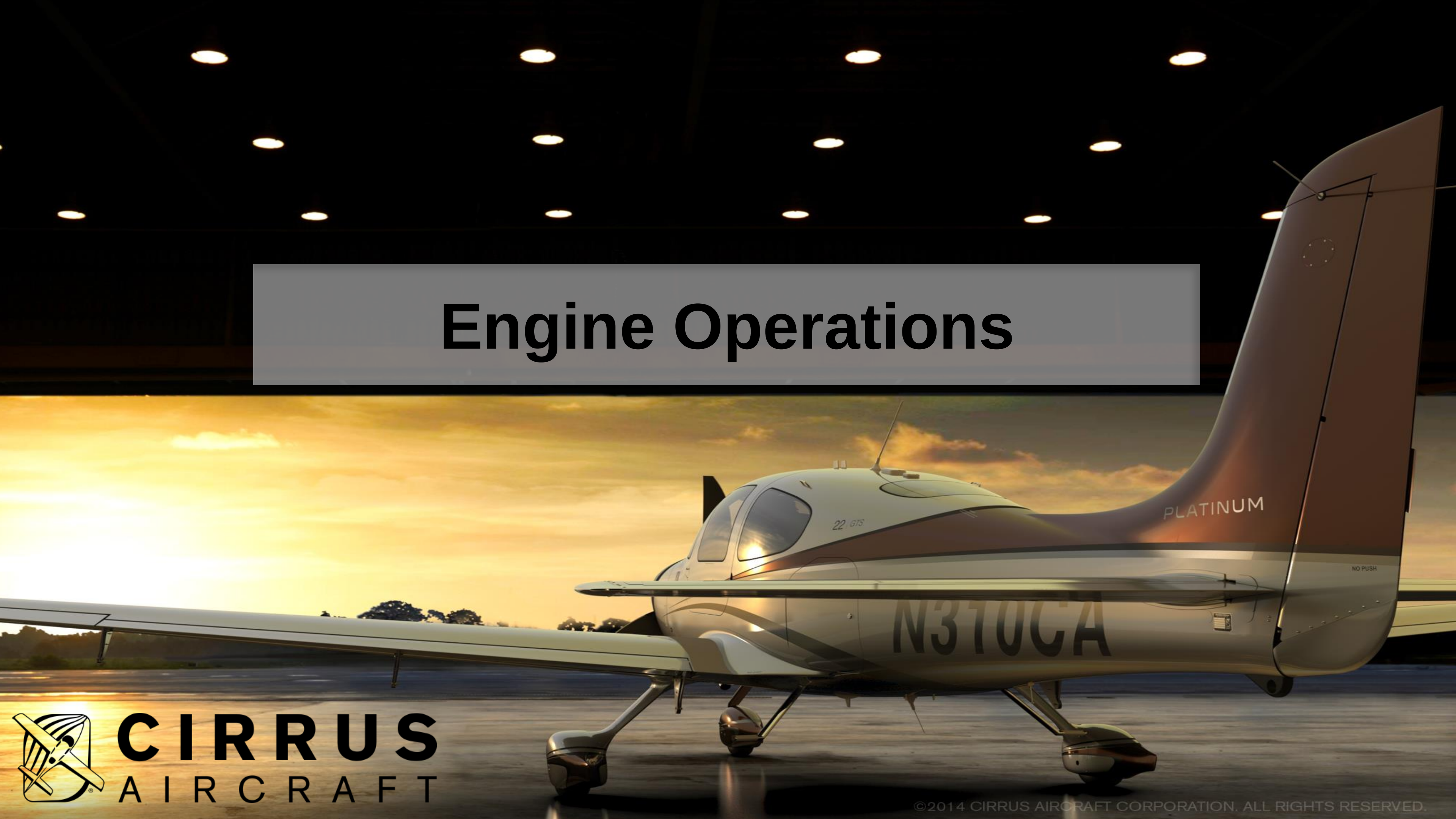
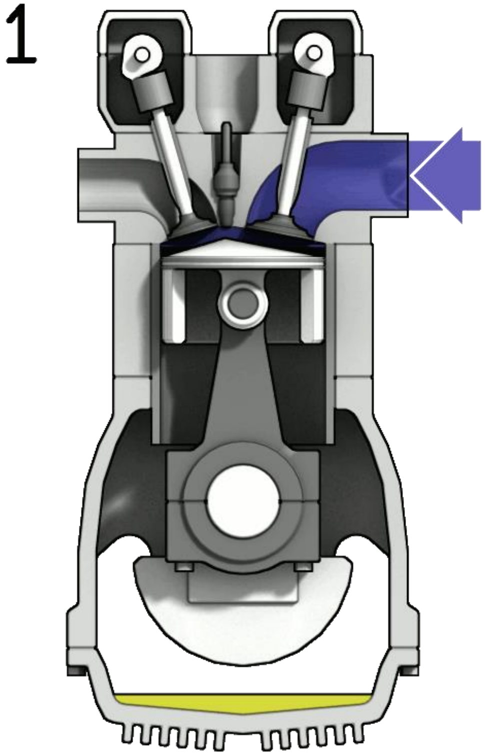
Engine Operations



CIRRUS AIRCRAFT

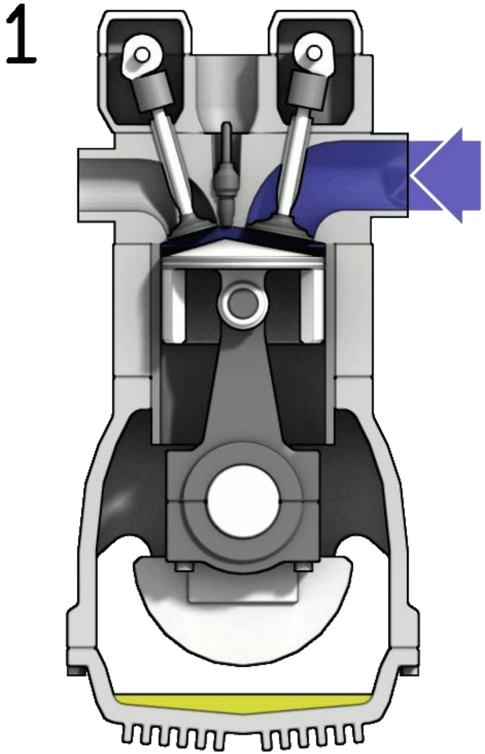
Principles of Internal Combustion Engines

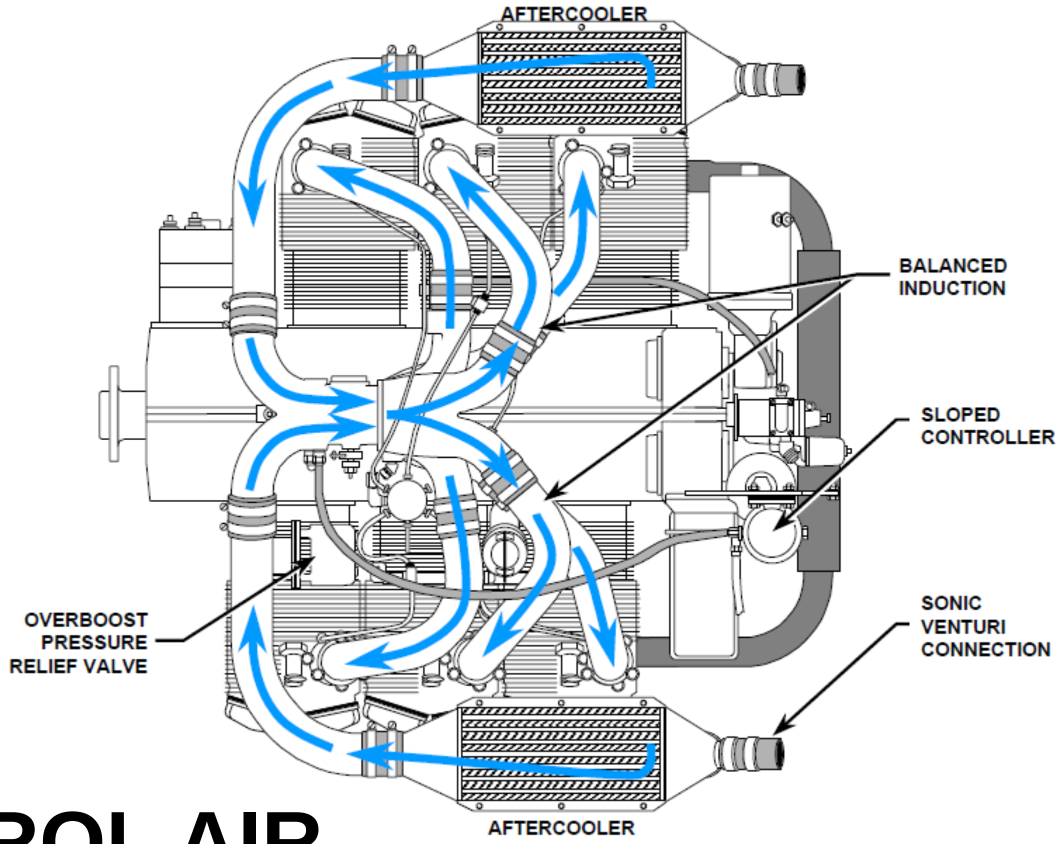
1. **Induction:** In this stroke the intake valve must be in the open position while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion.
2. **Compression**: In this stroke the piston compresses the air-fuel mixture in preparation for ignition during the power stroke (below). Both the intake and exhaust valves are closed during this stage.
3. **Power:** While the piston is at T.D.C. (the end of the compression stroke) the compressed air-fuel mixture is ignited by a spark plug. This stroke produces mechanical work from the engine to turn the crankshaft.
4. **Exhaust:** During the exhaust stroke, the piston once again returns to T.D.C from B.D.C while the exhaust valve is open. This action expels the spent air-fuel mixture through the exhaust valve.



Principles of Internal Combustion Engines

- Air + Fuel + Spark = Combustion
- What we Control
  - Air
    - Throttle
      - Manifold Pressure
      - RPM
  - Spark
    - Magnetos
      - L,R, Both
  - Fuel
    - Mixture
  - Cooling
    - Airspeed



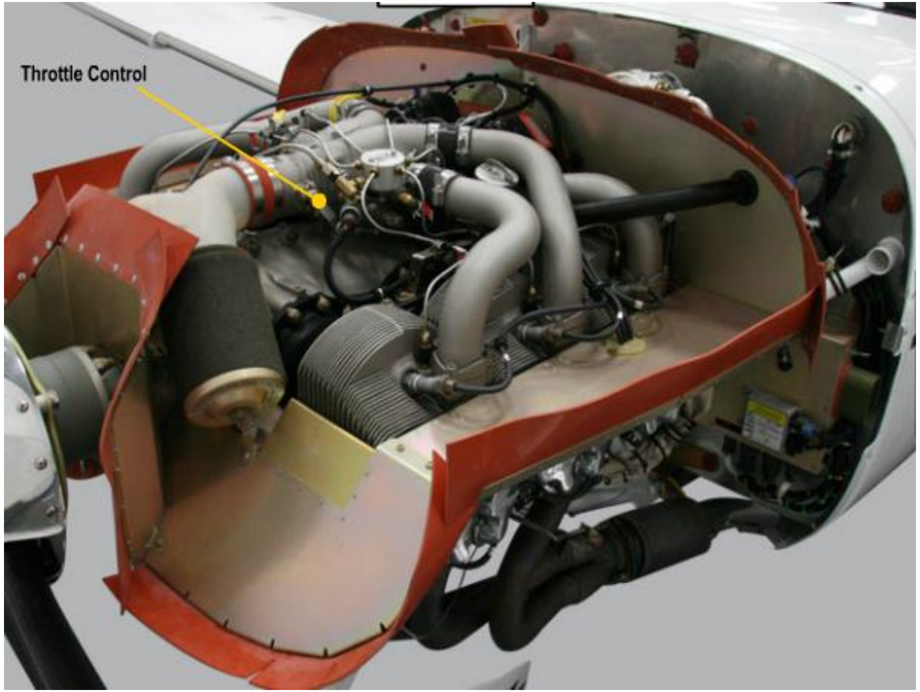


Power Lever/Throttle

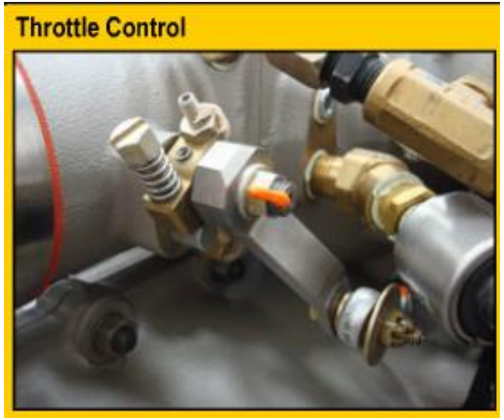
HOW WE CONTROL AIR

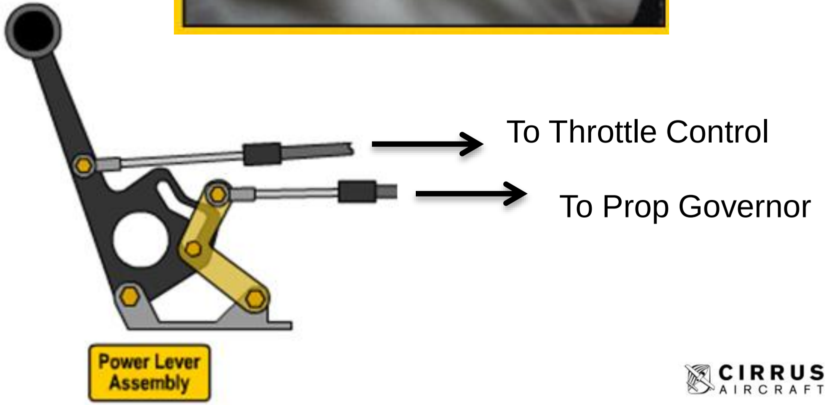
CIRRUS AIRCRAFT

Throttle Controls Airflow



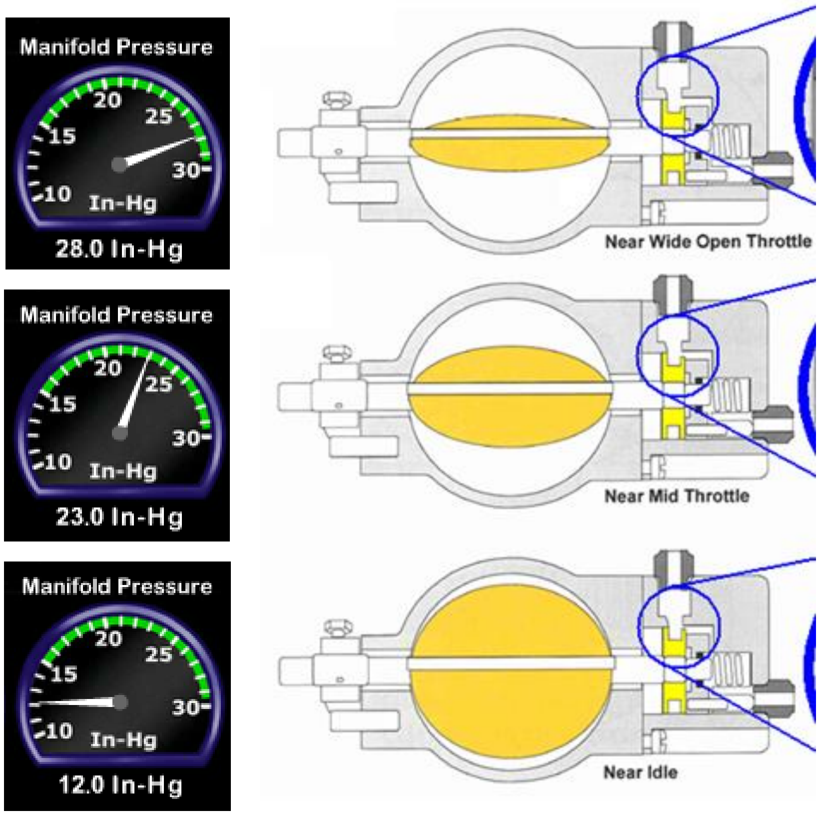
SR22





Throttle Position

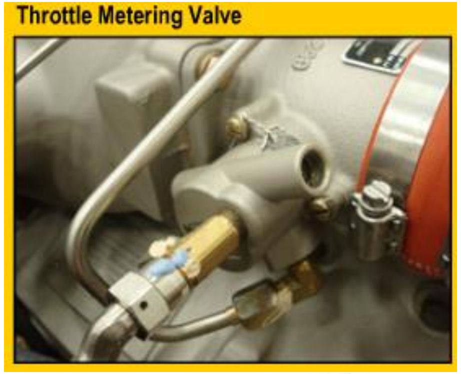
- Manifold Pressure increases as the throttle opens
- Airflow into the engine increases as the throttle opens
- Engine behaves like an air pump

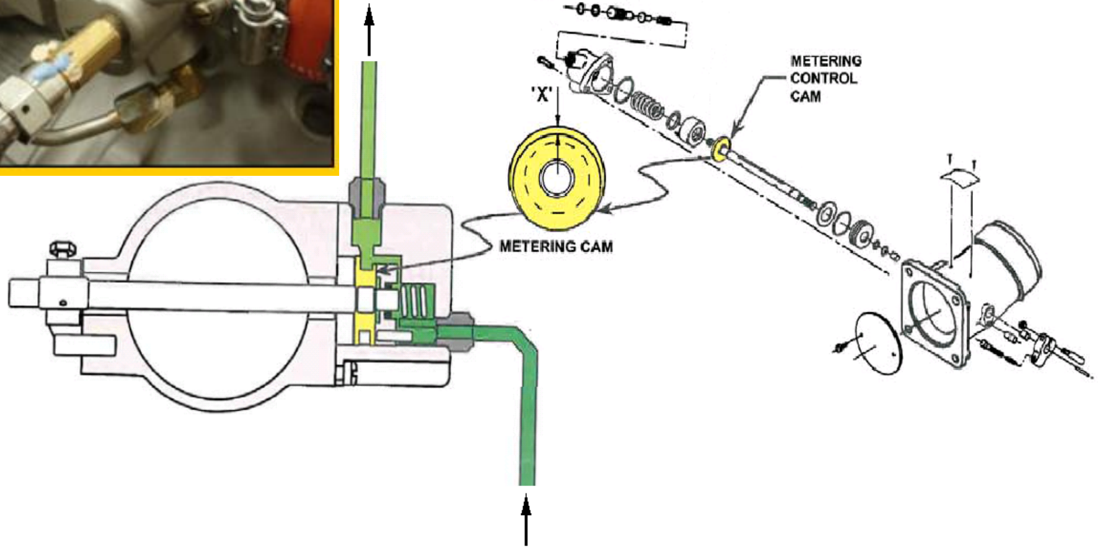


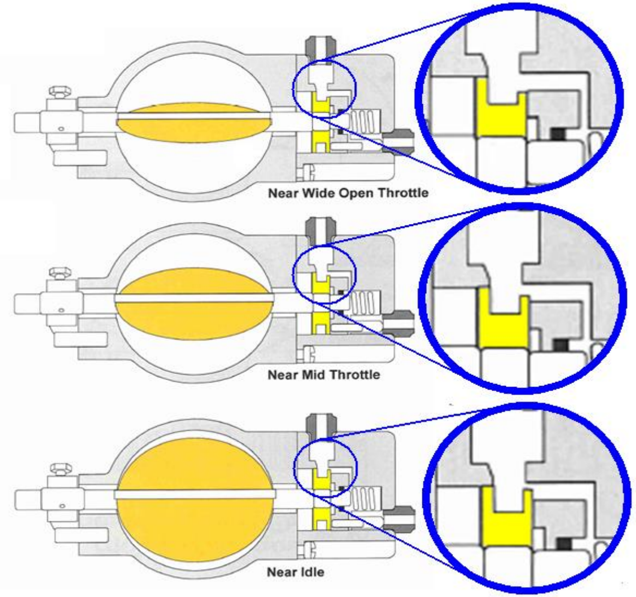
CIRRUS AIRCRAFT

Throttle Body Fuel Metering Cam

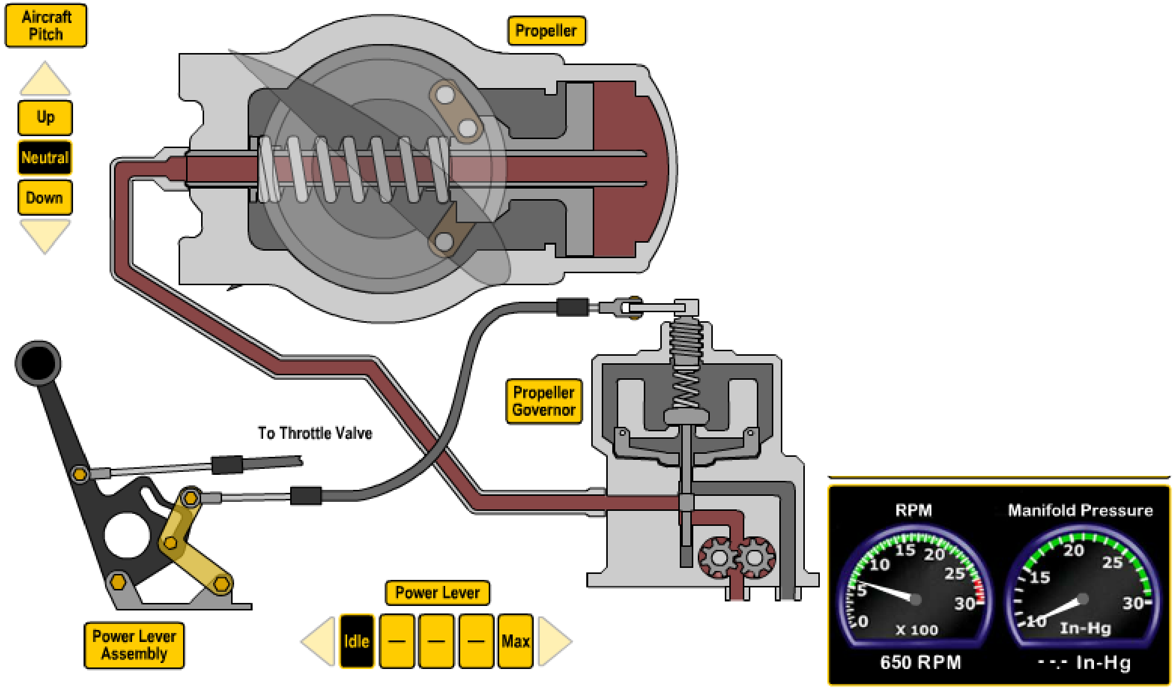
- Increases fuel flow as throttle plate opens
  - Fuel flow increases at wide open throttle to help with engine cooling during climbs



