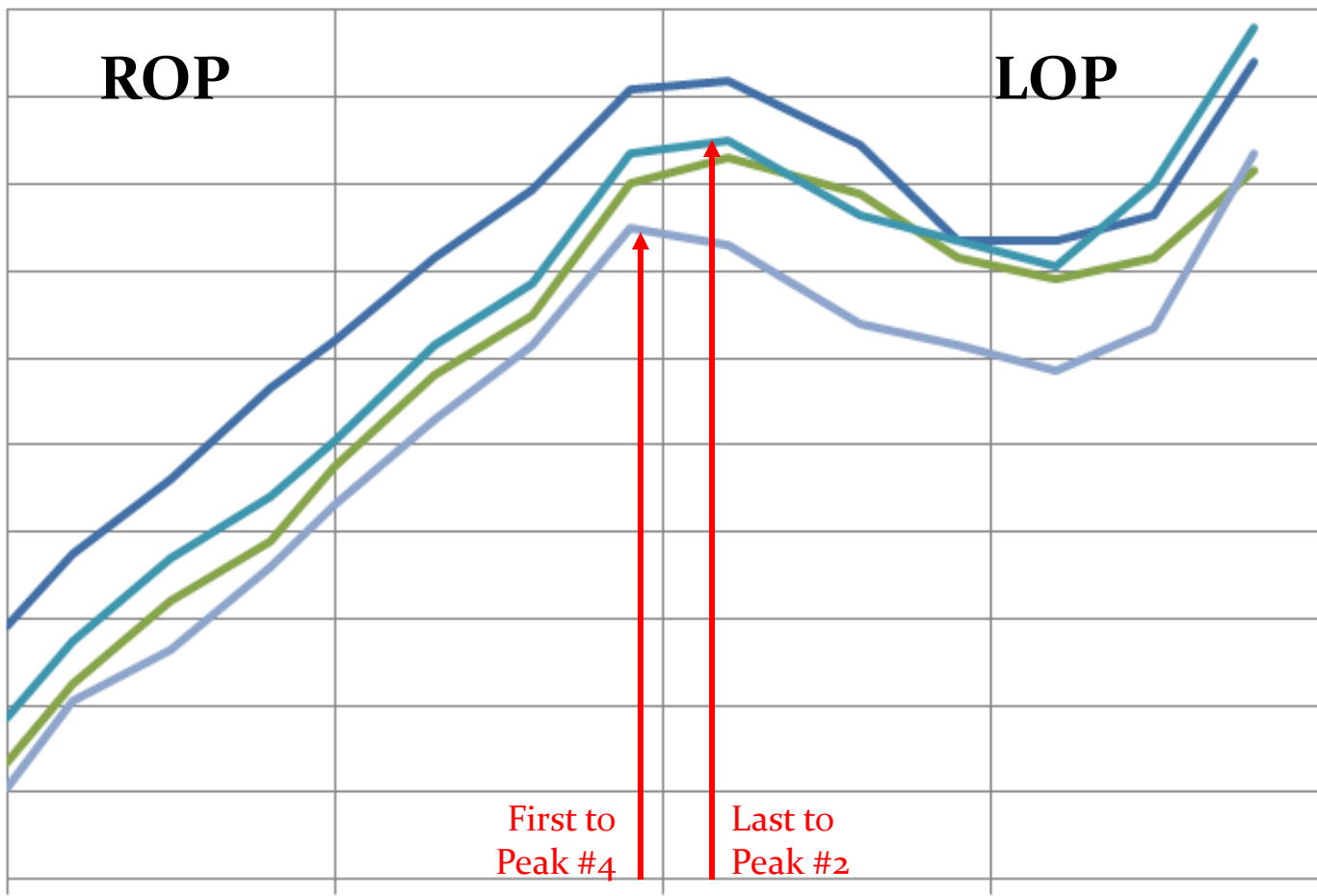
**LOP**

First to Peak #4

Last to Peak #2

Fuel Flow 11.0 10.0 9.0 8.0 7.0

1440  
1420  
1400  
1380  
1360  
1340  
1320  
1300  
1280  
1260  
1240



# Determining HP

- ROP: MP and RPM determine HP
  - 1% change in Mass Airflow = 1% change in HP
  - 10% change in Fuel Flow = negligible change in HP
- LOP: Only Fuel Flow determines HP
  - 10% change in Mass Airflow = negligible change in HP
  - 1% change in Fuel Flow = 1% change in HP



# Determining HP (cont.)

- ROP – Complex formula
  - Function of MP and RPM
  - Use POH tables
- LOP – Simple formula
  - Function of Fuel Flow
  - For 8.5:1 Compression  $HP = 14.9 \times \text{Fuel Flow in GPH}$
  - For 7.5:1 Compression  $HP = 13.7 \times \text{Fuel Flow in GPH}$

13 GPH = 194 HP = 65% for 300 HP engine

12 GPH = 179 HP = 60% for 300 HP engine

# Operating Tips

- Climb ROP
- Keep CHTs below 380F
- Cruise LOP unless you want to go fast
- Use WOT (Wide Open Throttle) when LOP
- Make mixture change ROP to LOP smooth and direct
- Descend LOP – increase fuel flow if necessary
- Set ROP before final for landing

# Some helpful links

- Mike Busch Webinars

[www.savvymx.com/webinar](http://www.savvymx.com/webinar)

- Advanced Pilot Seminars

[www.advancedpilot.com](http://www.advancedpilot.com)



Questions?