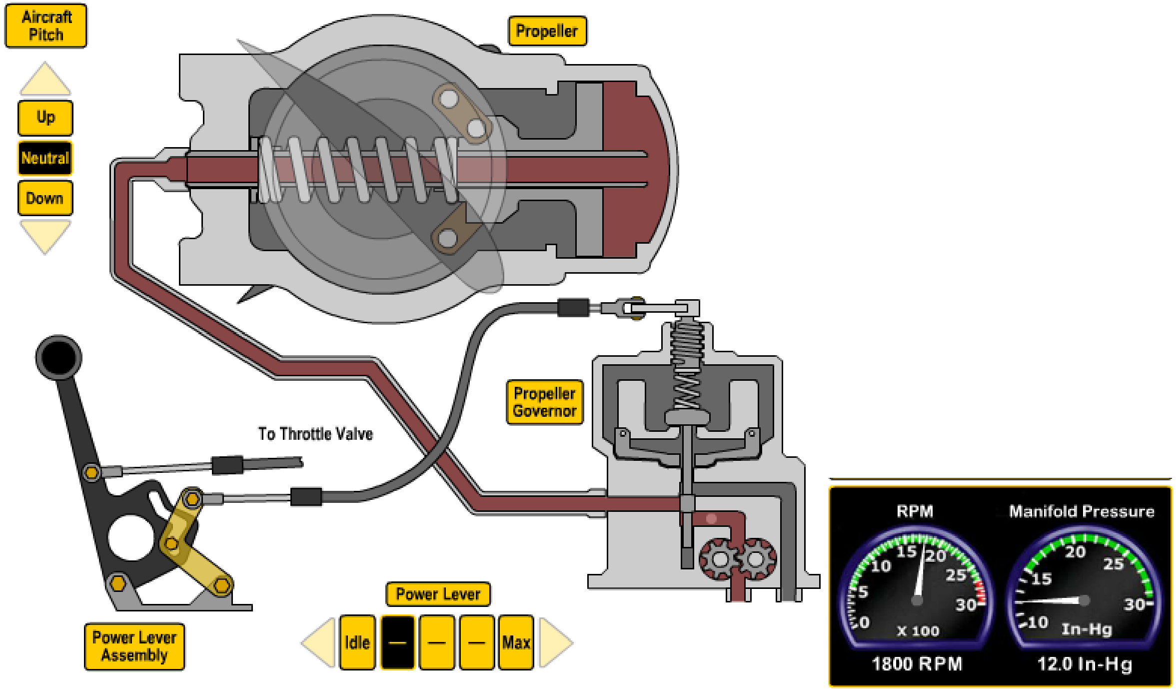




Power Level / RPM Control

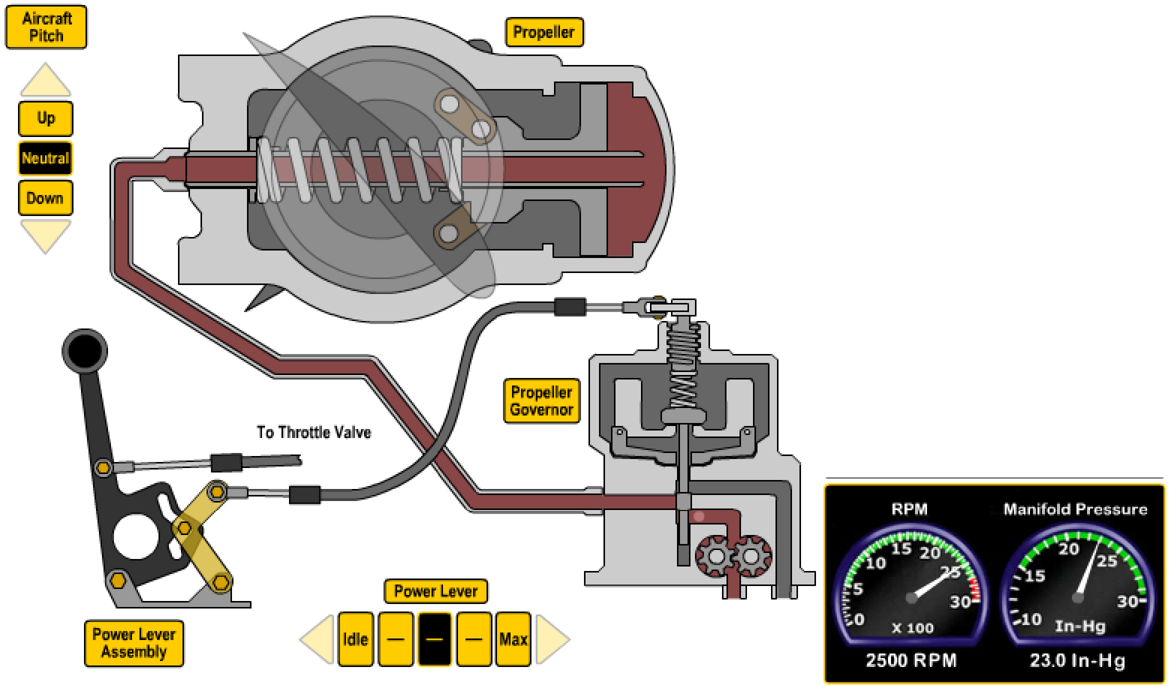


Power Level / RPM Control

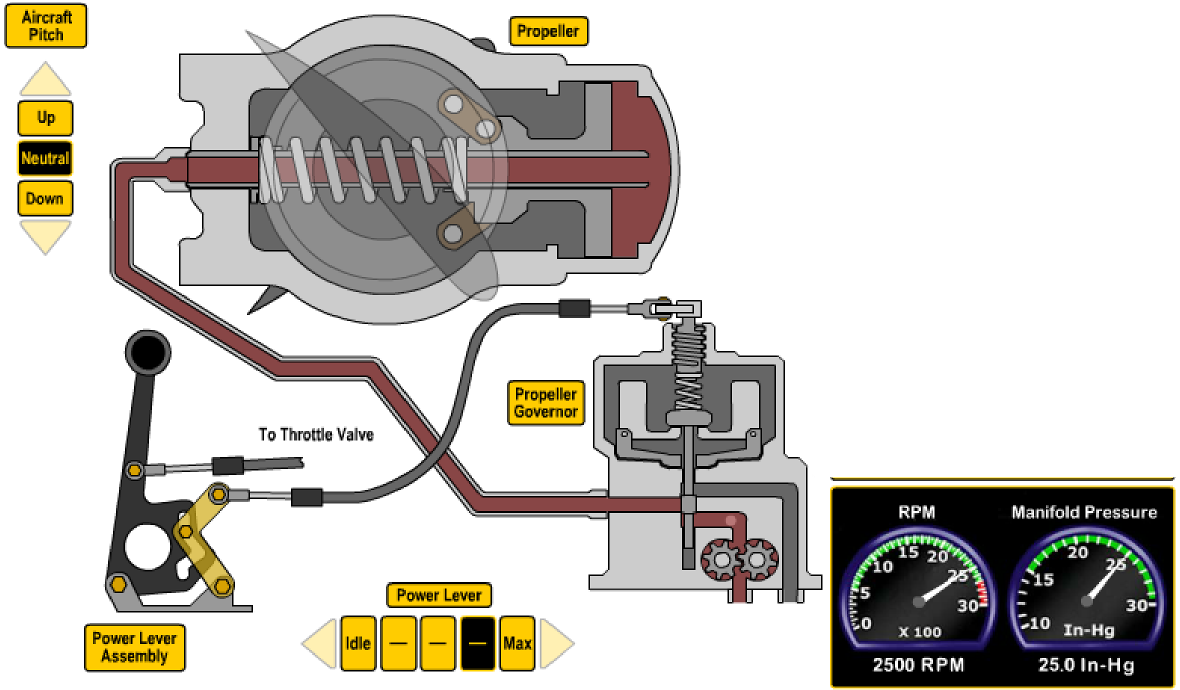


CIRRUS AIRCRAFT

Power Level / RPM Control

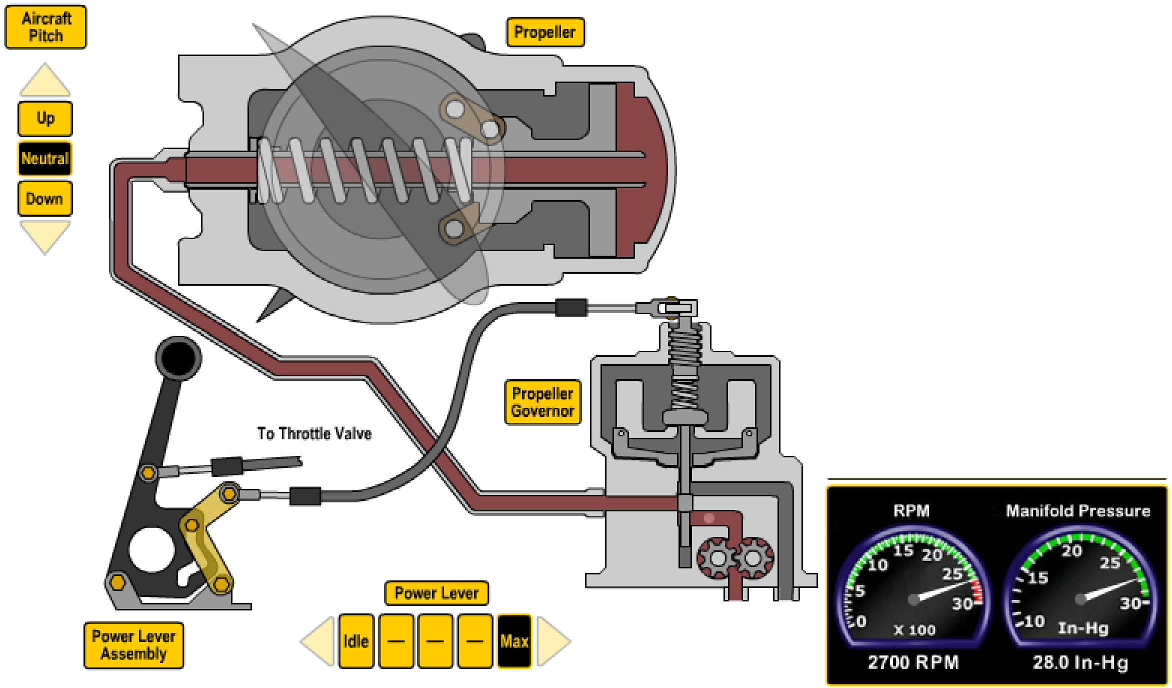


Power Level / RPM Control



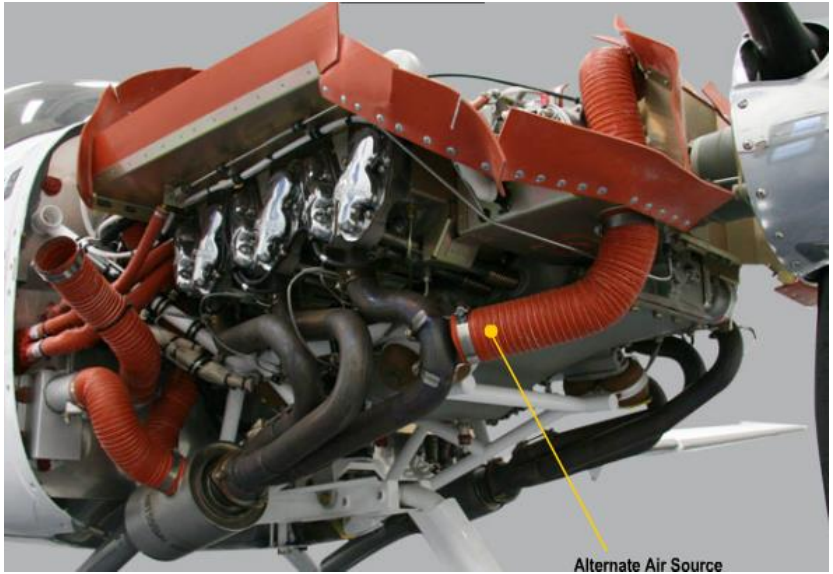
CIRRUS AIRCRAFT

Power Level / RPM Control



Alternate Air

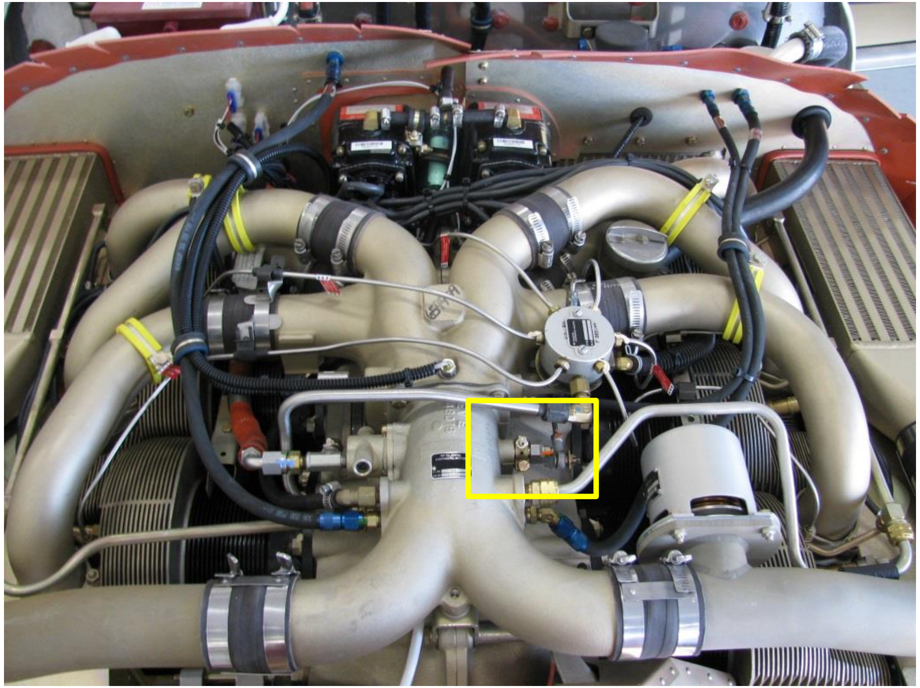
- Used for abnormal/emergency operations if air filter becomes clogged/blocked

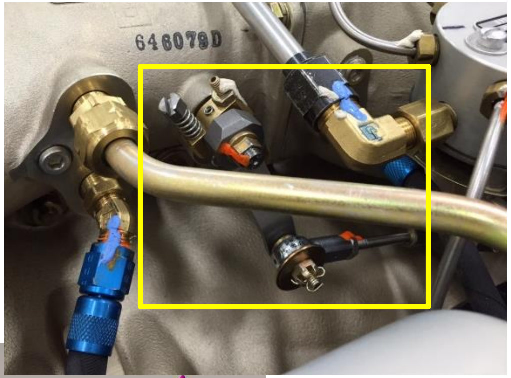


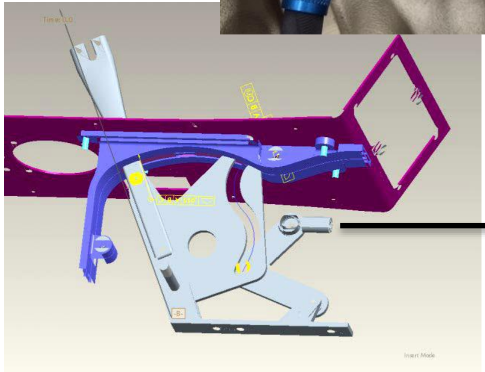
SR22

CIRRUS AIRCRAFT

Throttle Controls Airflow





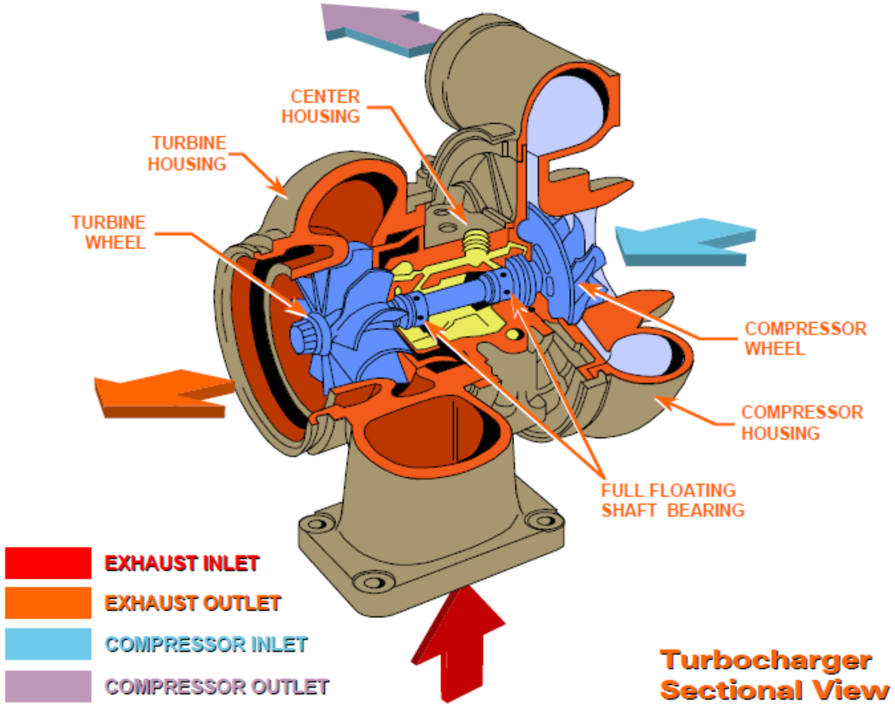


To Throttle Control

Power Lever

Turbocharger

- A centrifugal compressor which boosts the intake pressure of an internal combustion engine driven by an exhaust gas turbine fitted to the engine's exhaust manifold.

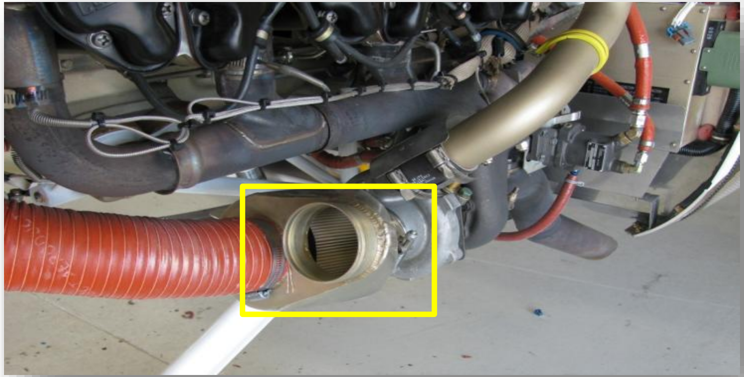


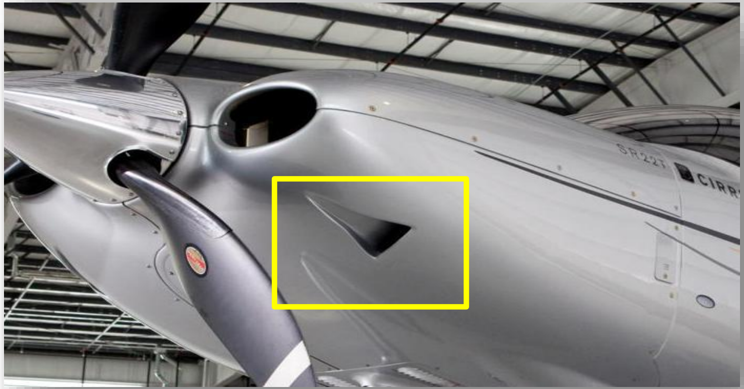
CIRRUS AIRCRAFT

Air Intakes

- 2 combustion air intakes
  - 1 on each side connected to NACA vent

- Fresh combustion air feeds directly into compressor-side of turbo

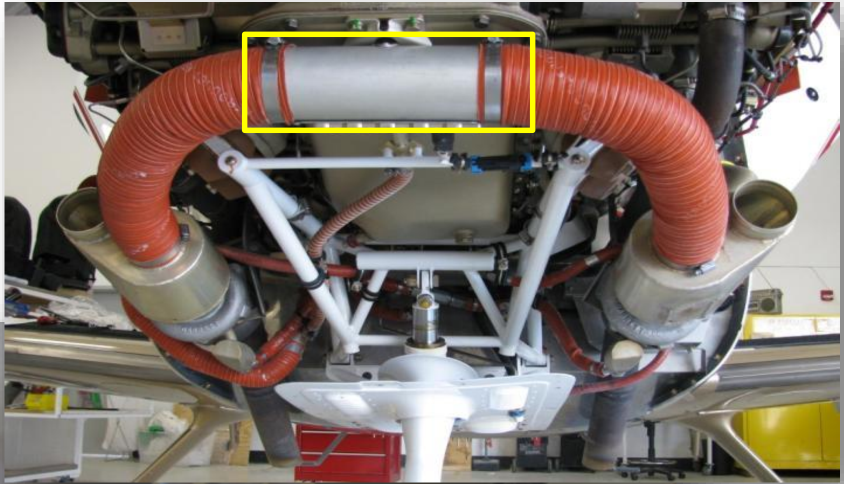


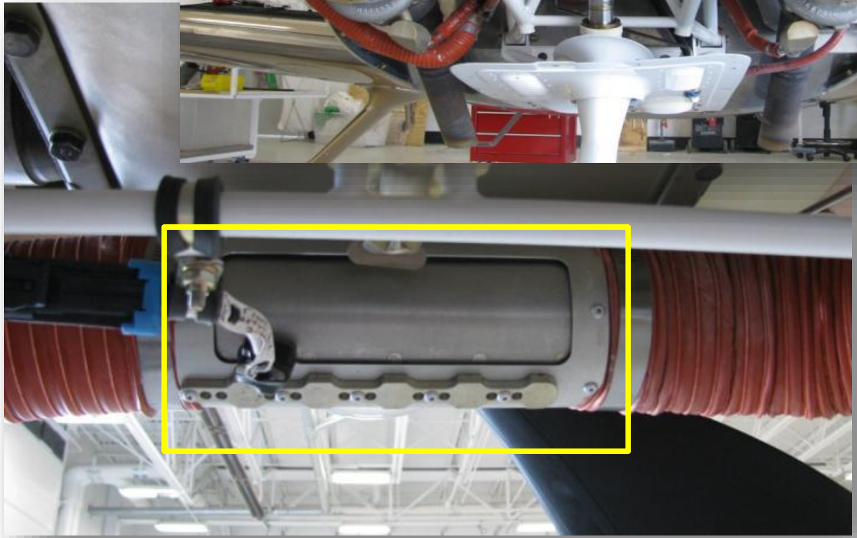


Air Intakes / Alternate Air

- Flexible tube connects intakes
- Automatic alternate air door in center
  - Held shut by spring/magnet
  - Will open automatically when normal air sources become clogged
  - Will close automatically when resistance is cleared
  - CAS message will appear to alert pilot

ALT AIR OPEN

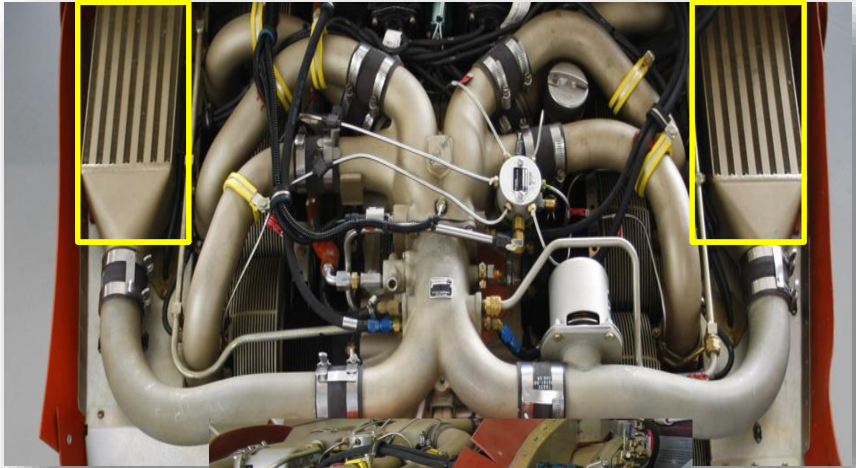




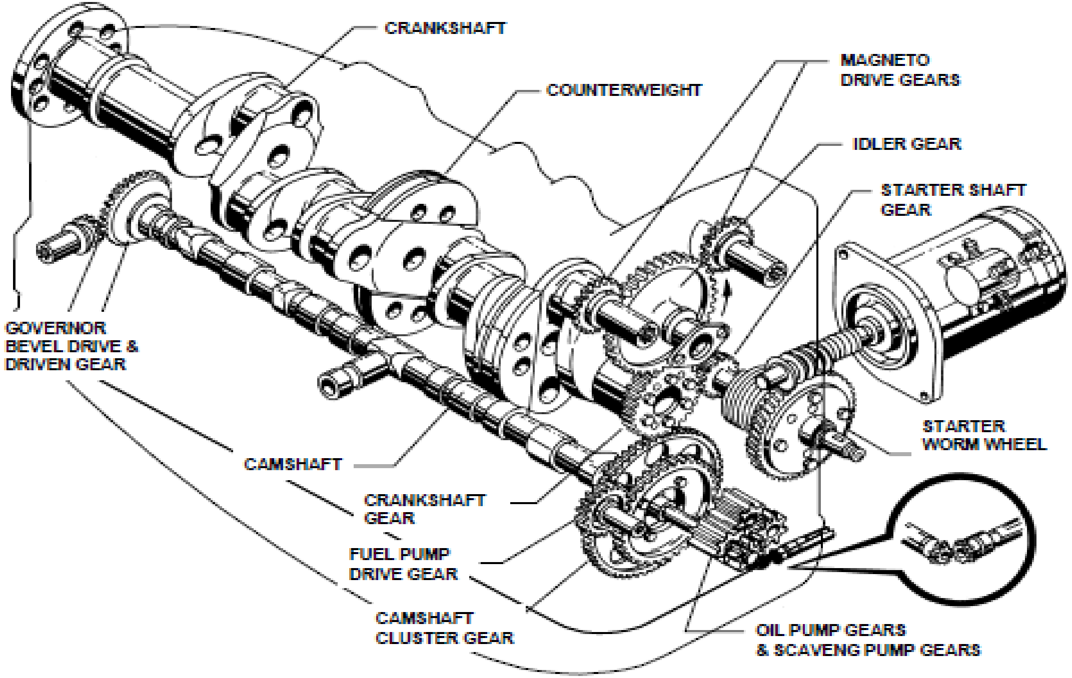
CIRRUS AIRCRAFT

Intercooler (Aftercooler)

- As the air is compressed in the turbo, it also warms up (up to 5 times as hot)
- Intercooler is installed in the induction air path between the compressor and the throttle plate
- The function is to cool down the compressed air, which improves the performance of the engine



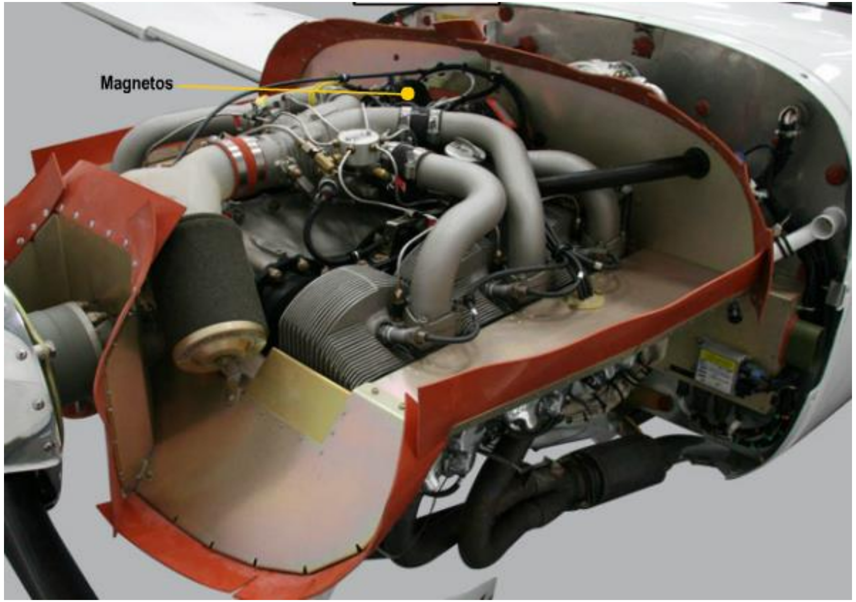
CIRRUS AIRCRAFT



Magnetos

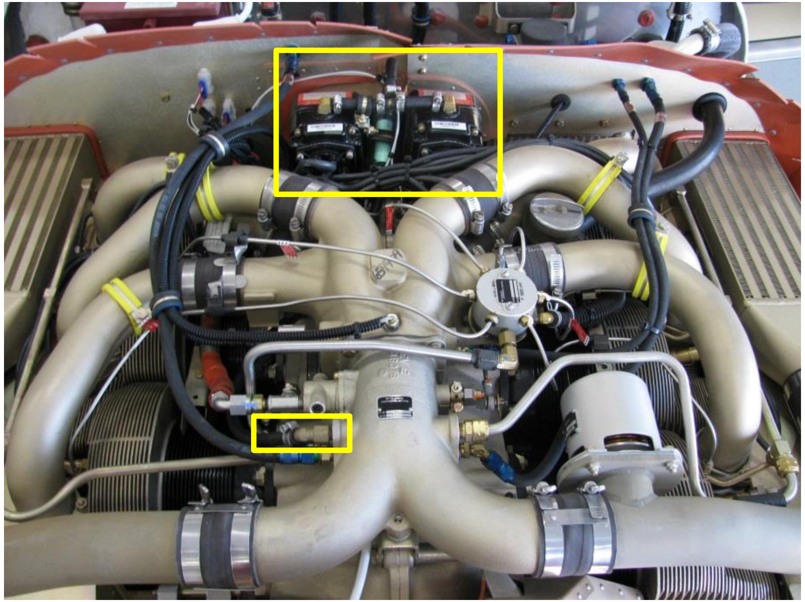
HOW WE CONTROL SPARK / IGNITION

Magnetos

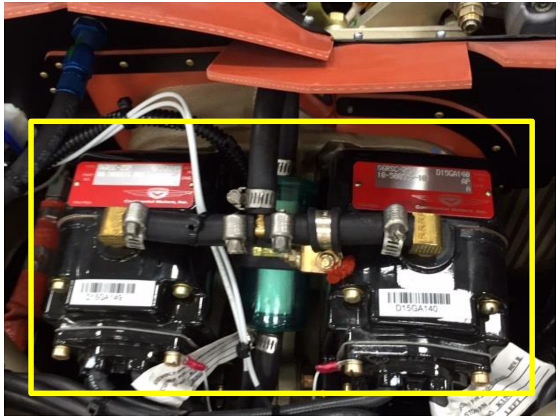


- Dual Magneto System
- Gear driven from the accessory drive
- Provides power to the spark plugs

Magnetos (SR22T)

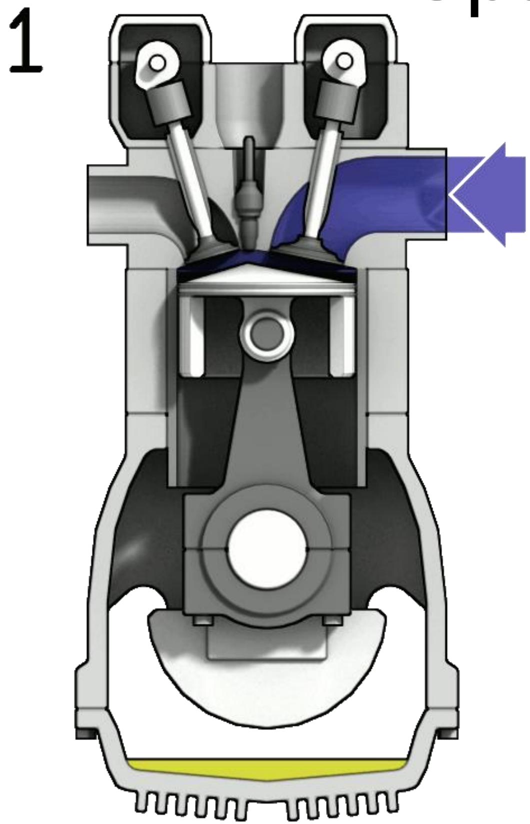


- Dual Magneto System
- Gear driven from the accessory drive
- Provides power to the spark plugs
- Magnetos are pressurized by air from the upper deck
    - Prevents electric arcing within Mag

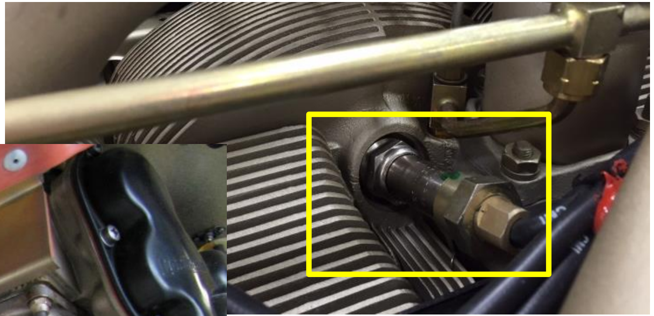


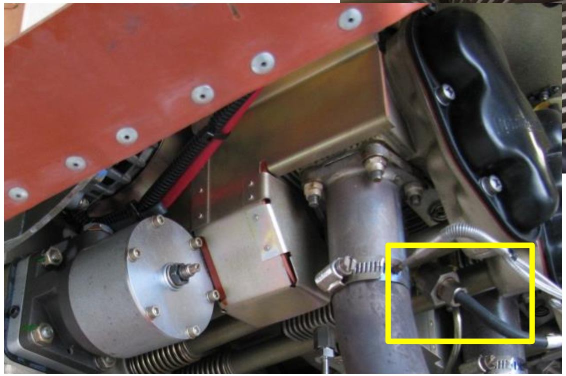
CIRRUS AIRCRAFT

Spark Plugs (SR22T)

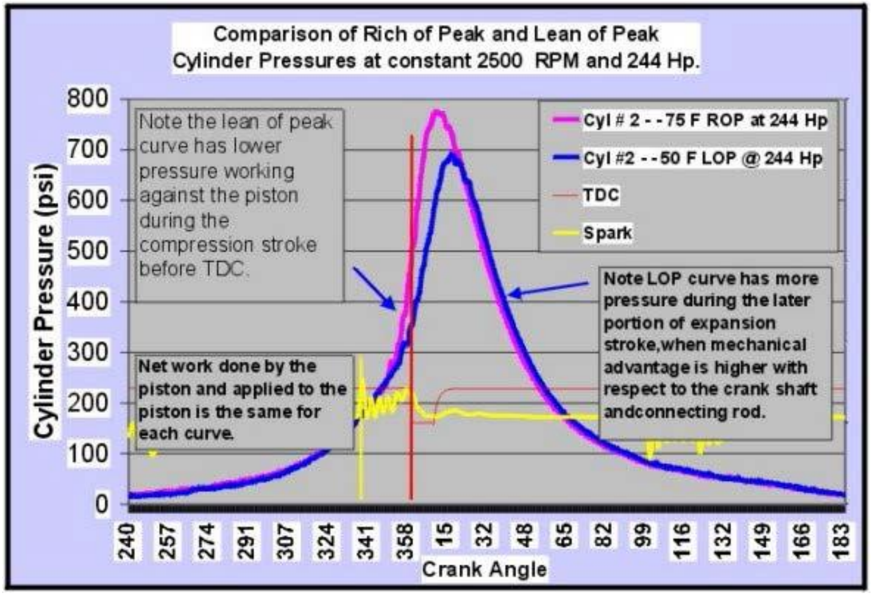


- Create spark/ignition for combustion event
- 2 spark plugs/cylinder
- Spark occurs 24° before piston reaches Top Dead Center (TDC)





Magneto Timing

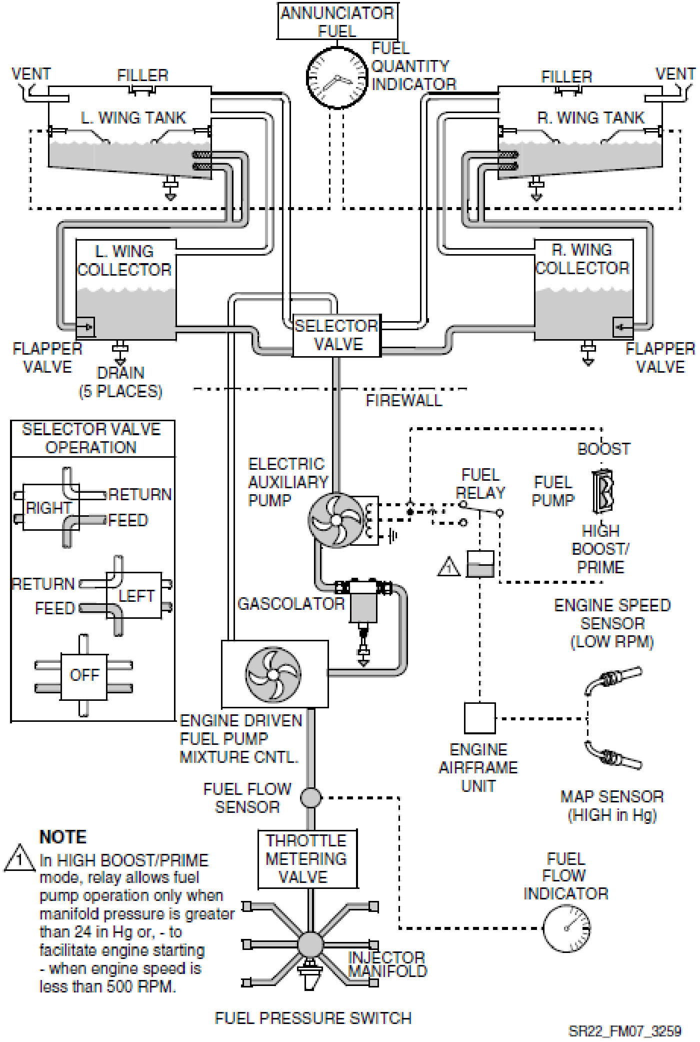


- Advanced Timing Characteristics (Early)
  - Higher than normal CHTs
  - Lower than normal EGTs &TITs
- Retarded Timing Characteristics (Late)
  - Lower than normal CHTs
  - High than normal EGTs & TITs

Mixture Lever

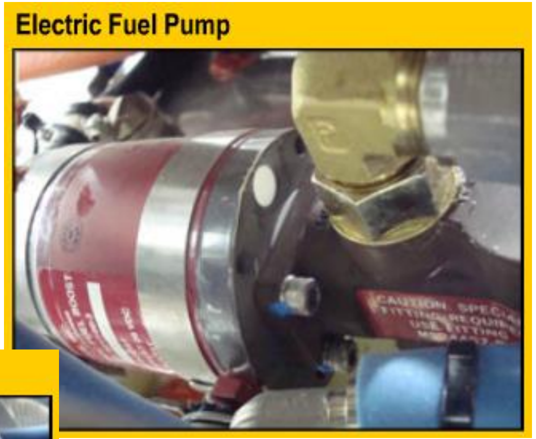
HOW WE CONTROL FUEL

CIRRUS AIRCRAFT



Fuel System

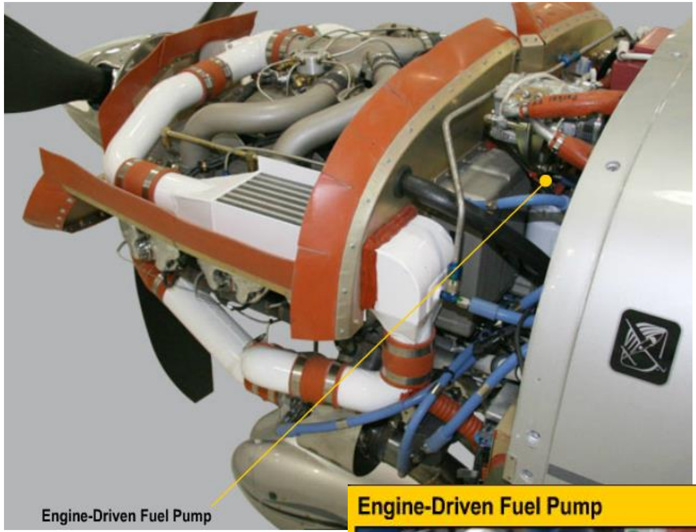
Electric Fuel Pump provides 4 to 6 PSI for vapor suppression

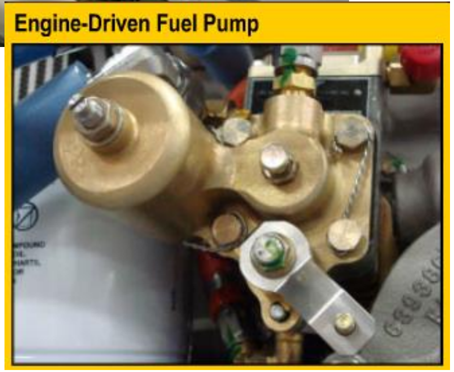


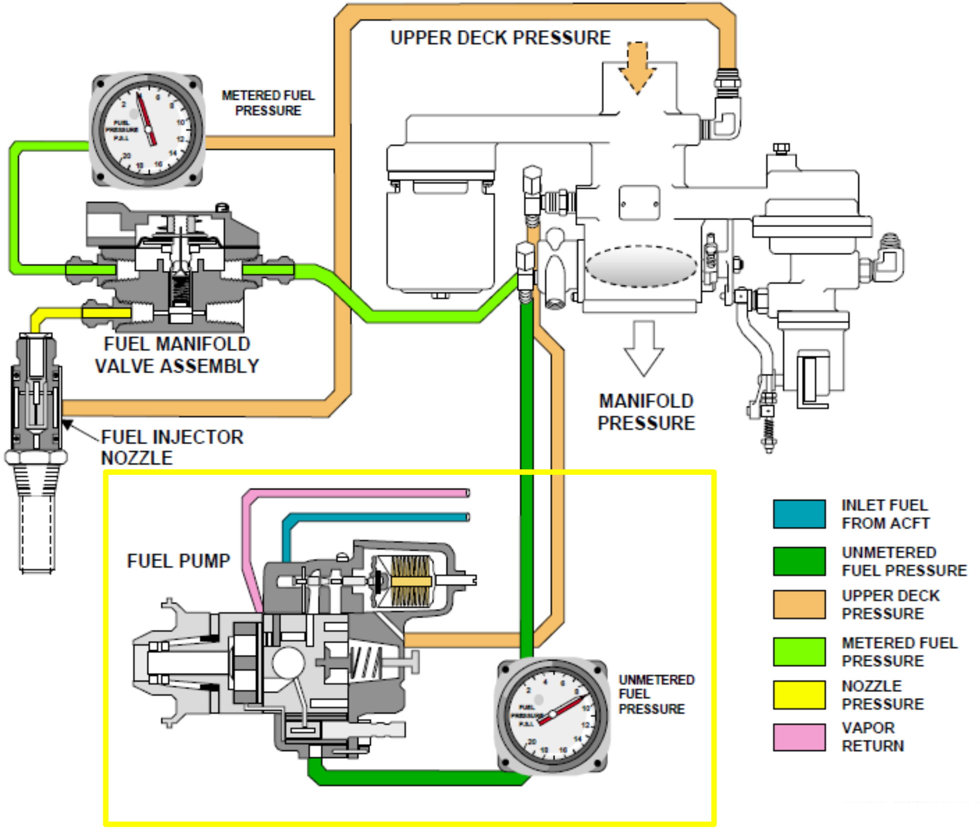
Gascolator filters fuel before entering the engine driven fuel pump

CIRRUS AIRCRAFT

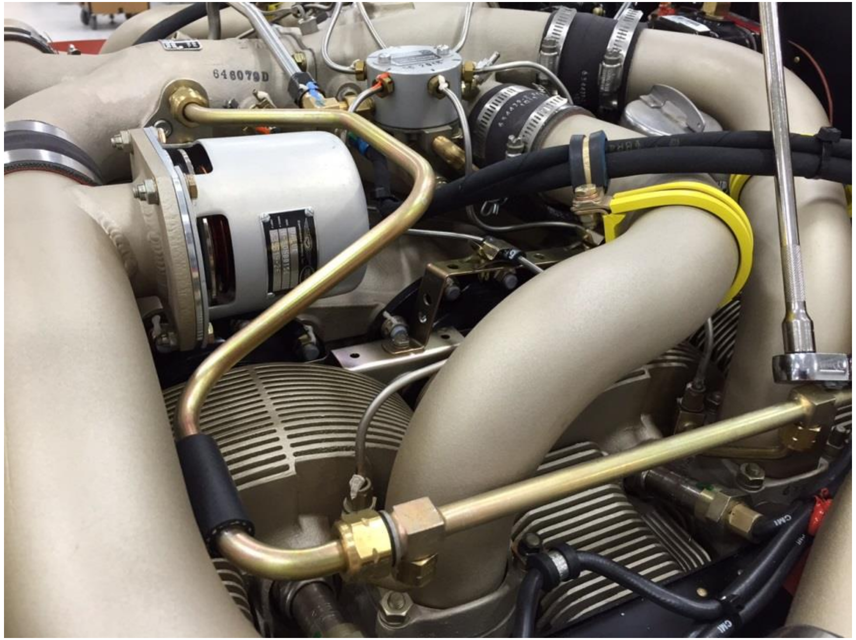
Mixture Lever Controls Fuel/Air Ratio



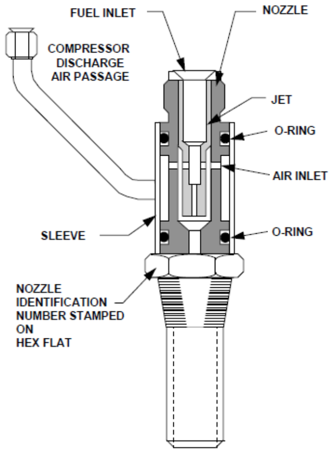


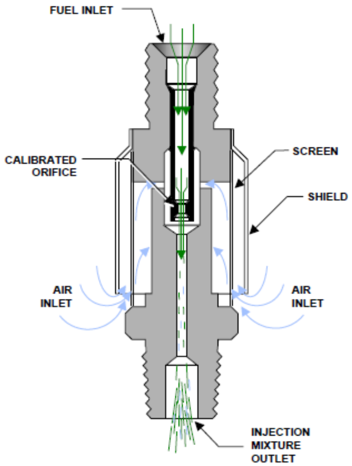


Fuel Injectors



- Pressurized by upper deck air
  - Prevents fuel backflow
- Tuned
  - Specific to each cylinder

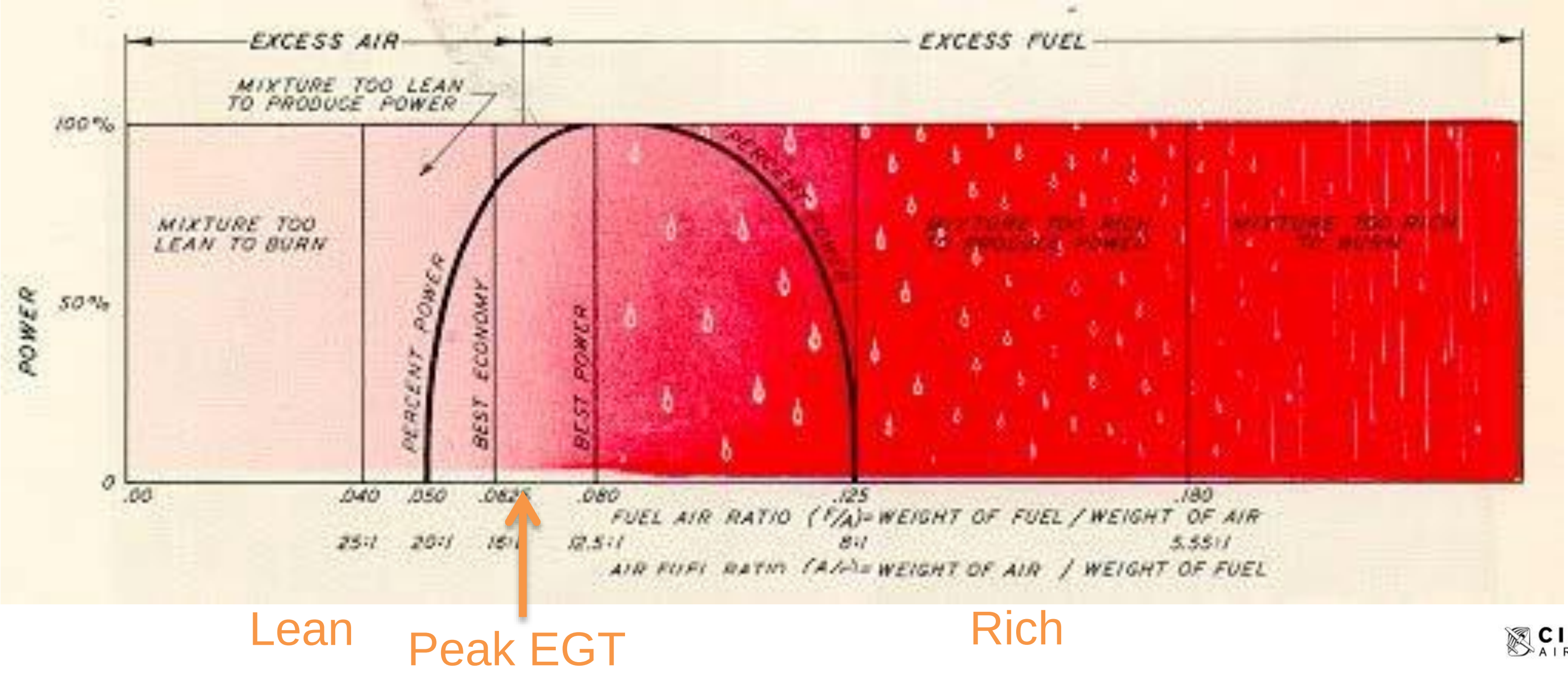




CIRRUS AIRCRAFT

Stoichiometric Ratio

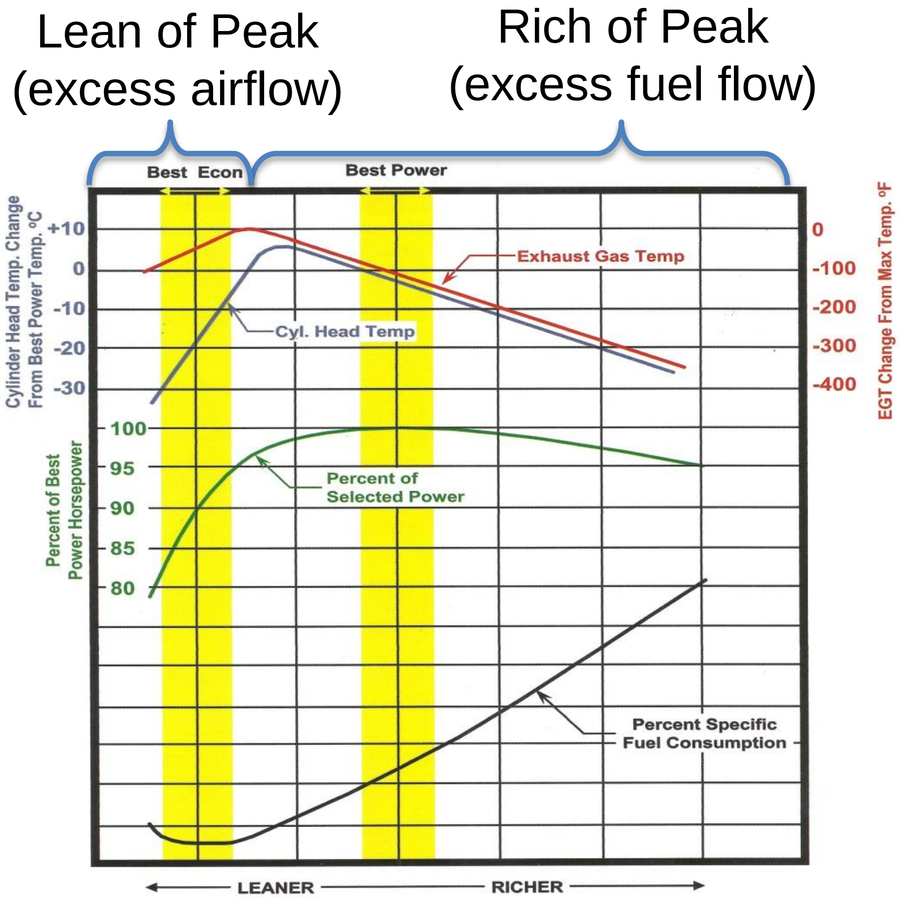
- If exactly enough air is provided to completely burn all of the fuel, the ratio is known as the stoichiometric mixture
- Fuel to Air Ratio – 14.7 lbs Air : 1 lb Fuel
- Too Rich or Too lean can lead to engine roughness or possible combustion failure



CIRRUS AIRCRAFT

Mixture Influence

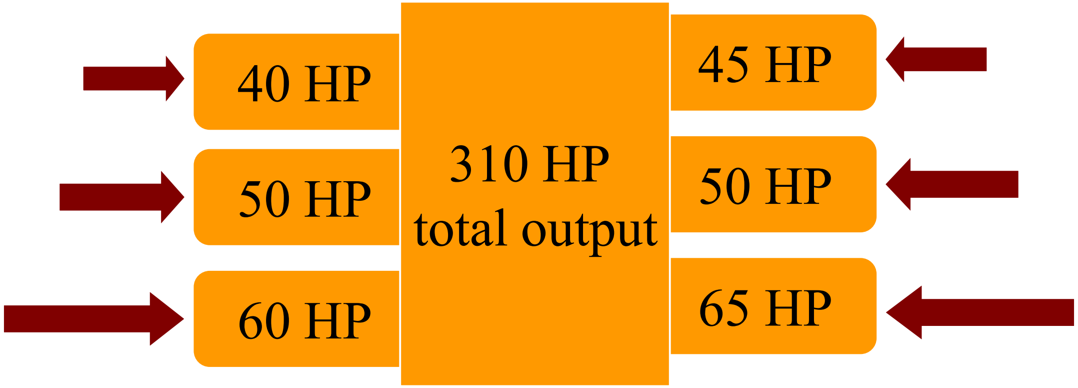
- Peak EGT
  - "Stochiometric mixture"
  - All fuel and oxygen consumed
  - Air:Fuel ratio of 14.7
- Rich of Peak
  - Power limited by oxygen quantity
  - Excess fuel flow (fuel not consumed) provides cooling
  - Rich mixtures will have slight degrade on power
  - Excessively rich will flood engine (large power degrade, roughness or flameout)
- Lean of Peak
  - Power limited by fuel quantity
  - Excess airflow (oxygen not completely consumed) provides cooling
  - Excessively lean → lean misfire



Engine Roughness at Lean of Peak

- Caused by unbalanced fuel/air ratios
- More apparent during lean of peak operations
- Why?
  - Remember the HP curve in relation the fuel/air ratios

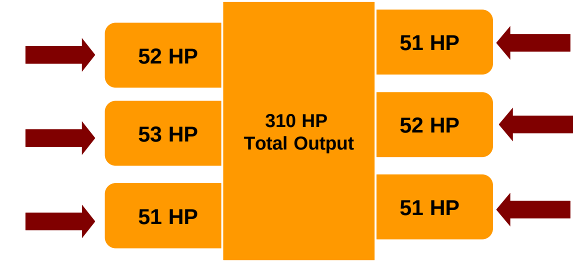
Unbalanced Injectors



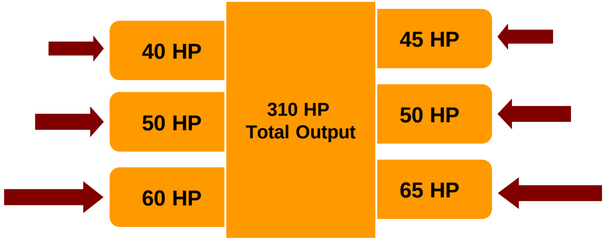
Unbalanced Fuel/Air Ratios

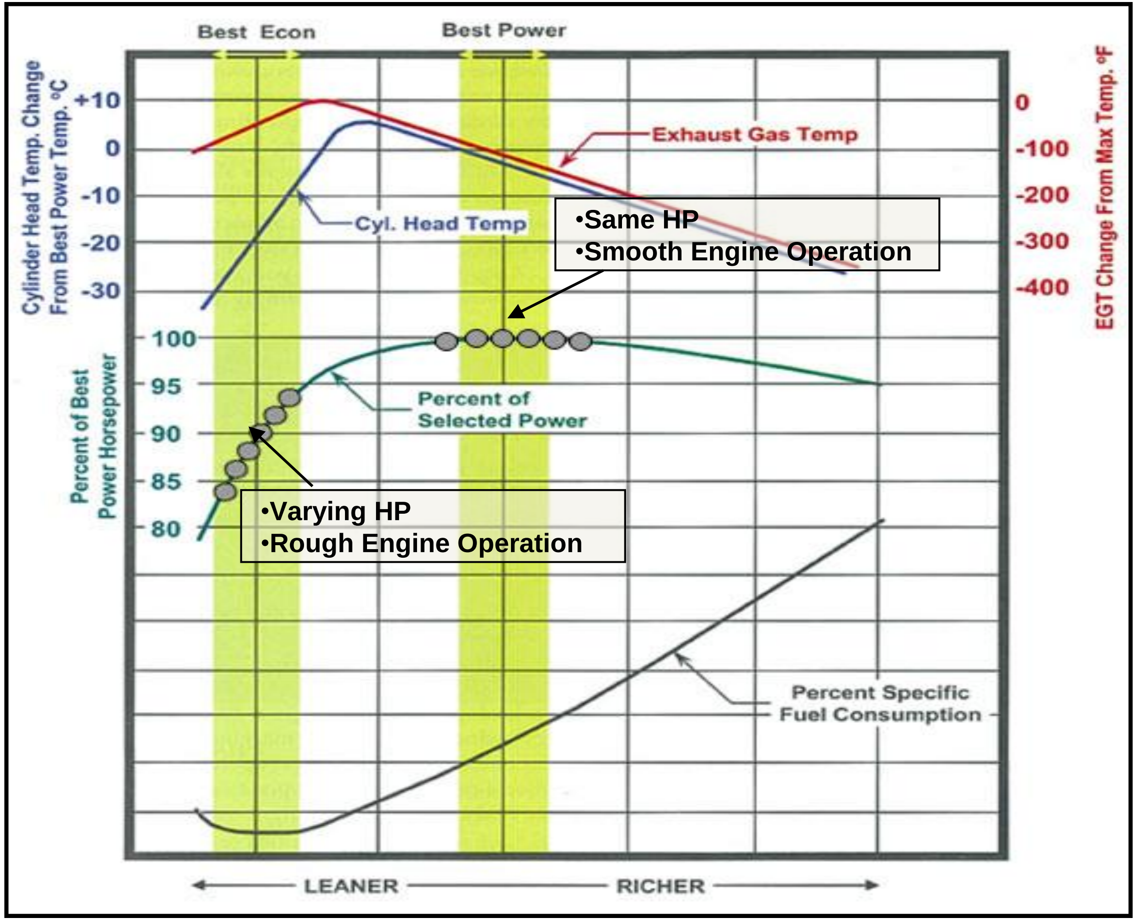
- Some cylinders receive more fuel than others
  - ROP, Same HP / Smooth
  - LOP, Varying HP / Rough

Unbalanced Injectors ROP

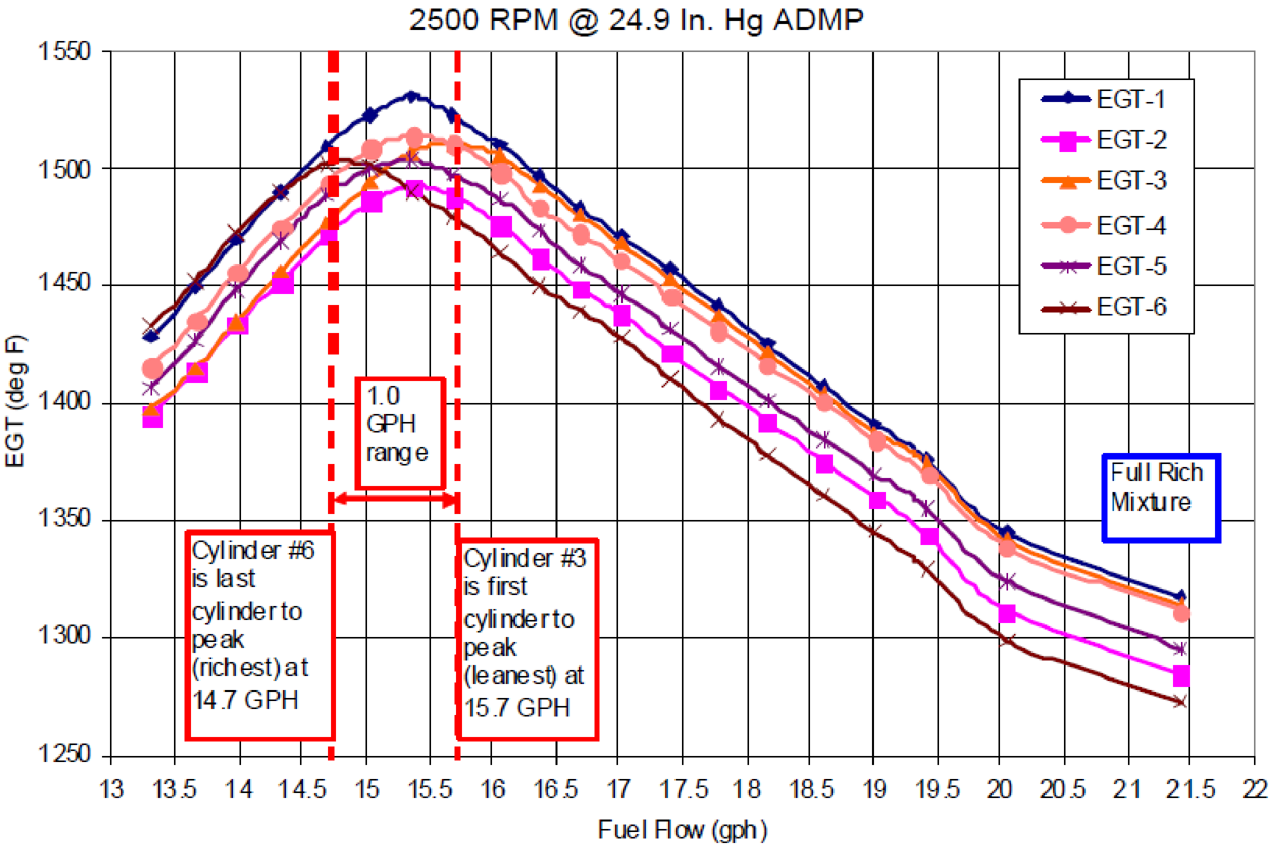


Unbalanced Injectors LOP



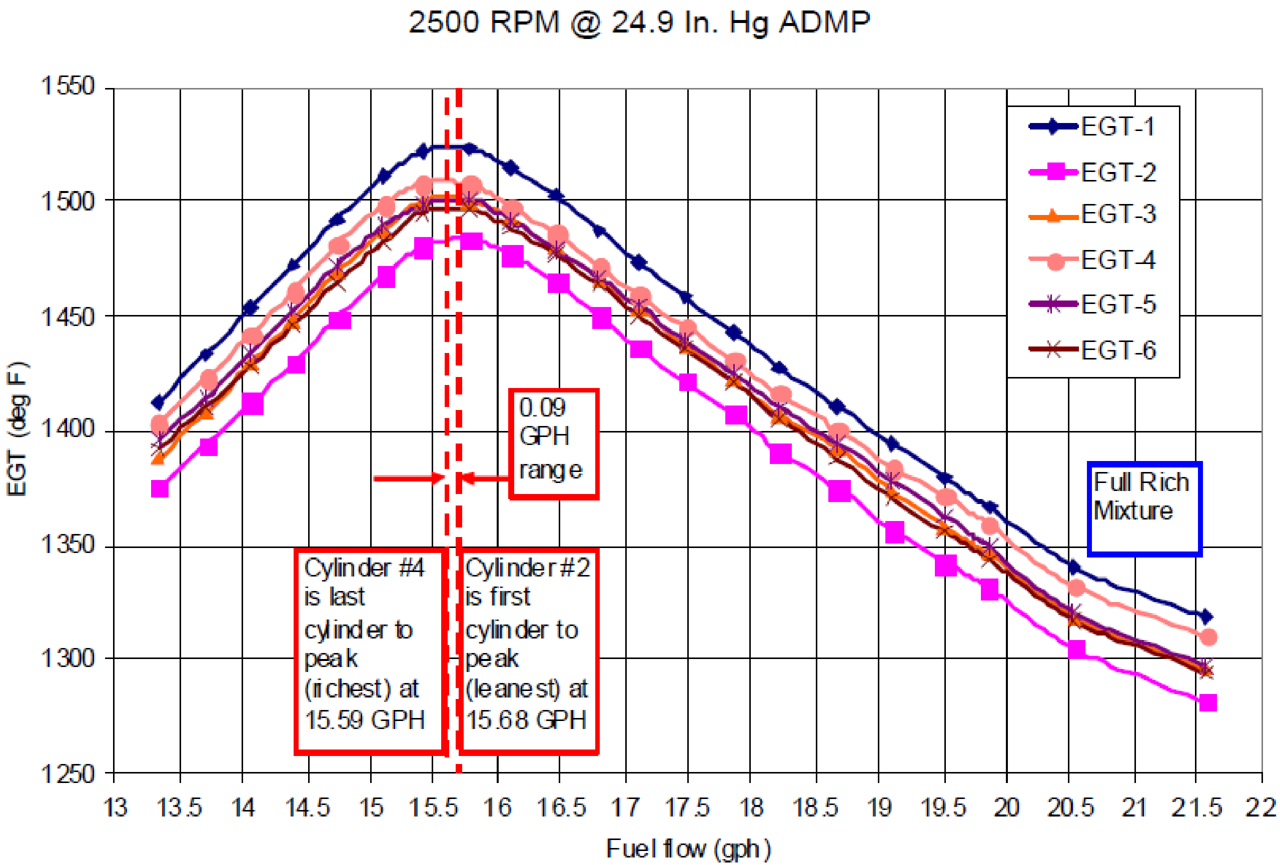


Unbalanced Fuel/Air Ratios



CIRRUS AIRCRAFT

Balanced Fuel/Air Ratios

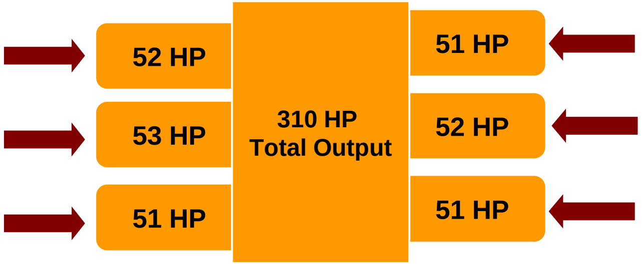


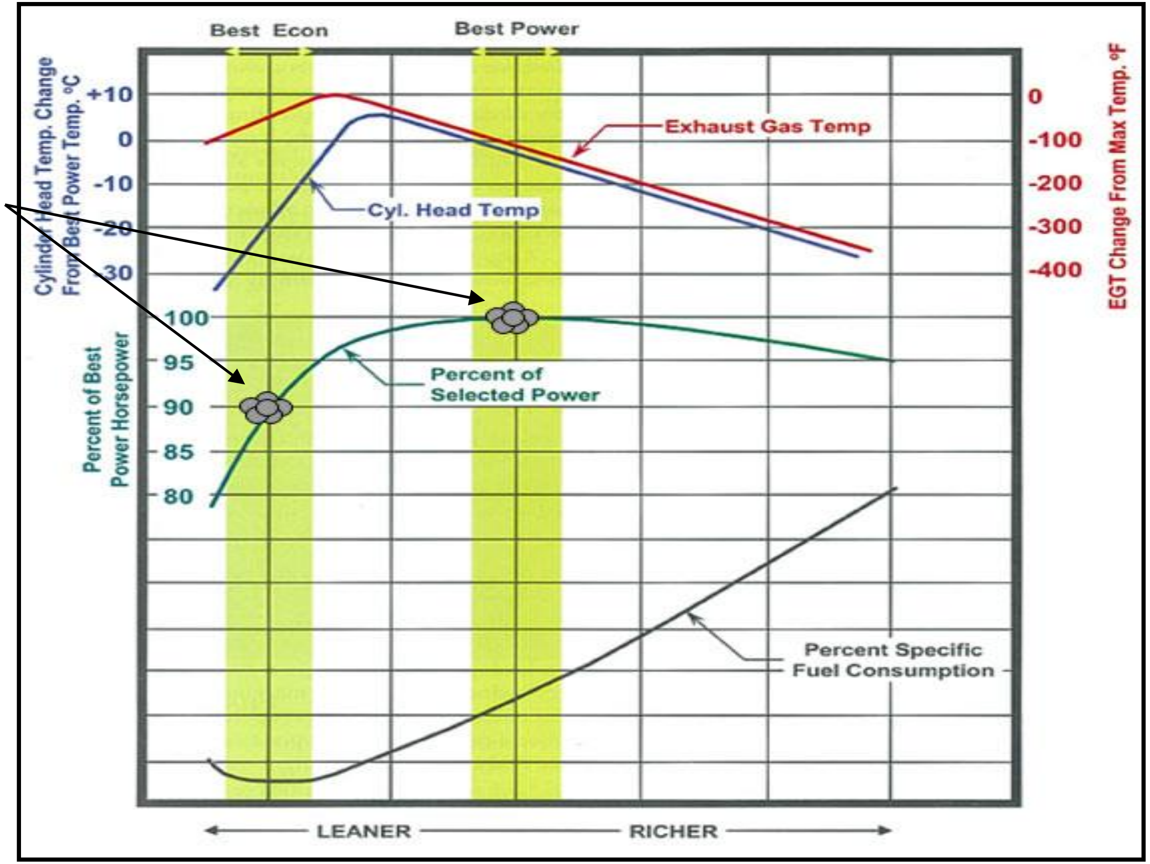
CIRRUS AIRCRAFT

Balanced Fuel/Air Ratios

- Each cylinder receiving same amount of fuel and air
- All cylinders developing equal HP even on steep LOP curve

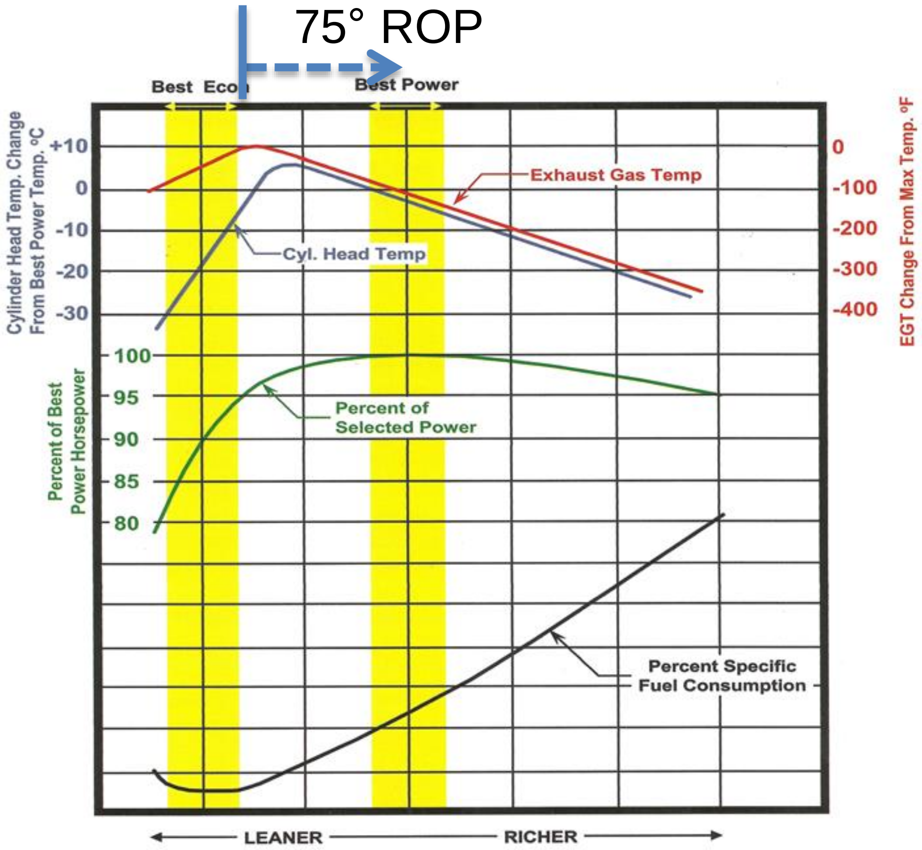
Balanced Injectors LOP & ROP





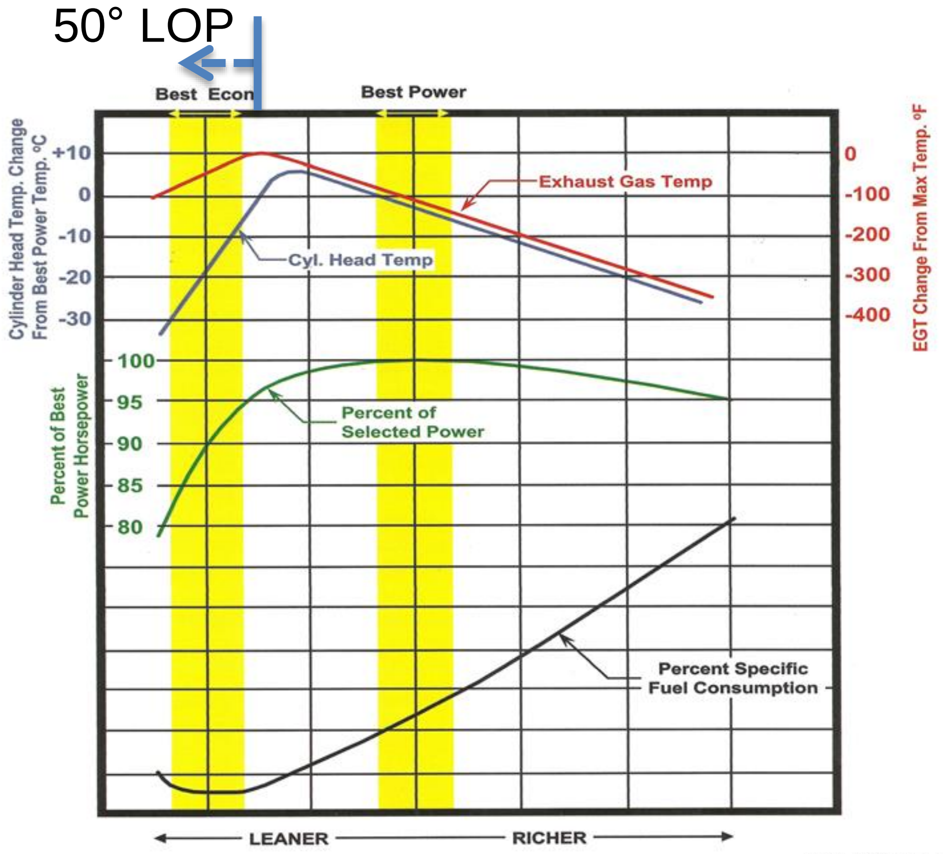
Best Power

- Set EGT 75° Rich of Peak (ROP) EGT
- Enriching mixture decreases CHTS when ROP



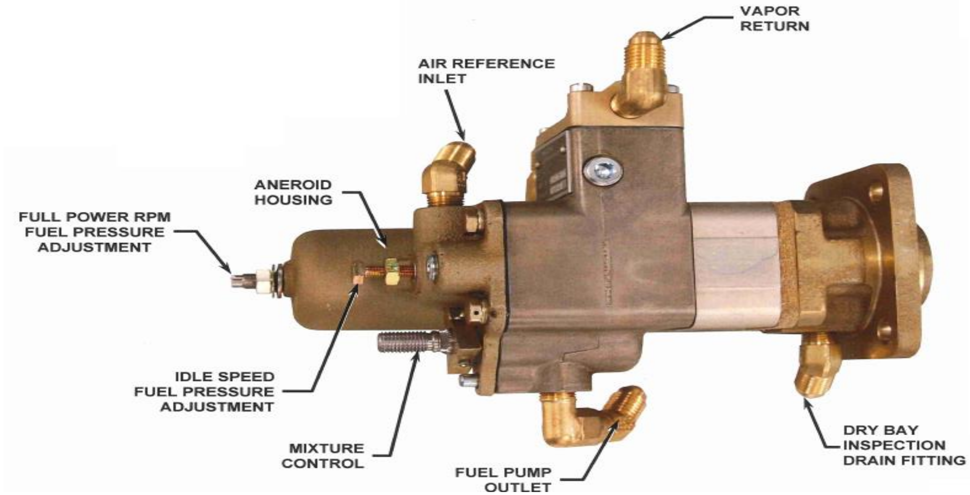
Best Economy

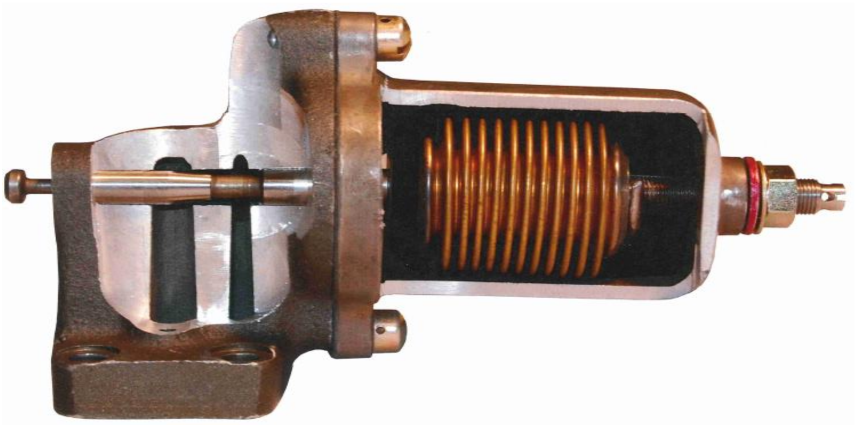
- Set EGT 50° lean of peak (LOP) EGT
- Power should be at 65 % or less when operating LOP
- Leaning mixture decreases CHTs when LOP



SR20 Unique Features

- Altitude Compensating Fuel Pump
  - Pressure sensing aneroid referenced to ambient (cowl) pressure
  - As altitude increased, ambient pressure drops and results in “auto-leaned” mixture
  - Normally alleviates need to lean mixture in full rich/full power

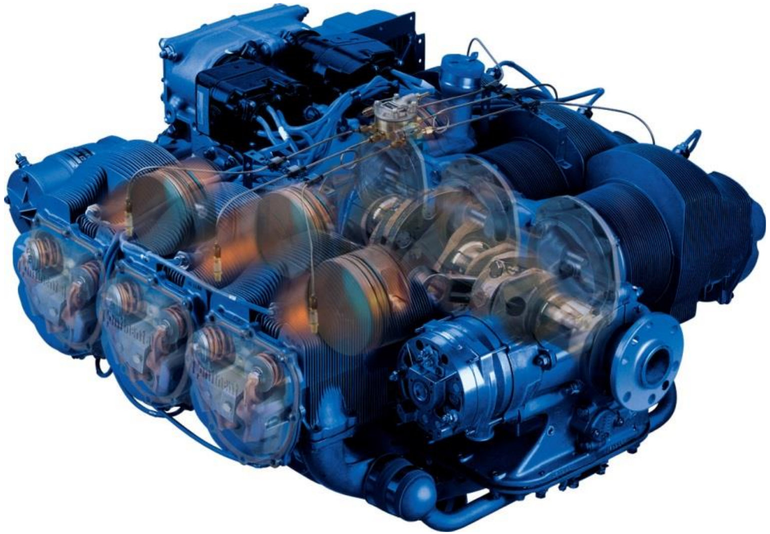




Normal Operations

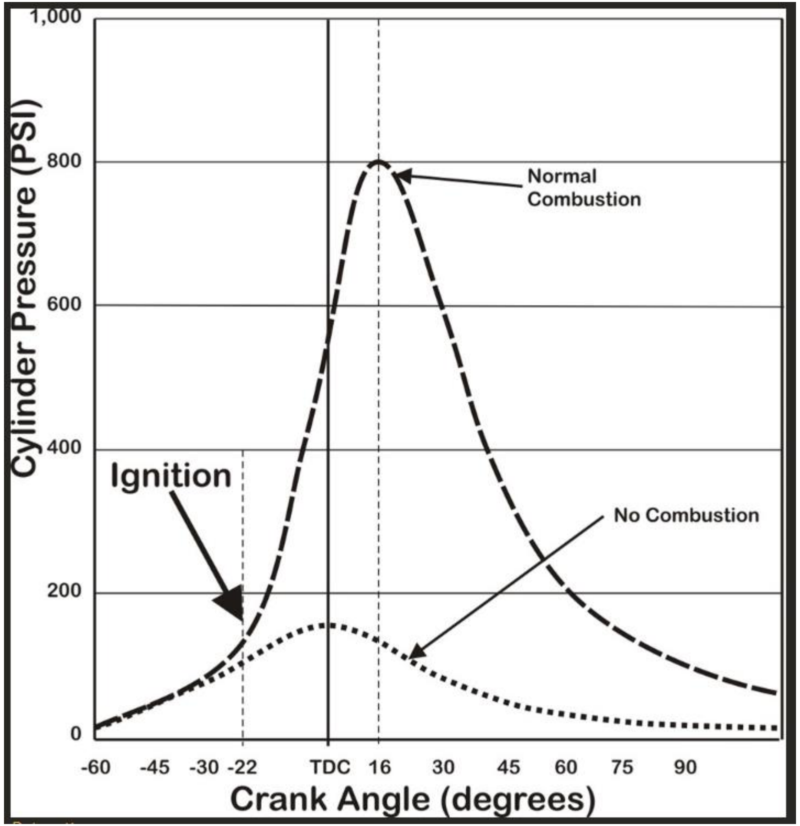
Continental Engine Certification

- The engine is certified to 14 CFR 33 (Code of Federal Regulations)
  - Extensive requirements for Detonation
  - Every approved power setting has a minimum 12% detonation margin
- What has CMI proven via testing
  - Cylinders can survive continuous operation at hot and high power settings
  - Engine parts remain “within service limits”
  - The FAA will approve 4X the test period as TBO
  - It is tested in very abusive conditions 103°F inlet air/240°F oil temp/460°F CHT
  - High power LOP may not have adequate (12%) Detonation Margin



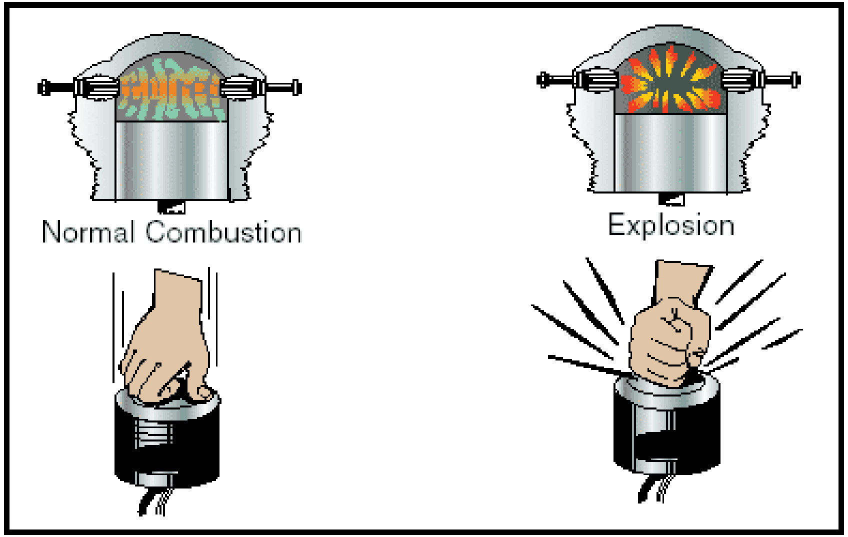
CIRRUS AIRCRAFT

Normal Combustion



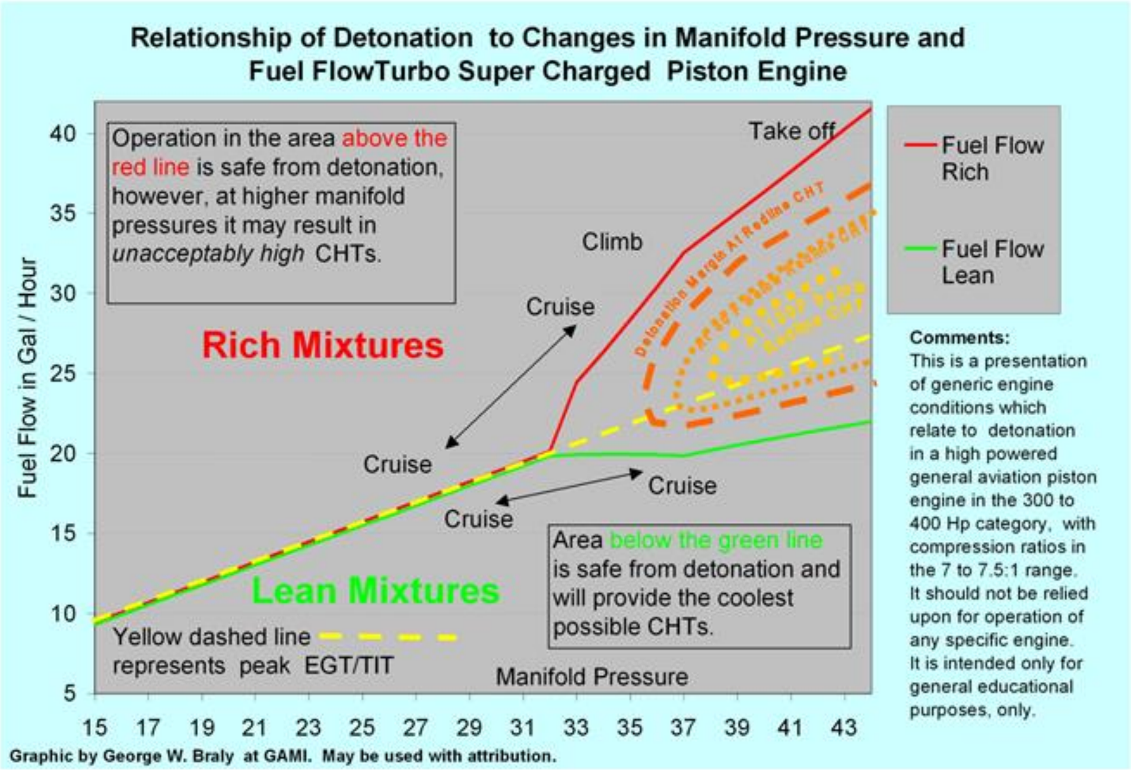
Detonation

- Detonation - Occurs when combustion of the air/fuel mixture in the cylinder does not start off correctly in response to ignition by the spark plug, but one or more pockets of air/fuel mixture explode outside the envelope of the normal combustion front
- If allowed to persist engine damage is likely

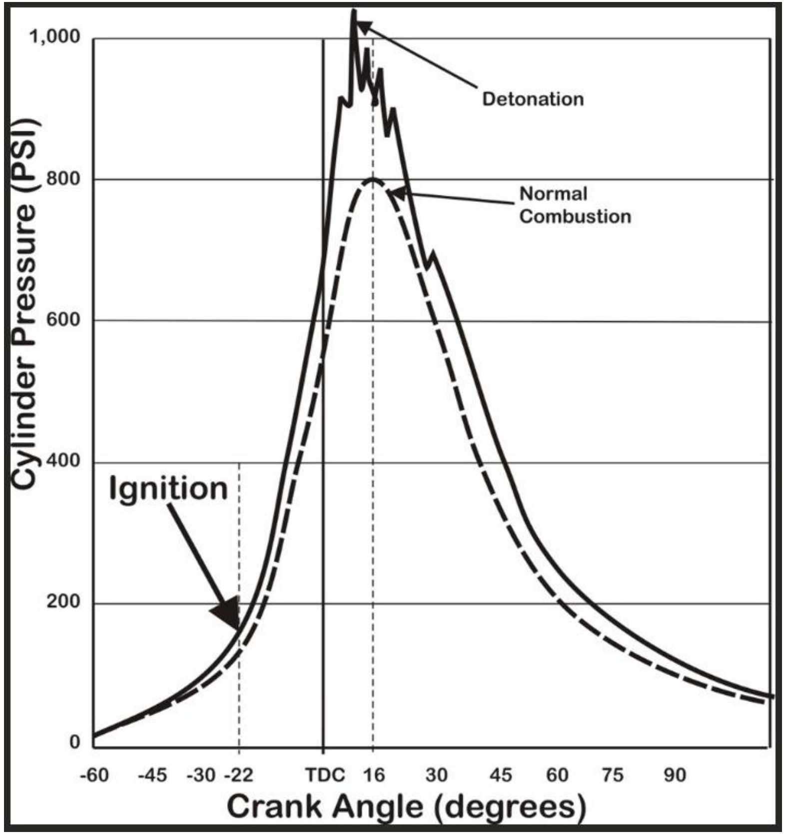


Detonation

- During engine certification, with CHT at 460°F and manifold Air temp > 120°F (obstructions on intercoolers) detonation was observed at 31.5” Manifold Pressure

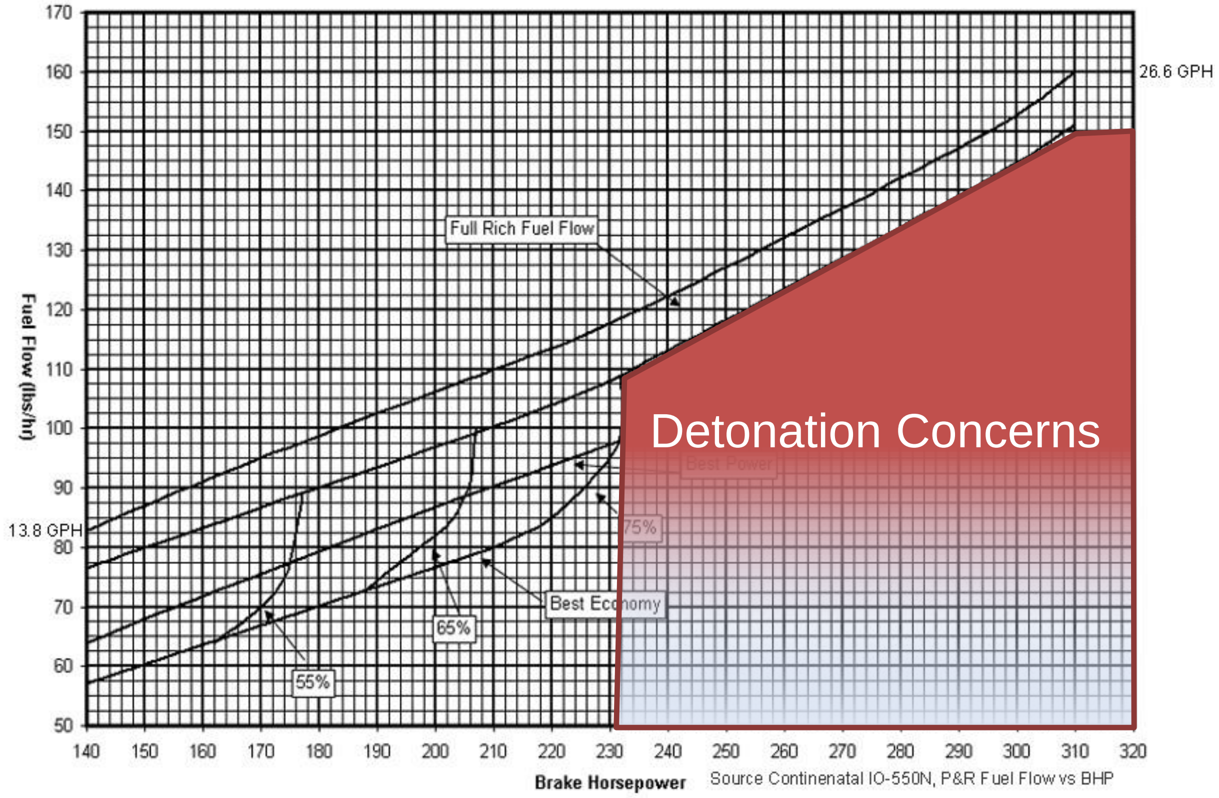


Detonation



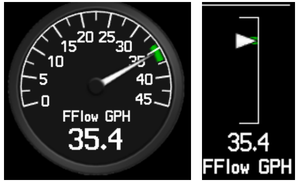
1,000
800
600
400
200
0
Cylinder Pressure (PSI)
Detonation
Normal
Combustion
Ignition
-60
-45
-30
-22
TDC
16
30
45
60
75
90
Crank Angle (degrees)

Continental Certification Data IO-550N

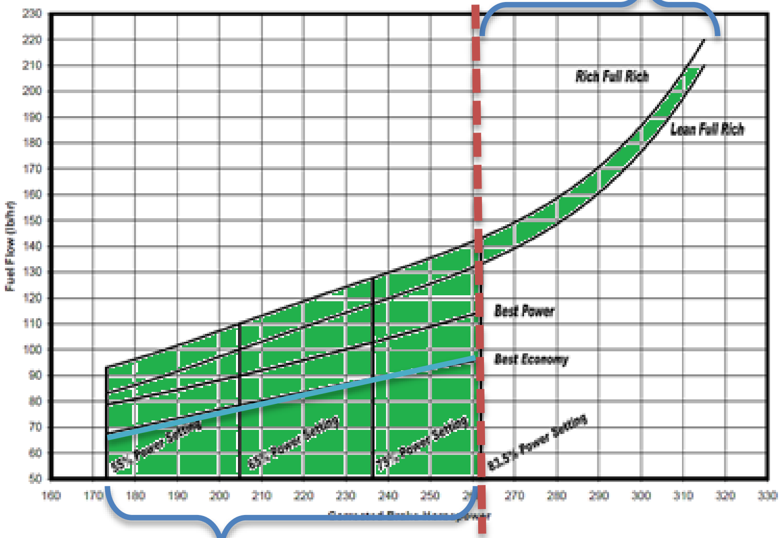


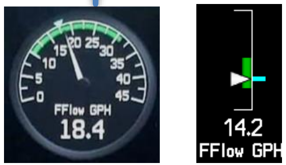
SR22T Leaning Limitations

- Leaning Prohibited if MAP > 30.5”
  - Detonation Margin
- Indicate by Green Arc
  - Reduced if MAP > 30.7”
  - Wide if MAP ≤ 30.7”



30.7”





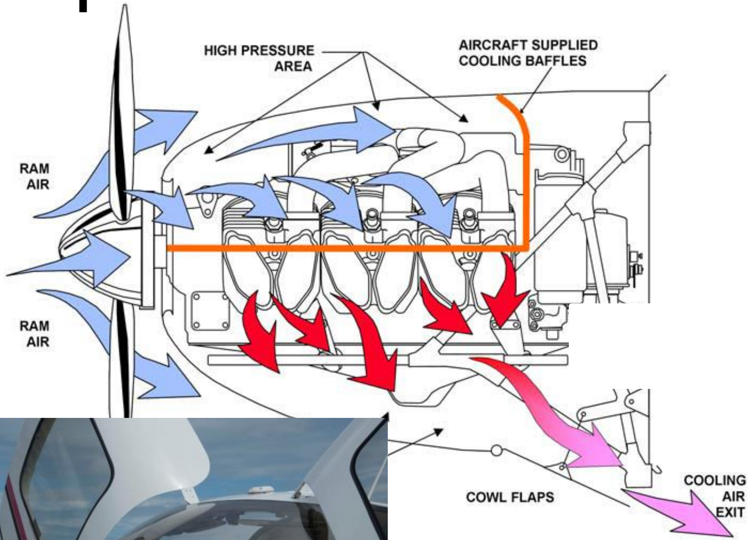
CIRRUS AIRCRAFT

Normal Start (Cold)

- Used for first start of the day or when engine (oil temps or CHTs) have cooled to ambient air temperatures

Hot Weather Tips

- Point the aircraft into the wind to increase airflow / cooling
- Open the oil door to allow hot air to escape
  - Be sure to verify secure/closed before engine start



Hot Start (SR 20)

- Used when engine temperature is above ambient air temperature
- No priming required for hot starts
- Limit starter engagement to 10 seconds
  - Let cool for 20 seconds

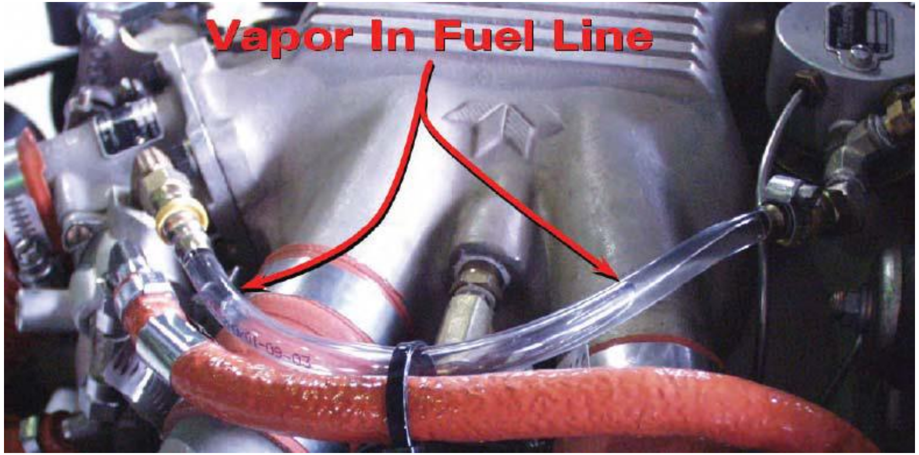
Hot Start SR22/SR22T

- Used when engine temperature is above ambient air temperature
- No priming required for hot starts
- Limit starter engagement to 10 seconds
  - Let cool for 20 seconds

CIRRUS AIRCRAFT

Hot Start

- Liquid fuel may begin to expand and vaporize in hot weather conditions
- Clearing the fuel lines of this vapor will be necessary prior to starting



Flooded Start

- Used if engine is expected to be flooded or if normal (hot) start was unsuccessful
- Weak intermittent firing followed by puffs of black smoke from the exhaust stack indicates over-priming or flooding.

Taxi

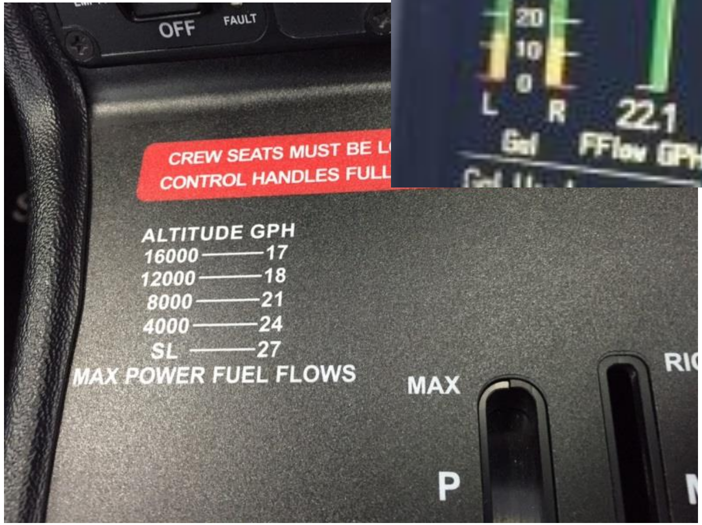
- Leaning during Taxi will help to reduce the likelihood of sparkplug fouling
- Lean to the “X” in Mixture or until Maximum RPM rise is achieved

Takeoff (SR20)

- Verify Mixture set to full rich
  - Altitude compensating fuel pump
- Increase Throttle to Full
  - Advance smoothly over 4-5 seconds from idle to full power
- EGTs approximately 1200° - 1300°

Takeoff (SR22)

- Increase Throttle to Full
  - Advance smoothly over 4-5 seconds from idle to full power
- Mixture
  - <4000 ft PA Full Rich
  - >4000ft PA lean to top of green arc or placard



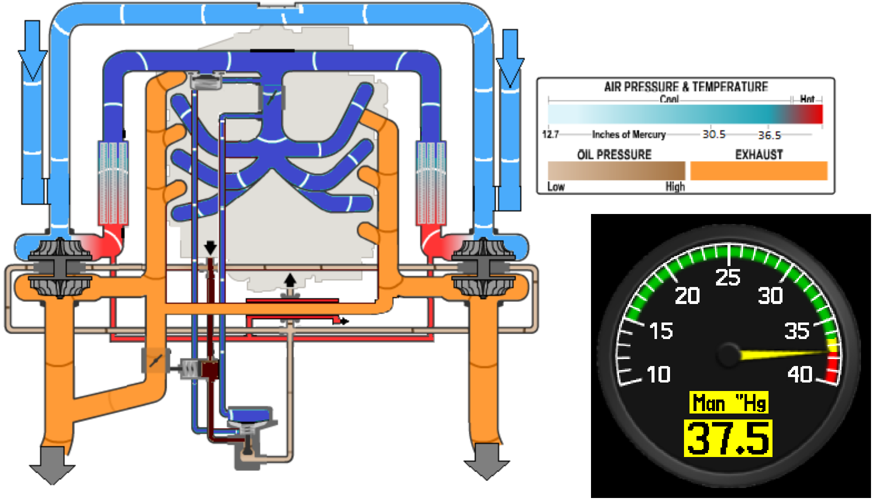
CIRRUS AIRCRAFT

Takeoff (SR22T)

- Full throttle
- Full mixture (for every altitude)
- Boost pump on
- Monitor MP for overboost
  - If the MP exceeds 37.0 inches reduce the throttle below 37.0 inches of MP
  - Due to cooler oil temperatures
- Monitor Fuel Flow (Green Arc)
  - Will increase in proportion to manifold pressure

Cold Weather Takeoff

- Pressure in the oil line to the wastegates may increase more than normal if the engine oil is not properly warmed before takeoff
- The wastegate may close prematurely causing higher upperdeck pressures than desired
- The pilot should reduce the power lever until MAP is below 37”
- The pilot should increase throttle as the oil warms during the climb



Climb (SR20)

- Throttle
  - Full
- Mixture
  - Rich
- Boost Pump
  - Off
- Cruise Climb Speed
  - 100 – 110 KIAS / 5 – 10 knots above Vy
  - Reduces CHTs
  - Note CHT Trends
    - Rising or Falling?
- Hot Weather Considerations
  - Air conditioner OFF
    - Increases climb rate by 75 FPM
  - Boost pump On
    - Vapor suppression for warm or hot fuel
    - Increases fuel flow slightly for increased cooling

CIRRUS AIRCRAFT

Climb (SR22)

- Throttle
  - Full
- Mixture
  - Lean to top of green fuel flow arc
- Boost Pump
  - On
    - Provides vapor suppression for hot fuel
- Cruise Climb Speed
    - 110 – 120 KIAS
    - Increase airflow / monitor CHTs
    - Note CHT Trends
      - Rising or Falling?
- Hot Weather Considerations
  - Use slightly richer mixtures than placarded for increased cooling

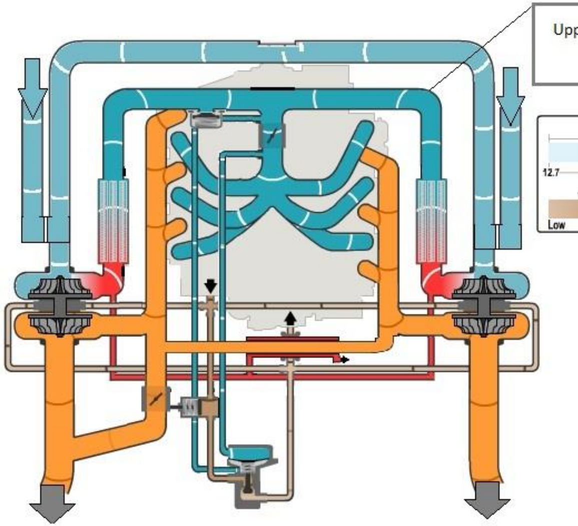
Rich of Peak (ROP) Climb (SR22T)

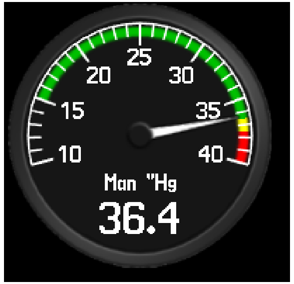
- Full Power Climb: Rich of Peak Technique
  - Power Lever – Full Forward
  - Mixture – Maintain Fuel Flow w/in Green Arc
  - CHT – Maintain below 420° F
    - Airspeed 120-130

CIRRUS AIRCRAFT

Take-Off

- Turbos boost Manifold pressure to ~36.5”
- Upper deck pressure regulated to ~36.5” by the slope controller

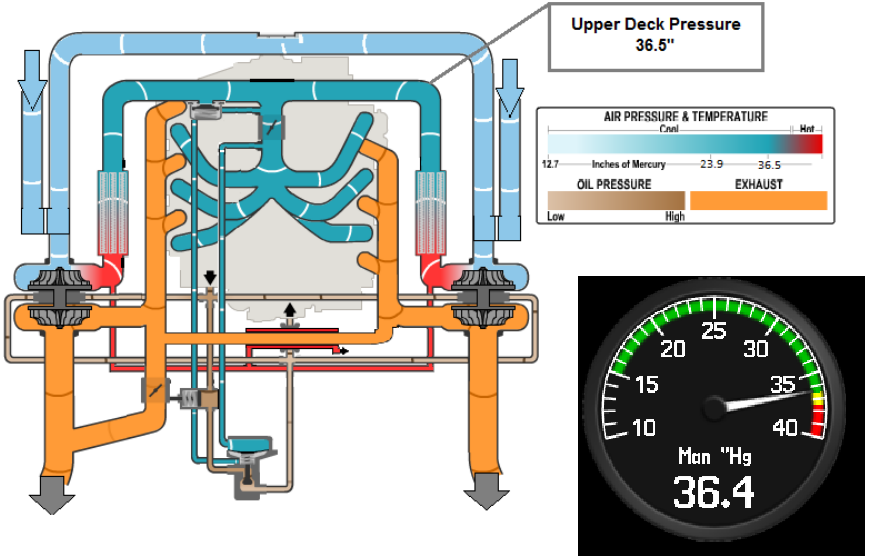




Initial Takeoff/ Full Power

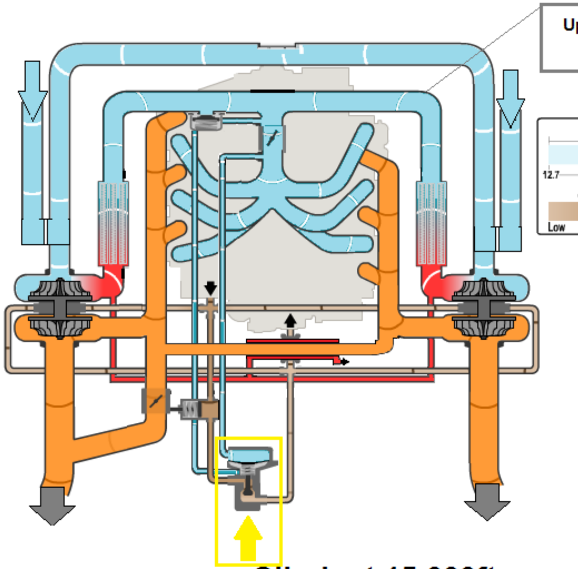
Climb

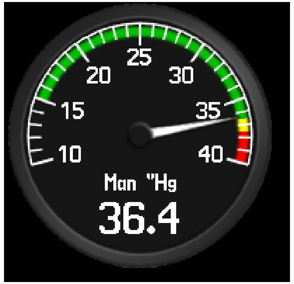
- Outside air pressure will begin to decrease
- Manifold pressure would normally start to decrease as well, resulting in a loss of engine power



Climb

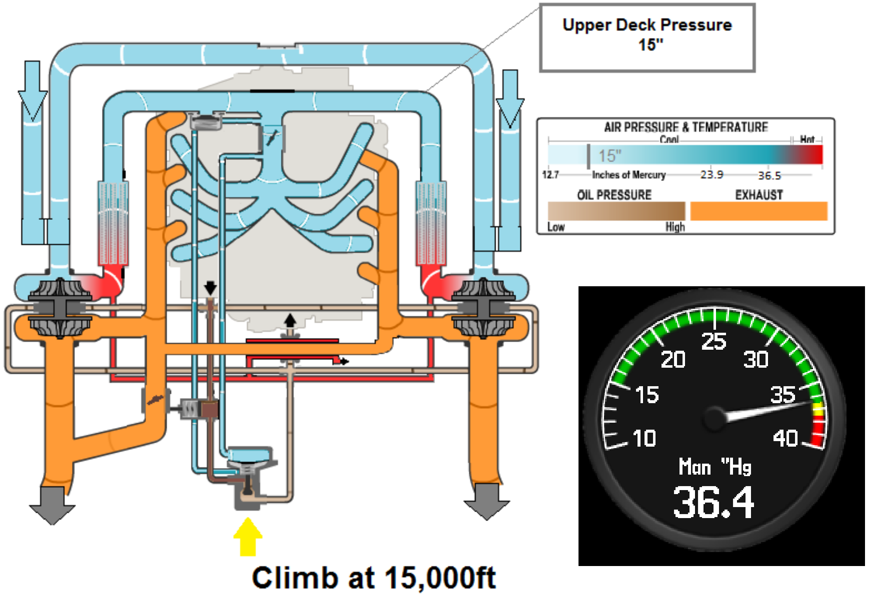
- Slope Controller
  - The aneroid in the slope controller contracts with loss of manifold pressure





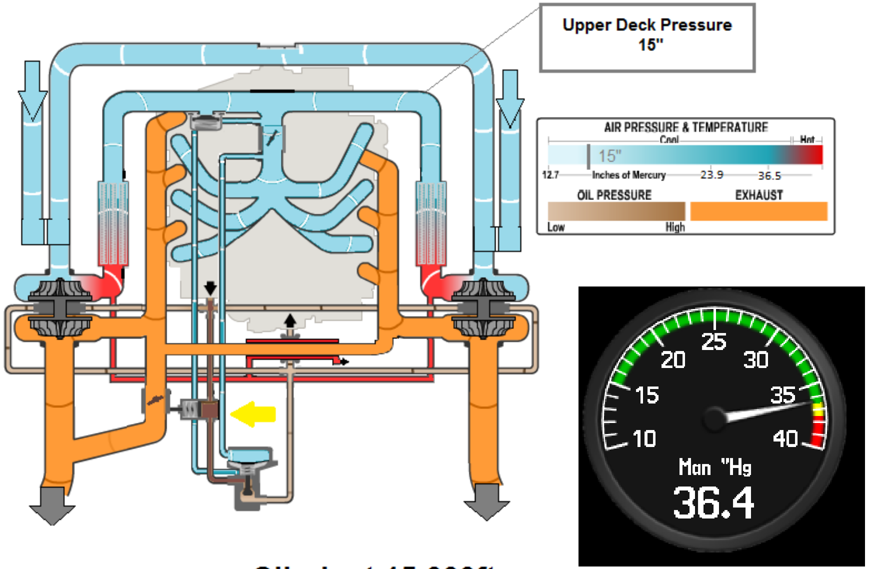
Climb

- Slope Controller
  - The poppet closes restricting oil flow, building pressure in engine oil line to the wastegate



Climb

- The increased pressure in the oil line pushes against the waste gate spring closing the wastegate as needed

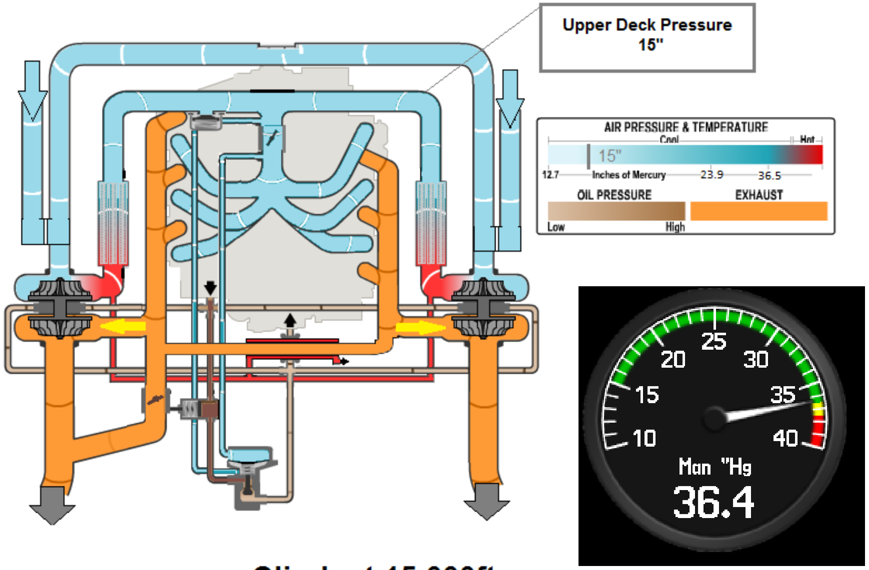


Climb at 15,000ft

CIRRUS AIRCRAFT

Climb

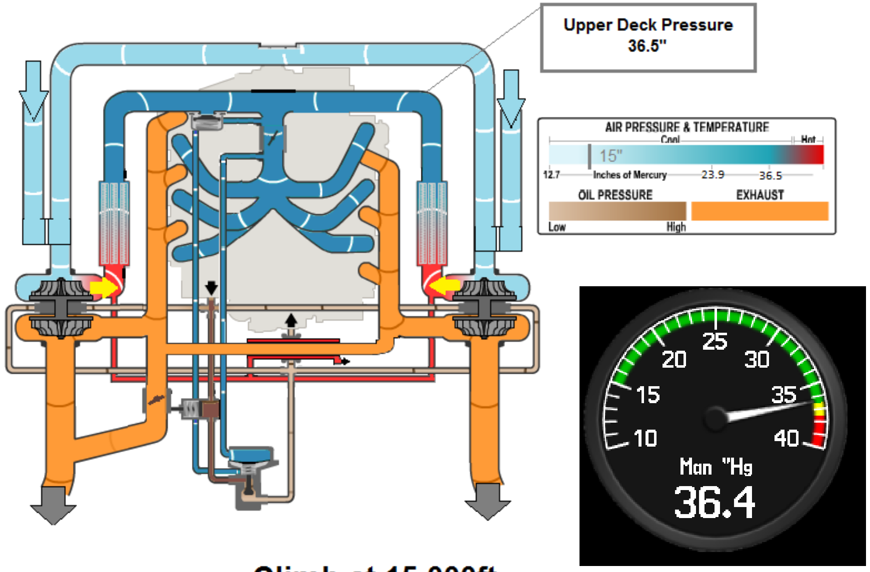
- As the wastegates close less exhaust air is allowed past the waste gates and more air directed through the turbos
- This increase in airflow through the turbos increase the turbo's RPM



Climb at 15,000ft

Climb

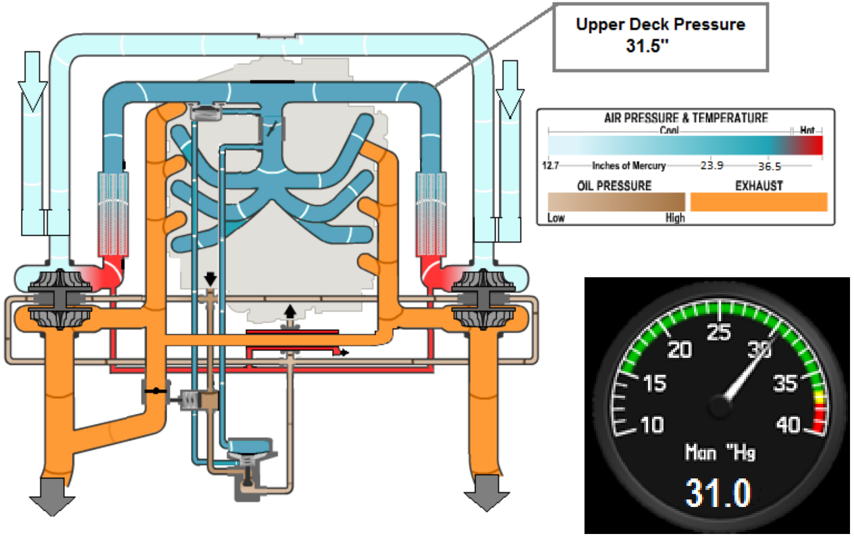
- When the turbo’s RPMs increase the compressor will also start to spin faster
- An increase in compressor RPMs will result in an increase in the Upper Deck manifold pressure
- The upper deck manifold pressure will be regulated to maintain 36.5” up to about 18,000ft (critical altitude)



Climb at 15,000ft

Climb to 25,000ft

- Wastegates will be fully closed above 19,000ft (Critical Altitude)
- All possible exhaust gas is directed through the turbos
- As you climb above the critical altitude intake manifold pressure will begin to decrease
- Engine should still be able to maintain 31” MAP and 85% power at 25,000 ft



Climb to 25,000ft/Full Throttle

Lean of Peak (LOP) Climb (SR22T)

- Cruise Climb: Lean of Peak Technique
  - Power Lever – 30.5” MAP
  - Mixture – Cyan Target or less
    - FF Target will bias if CHT > 390 or Manifold air inlet temp increases above 85°F
  - CHT – Maintain below 420 ° F
    - Airspeed 120-130
    - Lean as required to maintain <420 ° F
      - If unable use Full Power Climb

Full Power Climb vs. Lean of Peak Climbs

Cruise Altitude (MSL)	Fuel Savings LOP (Gallons)	Range Increase LOP (NM)
2,000	.4	4
4,000	.7	8
6,000	1	13
8,000	1.4	17
10,000	1.8	23
12,000	2.1	27
14,000	2.5	33
16,000	2.9	38
18,000	3.3	44
20,000	3.6	52
22,000	4.2	59
24,000	4.7	67
25,000	5.1	71

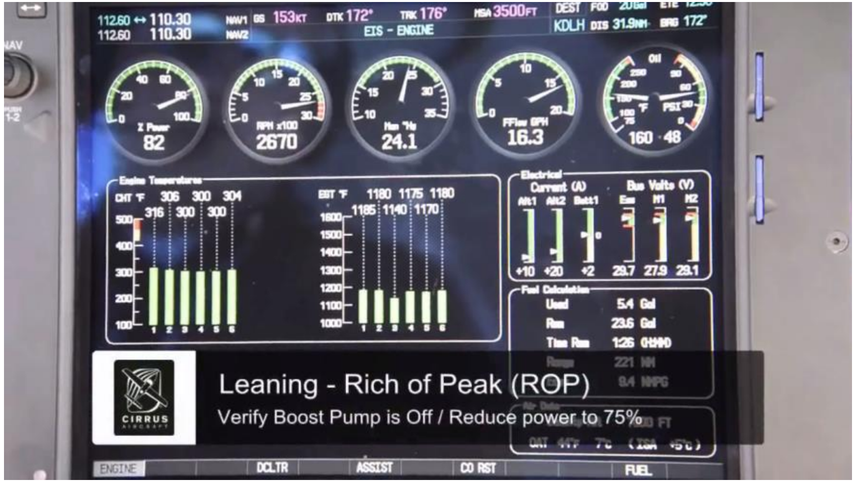
Full Power Climb vs. Lean of Peak Climb

Consider the following factors when deciding to climb LOP or ROP

- Workload associated with LOP climbs
  - Closely monitor CHT’s
  - Adjusting mixture/airspeed for cooling
- Decrease in climb performance
- Significance of fuel savings
- Significance of extra range

Best Power Cruise – Rich of Peak (ROP)

- Reduce power to 75% or less
- Verify boost is off
  - Unless required for vapor suppression
- Set EGT to 75° ROP

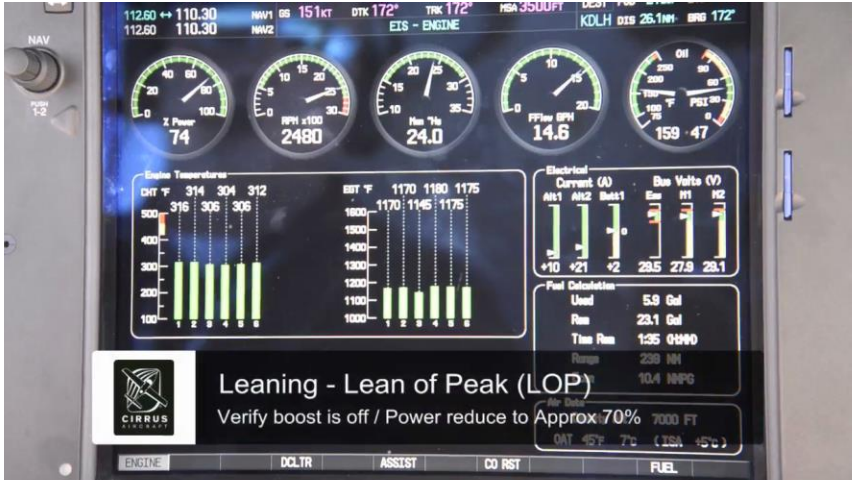


SR20 - * Caution * If moving the mixture control from the full rich position only decreases the EGT from the full rich value, place the mixture control back in the full forward position and have the fuel system serviced.

CIRRUS AIRCRAFT

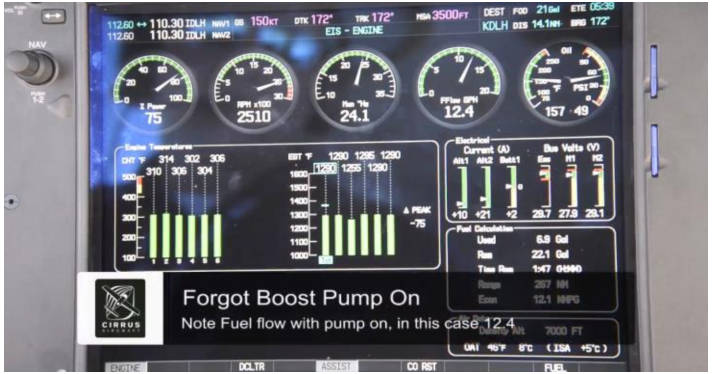
Best Economy Cruise – Lean of Peak (LOP)

- Verify boost is off
- Reduce power to approximately 70%
- After leaning power should be 65% or less
- Set EGTs 50° LOP
- Roughness LOP may be due to unbalanced / clogged injector or poor magneto timing



Common Mistakes

- Leaning too fast
  - Doesn’t allow EGTS to find true peak
- Forgetting to turn off boost pump before leaning
  - Note fuel flow
  - Turn pump off
  - Reset fuel flow



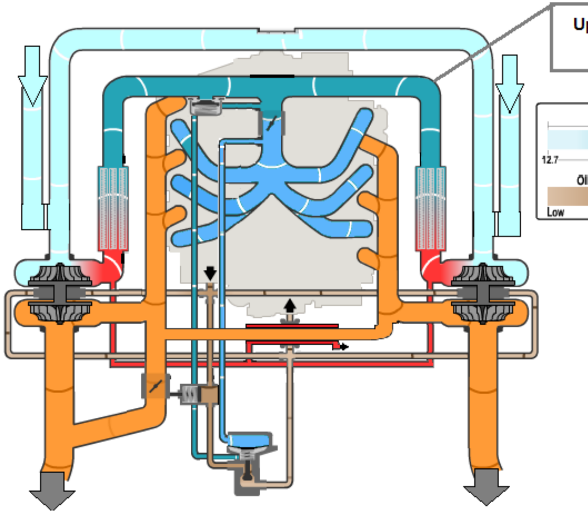
CIRRUS AIRCRAFT

Cruise SR22T

- Cruise- Power settings will be lean of peak
  - Power Lever – 30.5” MAP or less
  - Fuel pump- As required
    - Low boost for at least 30 minutes
  - Mixture – Cyan target or less
    - 50 °-75°F lean of peak TIT
  - CHT’s – Maintain below 420 ° F
    - IF CHT’s are greater than 420 °F then lean .5 GPH
      - Should result in a 15 °F reduction in CHT temperature for every .5 GPH
    - 390° - 400°F CHT’S TYPICAL

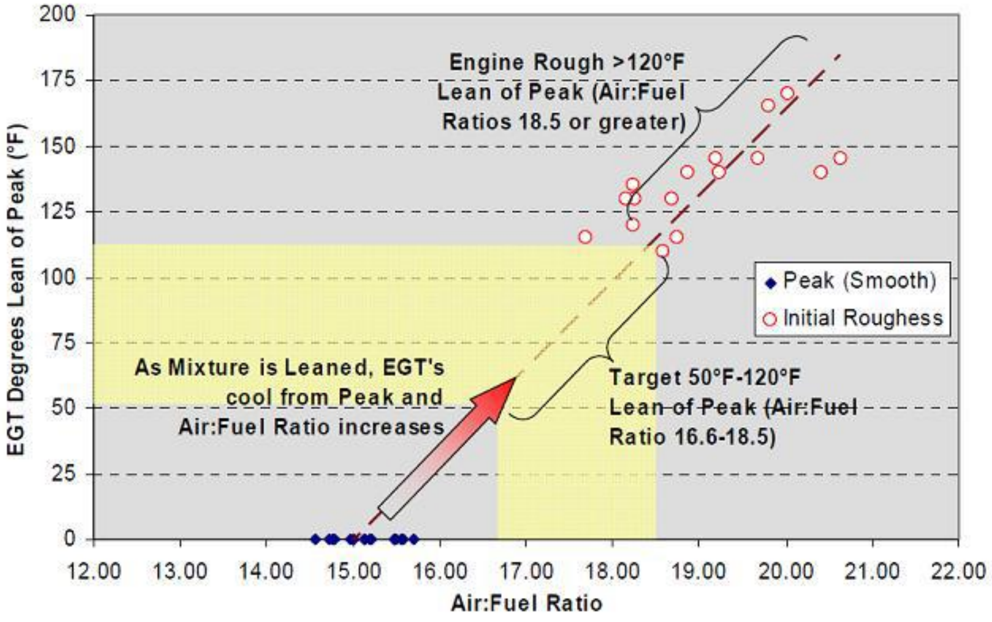
Cruise

- Manifold Pressure set to 30.5 or less (power lever)
- The Slope Controller maintains upper deck pressure 4” higher (~34.5”) than the intake manifold
  - Allows for immediate power response
    - No need to wait for turbos to spool up if additional power is needed



Lean Misfire

- Lean Misfire
  - Generally observed/characterized by sudden engine roughness
- Typically occurs at air: fuel ratios > 18.5 (approximately corresponds to 120°F LOP)



Boost Pump Operation

- Pressure affects the temperature required to vaporize fuel
  - Lower pressure = lower vaporization temperature
- Low boost provides extra pressure to keep fuel from vaporizing at high altitude
- High boost may be necessary above FL180 with warm or hot fuel if vapor lock is present
- Vapor lock can be recognized in flight by:
  - Fluctuations in normal fuel flow
  - Rising EGTs and TIT coupled with falling fuel flow
  - Rising CHTs

Maneuvering

- Boost Pump On for any maneuvering
- Mixture set as required
  - Normally full rich

Descent (SR20/SR22)

- Plan your descent to allow for a gradual 500 fpm – 800 fpm descent
- Percent power will increase as you descend
  - Reduce power as needed
- Mixture SR22 – enrichen
  - Maintain similar EGT from cruise
- Mixture SR20
  - Automatic (SR20)

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Descent (SR22T)

- Power Lever – As Required
- Mixture – Cyan Target or less
- CHT – Maintain in green arc (above 240° F)
- Avoid Prolonged idle settings
- Rapid Descent
  - Power lever - Smoothly reduce MAP 18 to 20”

Before Landing

- Mixture (SR20 / SR22T)
  - Set Full Rich
    - Ensures for maximum power in case of a go around
- Mixture (SR22)
  - Lean to a setting that will result in placarded fuel flows if throttle is advanced to wide open
  - Below 4,000ft PA Full Rich

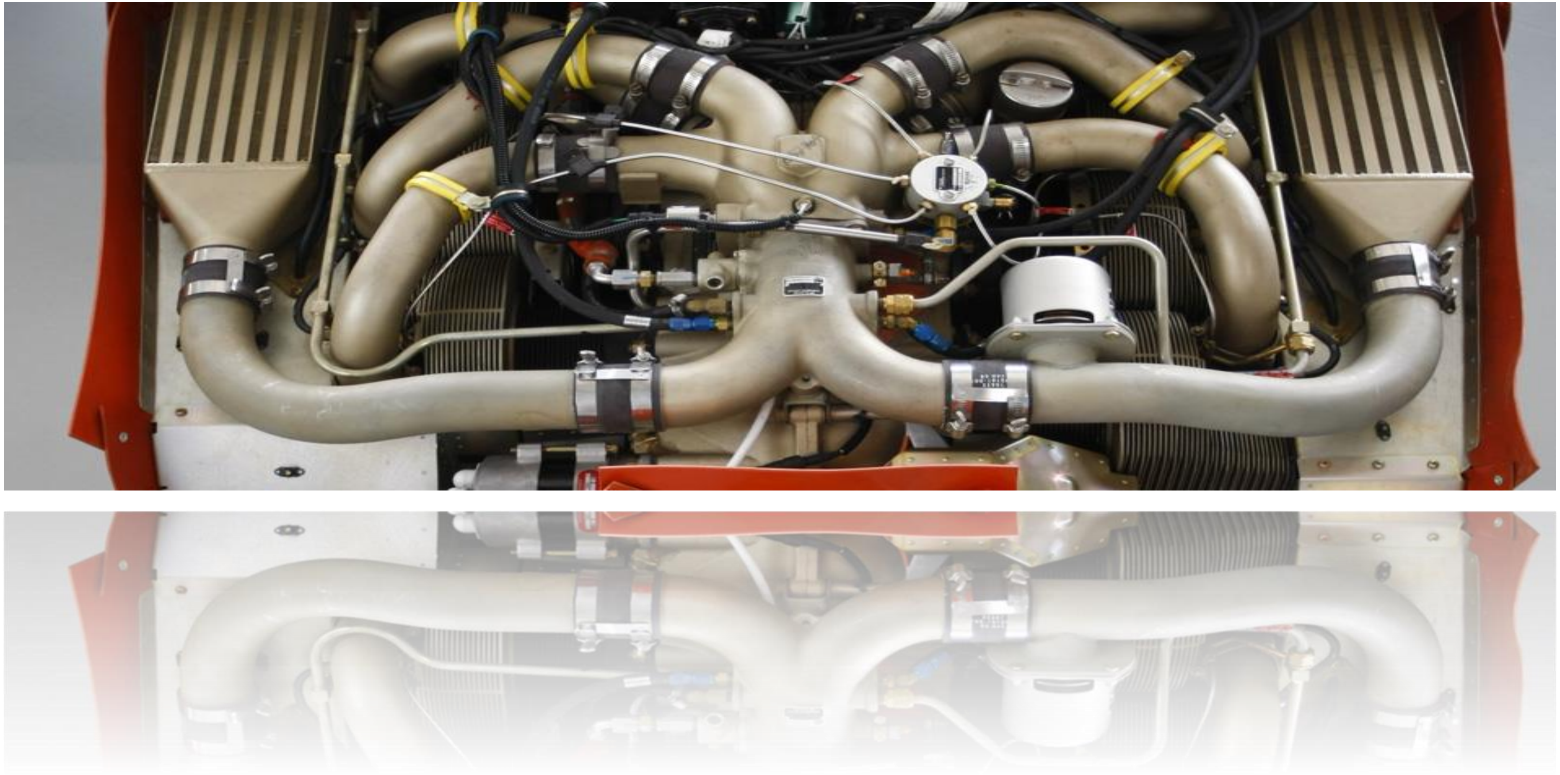
- Boost Pump ON

Taxi

- Leaning during Taxi will help to reduce the likelihood of sparkplug fouling
- Lean to the “X” in Mixture or until Maximum RPM rise is achieved

CIRRUS AIRCRAFT

Questions?



SR22T TURBO SYSTEM COMPONENTS

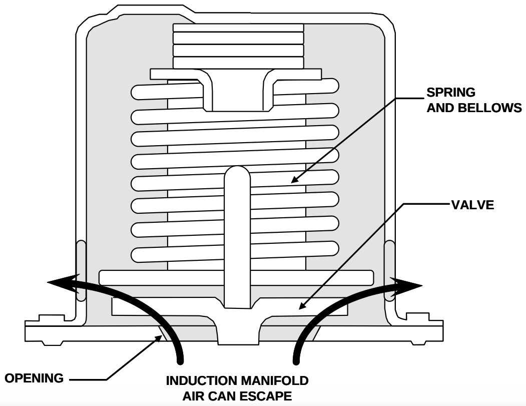
CIRRUS AIRCRAFT

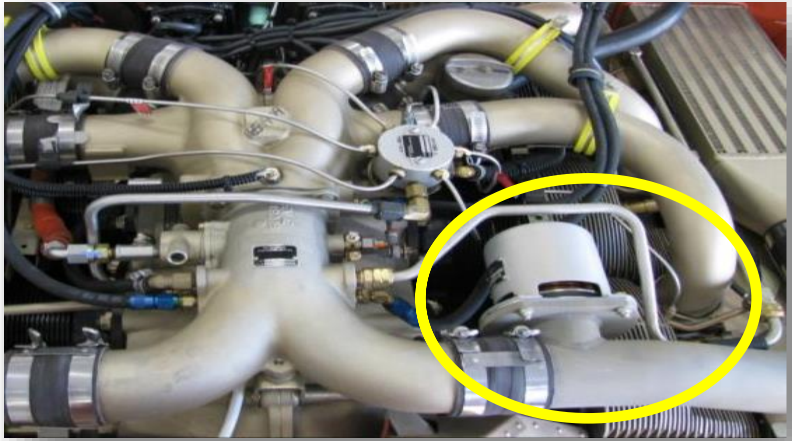
OVER-BOOST VALVE

- An overboost pressure relief valve is incorporated on turbocharged engine models to prevent over pressurization of the induction system

- The overboost pressure relieve valve is set to open at roughly 2 to 4 inches of mercury above the rated maximum manifold pressure of the engine

- This acts as a “fail safe” device to prevent the engine from reaching an overboost situation





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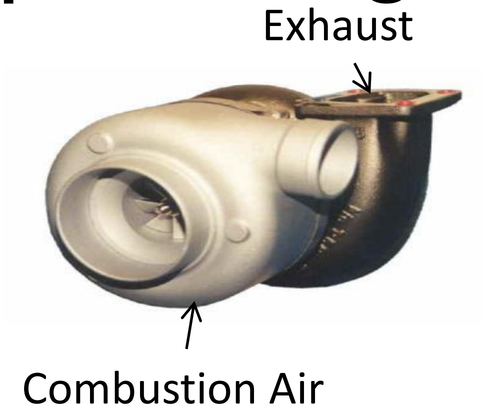
Turbo-Supercharger

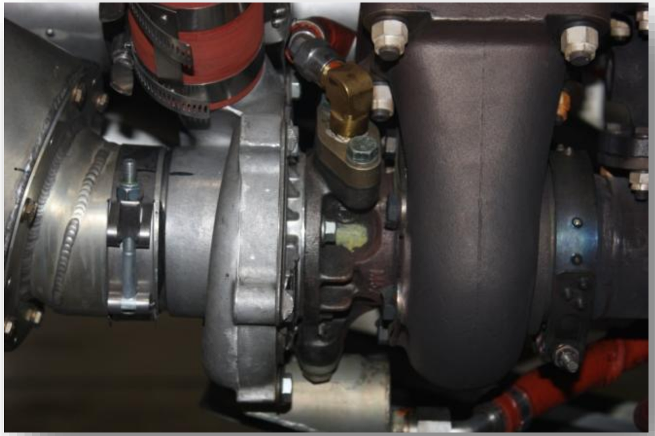
- Turbo uses accelerated exhaust gases to spin a compressor which increases the pressure in the upper deck

- Capable of +100,000 RPM

- Maximum Normal Turbo Inlet Temperature (TIT) is 1750°F, seen on MFD

- Turbo is lubricated via the engine oil system





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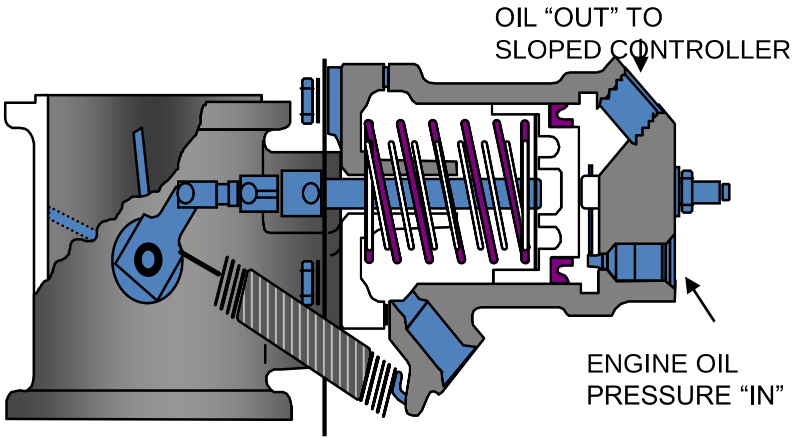
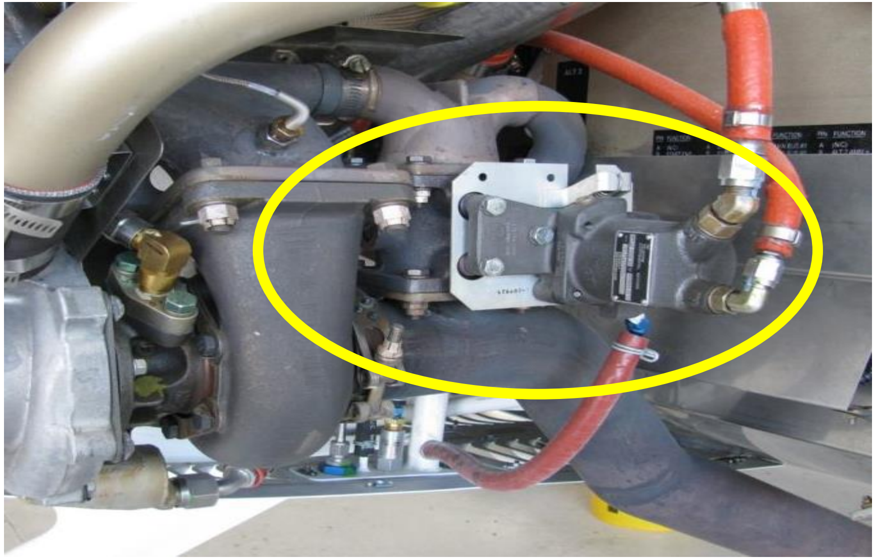
Wastegate

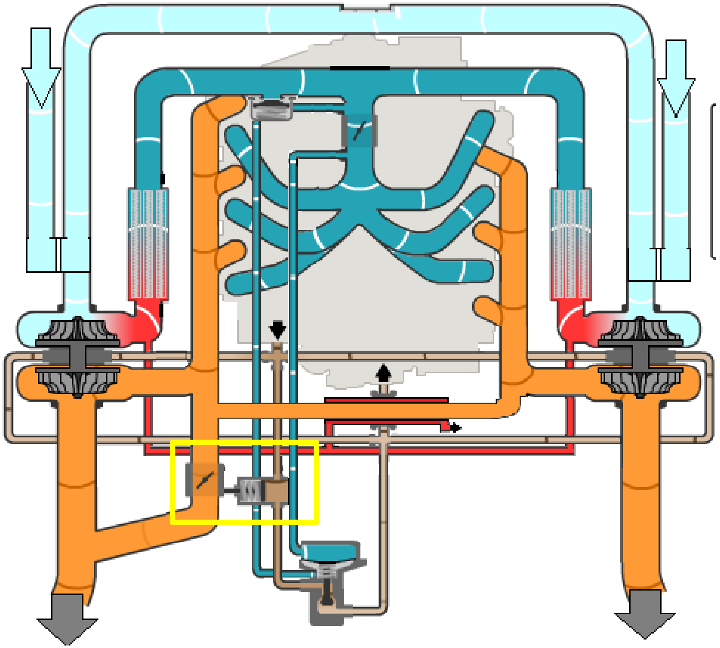
- The waste-gate is a hydraulically controlled device using engine oil pressure, to close a butterfly valve that will direct exhaust gasses to the turbocharger

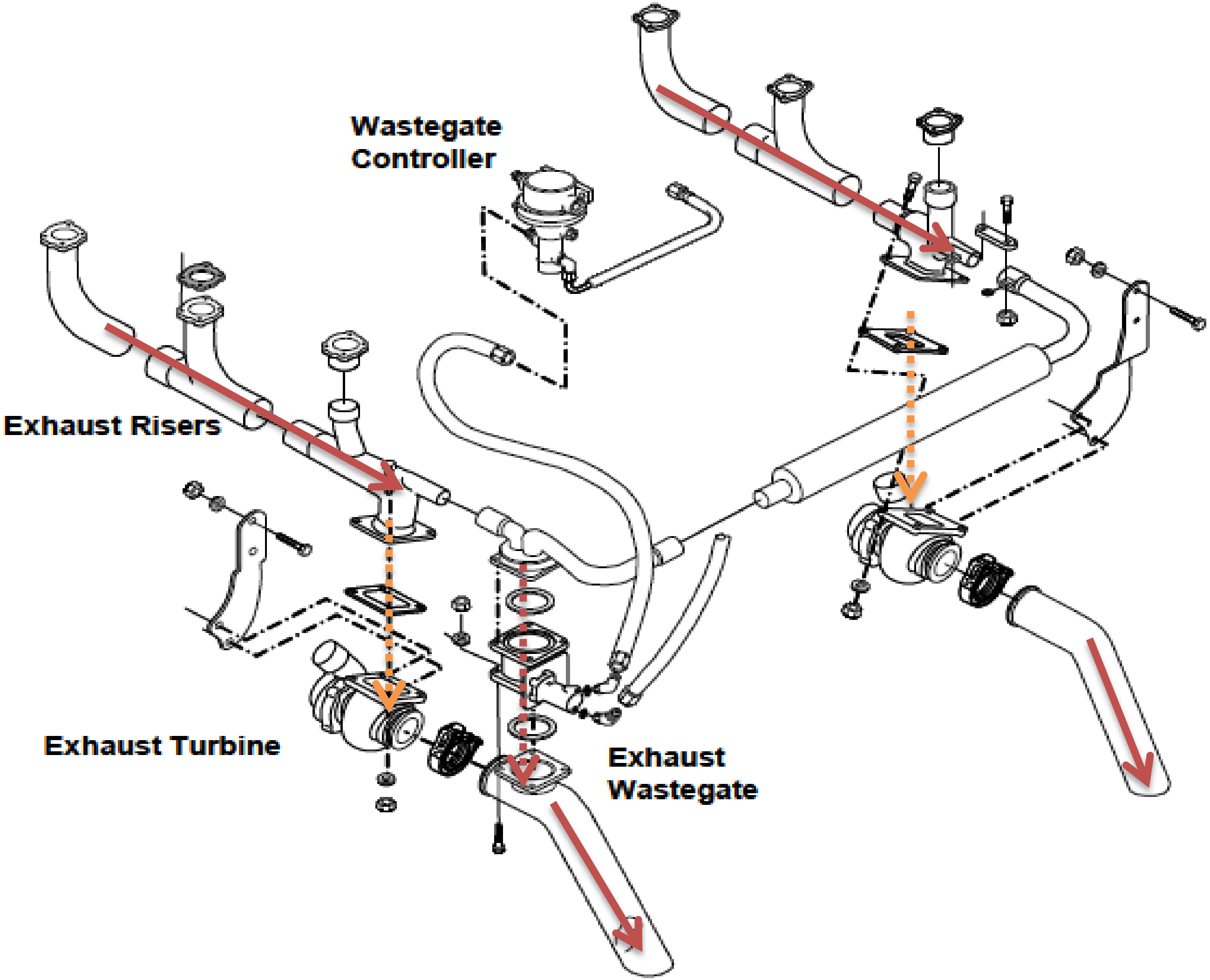




Wastegate

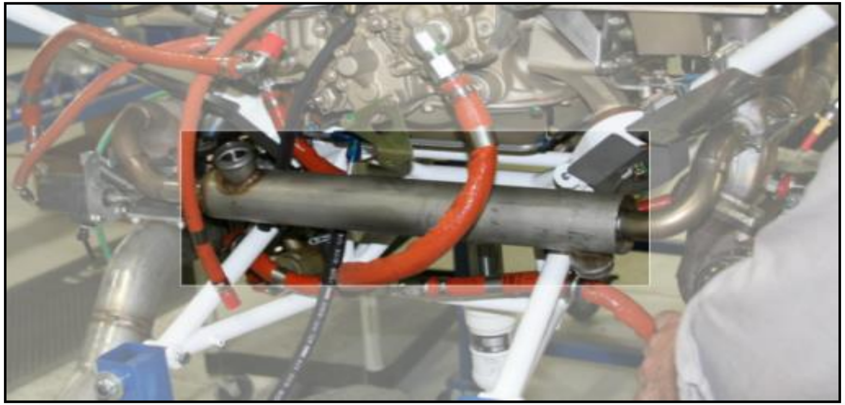
- The wastegate controls the amount exhaust that is allowed to flow through the turbo
- Air will take the path of least resistance
- A closed wastegate sends more exhaust through the turbo
- An opened wastegate allows Exhaust to bypass the turbo and be dumped overboard
- A spring holds the wastegate in the open position. Oil pressure closes the wastegate
- There is only 1 wastegate that controls both turbos via a crossover tube

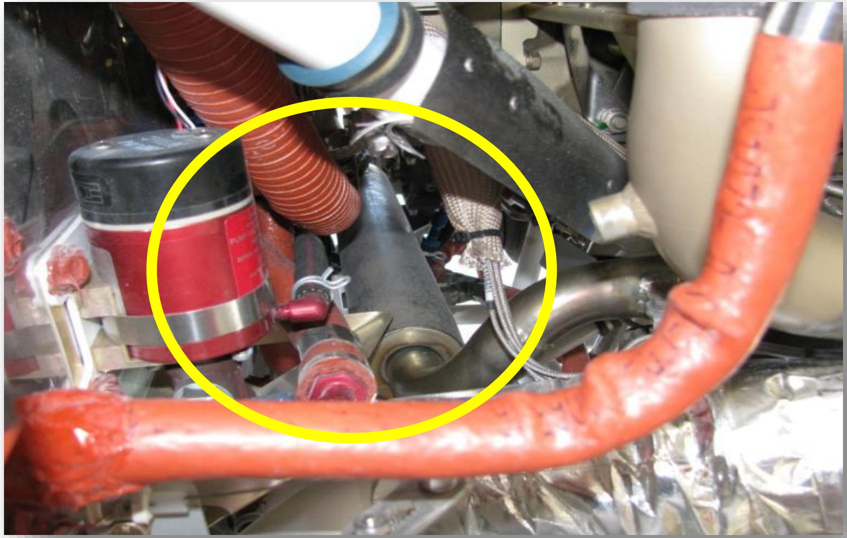



Wastegate Controller
Exhaust Risers
Exhaust Turbine
Exhaust Wastegate

Crossover Tube

- The left and right exhaust manifolds are connected via a crossover tube
- This architecture equalizes exhaust pressure in the exhaust manifolds and both turbines are driven equally



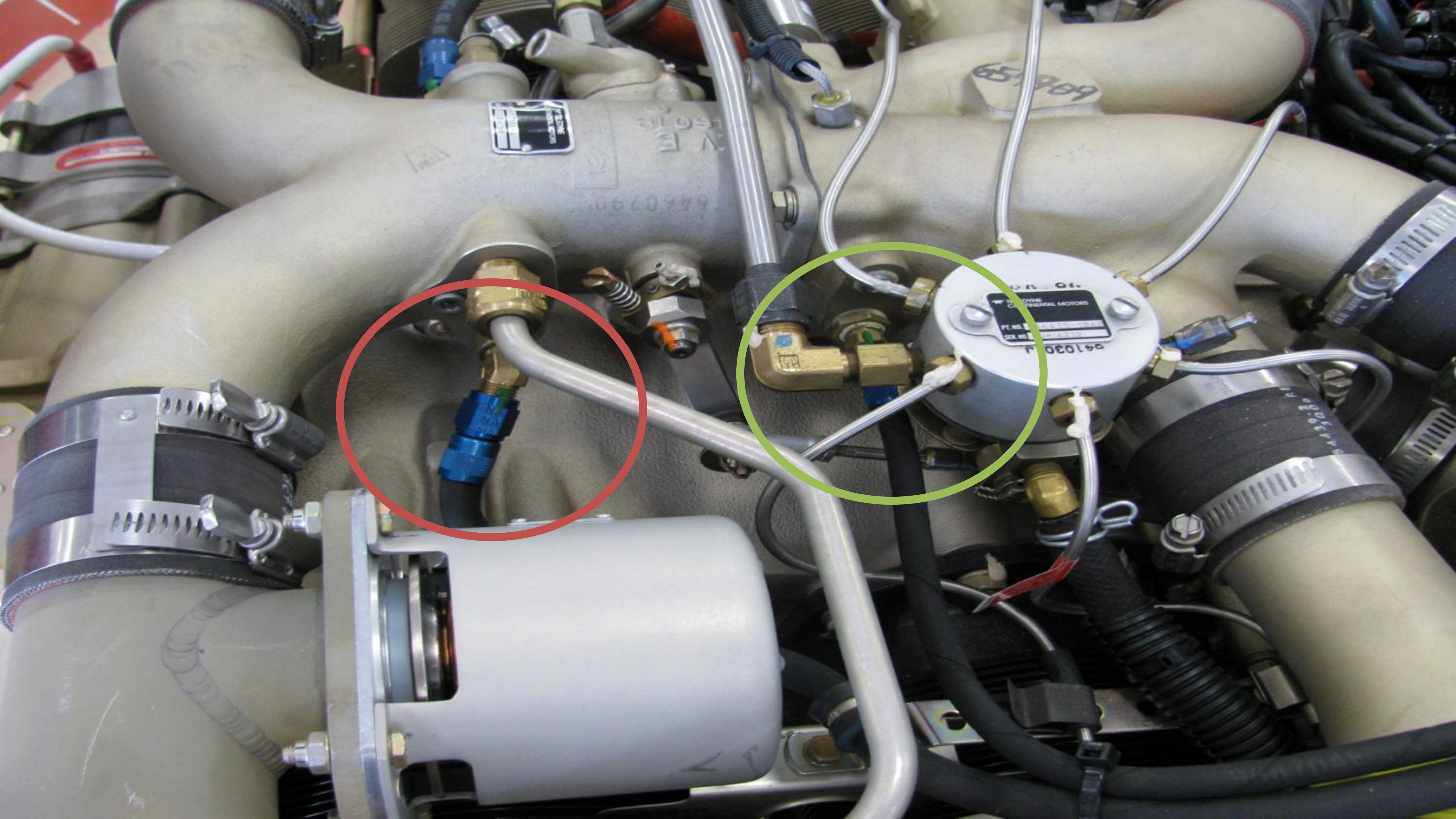


CIRRUS AIRCRAFT

SLOPE CONTROLLER

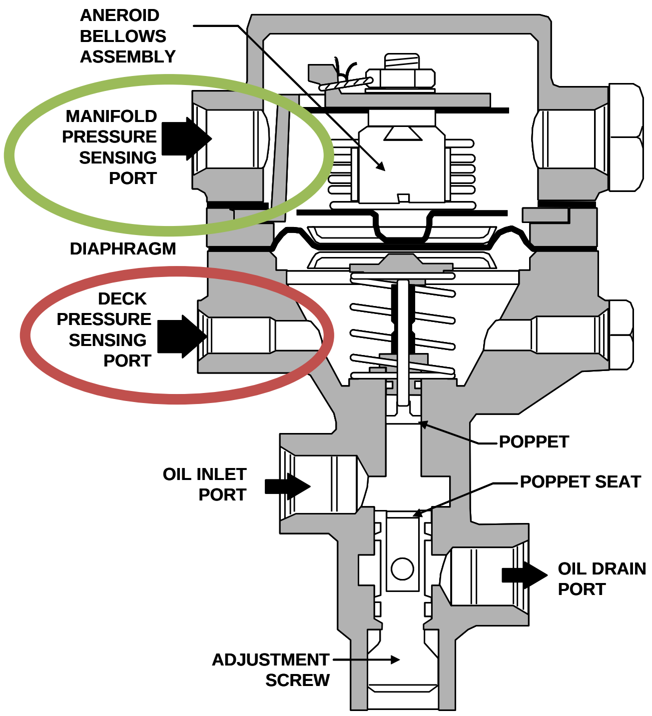
- Moves the wastegate to manage the pressure created by the turbo
- Maintains a pressure differential across the throttle valve of about 4“ Hg at partial power settings and limits maximum MAP to 36.5” at full power

CIRRUS AIRCRAFT


CONTINENTAL MOTORS
PT. NO.
SER. NO.

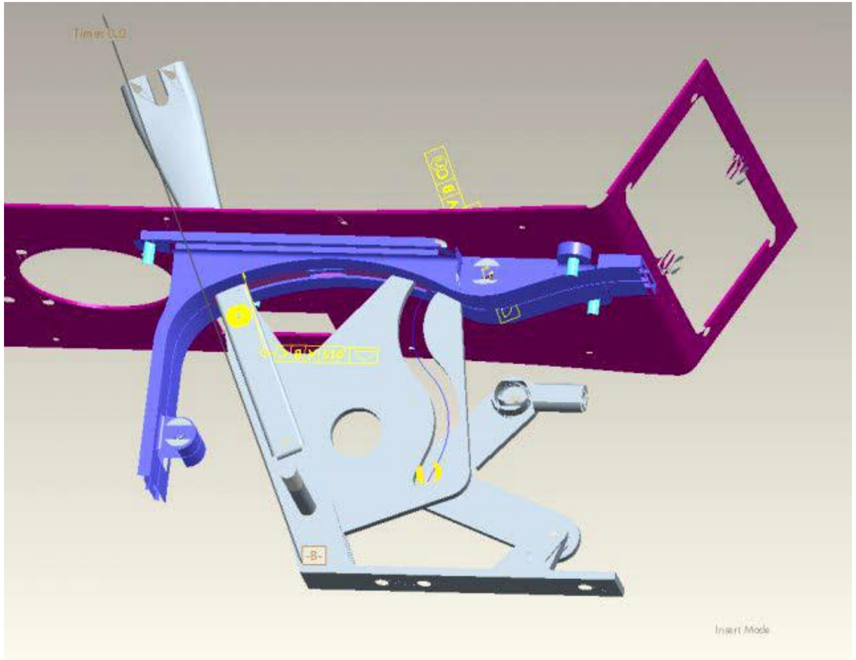
SLOPE CONTROLLER

- On takeoff at full power, slope controller limits MAP to 36.5”
- As the aircraft climbs at full power and the ambient pressure decreases, the controller commands the wastegate to close to maintain 36.5” MAP
- As power is reduced, the controller commands the wastegate to open to maintain the 4” differential across the throttle plate



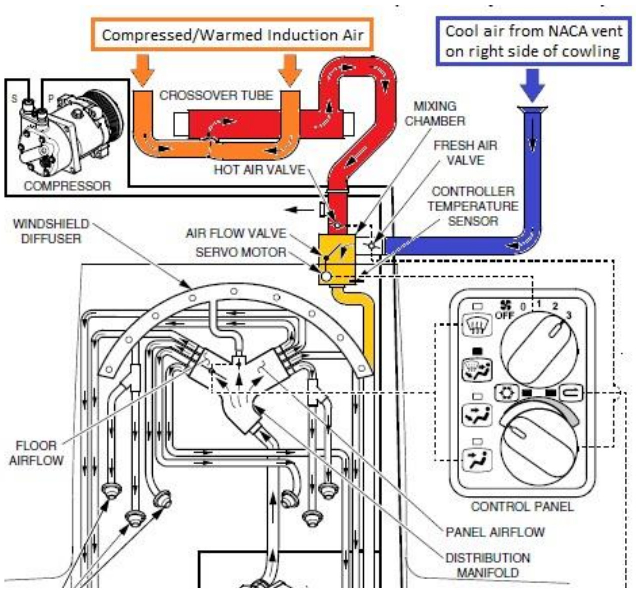
SR22T Power Lever

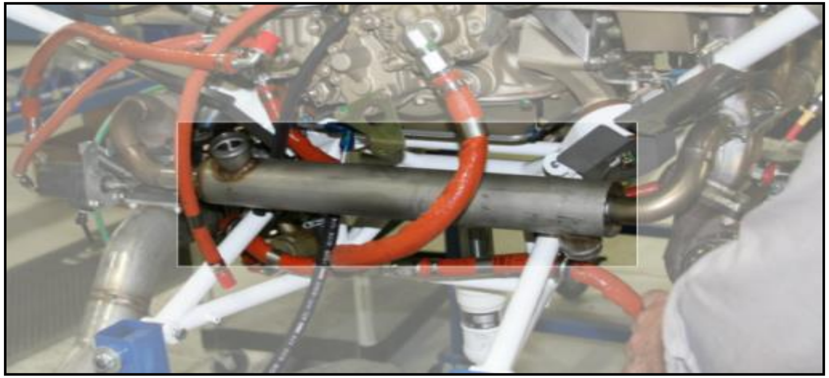
- No connection or linkage to prop governor
- Throttle cable “slowed” in cruise power range
  - Small changes in throttle position result in large changes to manifold pressure due to the slope controller



Modified ECS Controller

- SR22T
  - Larger heat exchanger on crossover tube, 50°F higher heat rise
  - Uses electronic control to actively monitor and bias valves if hot air temp exceeds limits
  - Benefits are plenty of heat on the ground, and at low and high altitudes
  - Pressurized prevents CO





Prop Governor

The SR22T incorporates a cable-less Hartzel propeller governor.

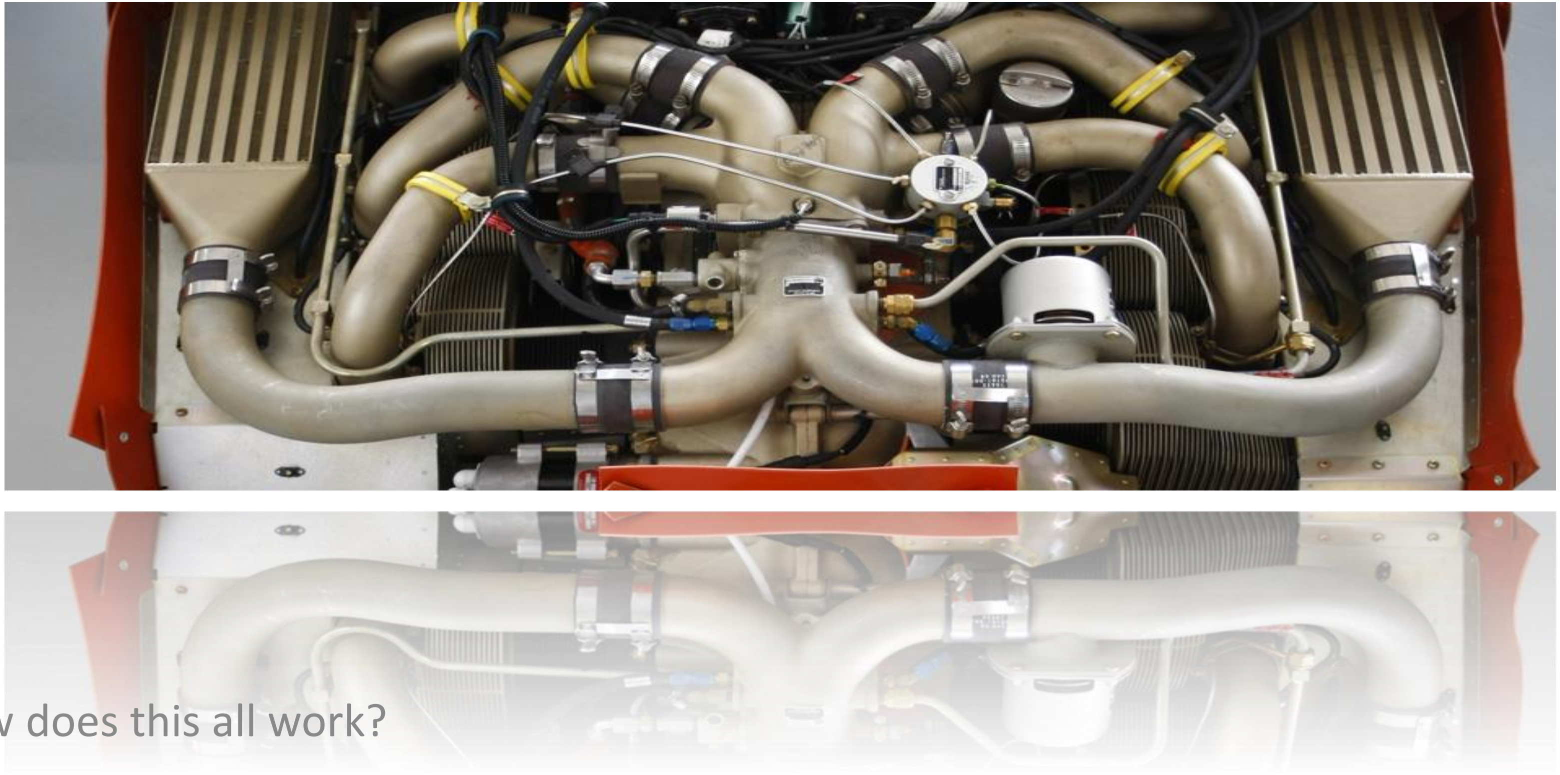
The governor operates on the same principle as other propeller governors; sensing engine speed, the governor regulates pressurized engine oil in the propeller piston assembly, which controls propeller blade angle.

Begins controlling blade angle and engine speed at approximately 1400 RPMs.

The engine reaches its maximum speed of 2500 RPMs at power settings as low as 55%.

As the power lever is advanced, engine speed will remain at 2500 RPMs, but MAP and Fuel flow will increase as will % Power.

With the high speed stop set at 2500 RPMs, additional power input causes the governor to increase propeller blade angle, thus increasing thrust.

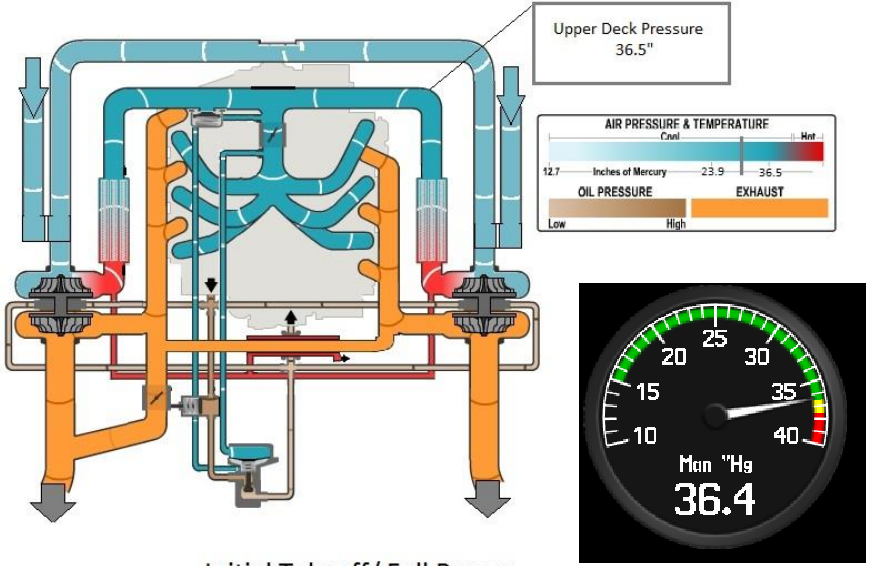


So how does this all work?

PUTTING IT TOGETHER

Take-Off

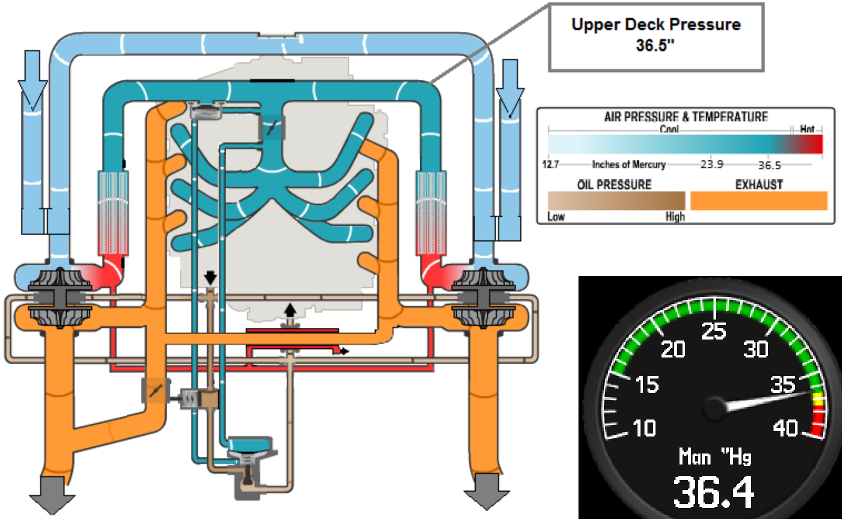
- Turbos boost Manifold pressure to ~36.5”
- Upper deck pressure regulated to ~36.5” by the slope controller



Initial Takeoff/ Full Power

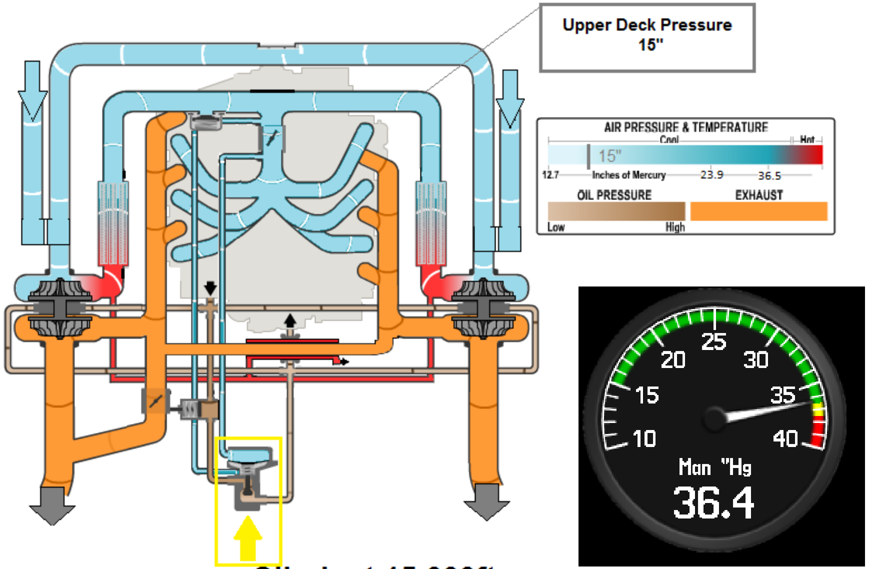
Climb

- Outside air pressure will begin to decrease
- Manifold pressure would normally start to decrease as well, resulting in a loss of engine power



Climb

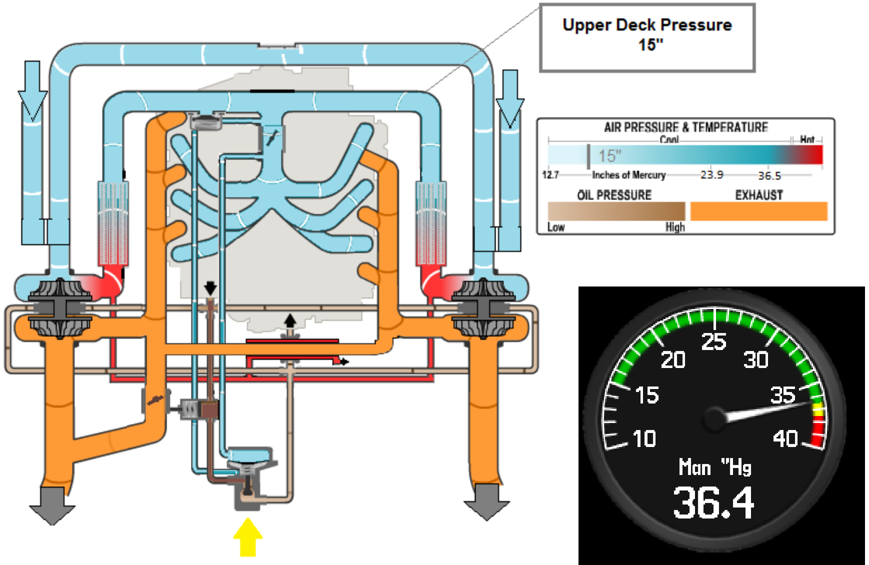
- Slope Controller
  - The aneroid in the slope controller contracts with loss of manifold pressure



Climb at 15,000ft

Climb

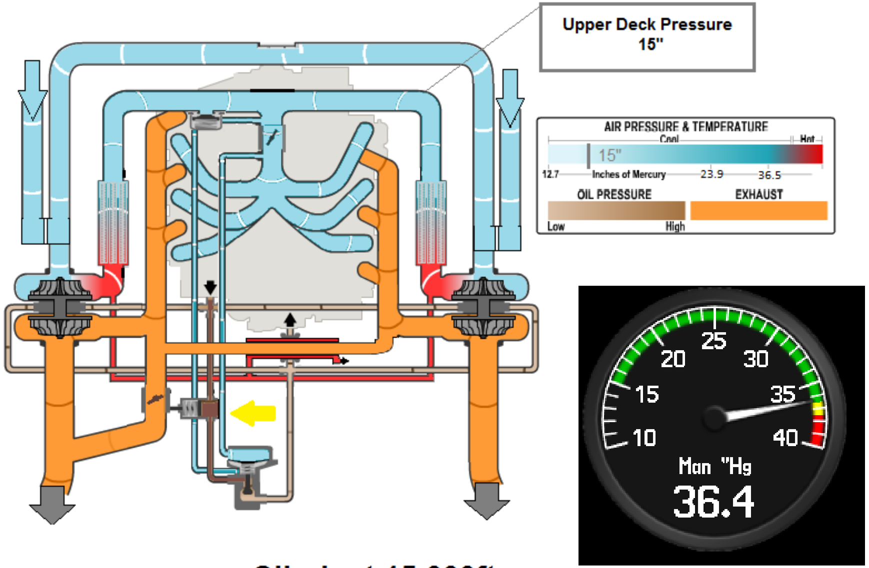
- Slope Controller
  - The poppet closes restricting oil flow, building pressure in engine oil line to the wastegate



Climb at 15,000ft

Climb

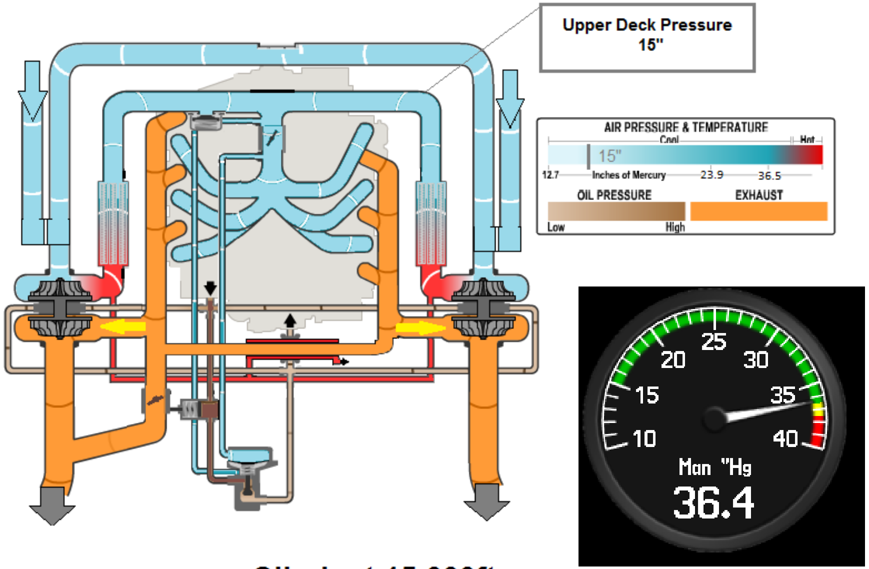
- The increased pressure in the oil line pushes against the waste gate spring closing the wastegate as needed



Climb at 15,000ft

Climb

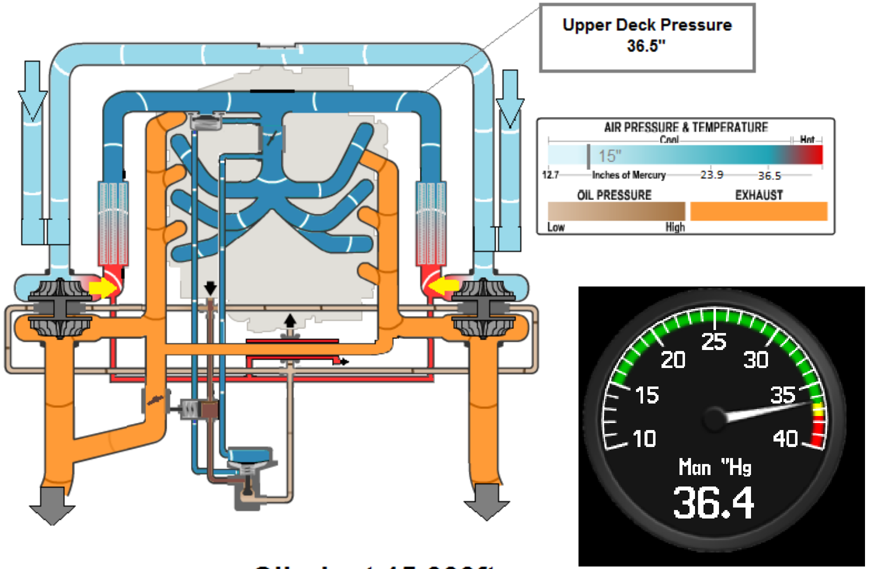
- As the wastegates close less exhaust air is allowed past the waste gates and more air directed through the turbos
- This increase in airflow through the turbos increase the turbo's RPM



Climb at 15,000ft

Climb

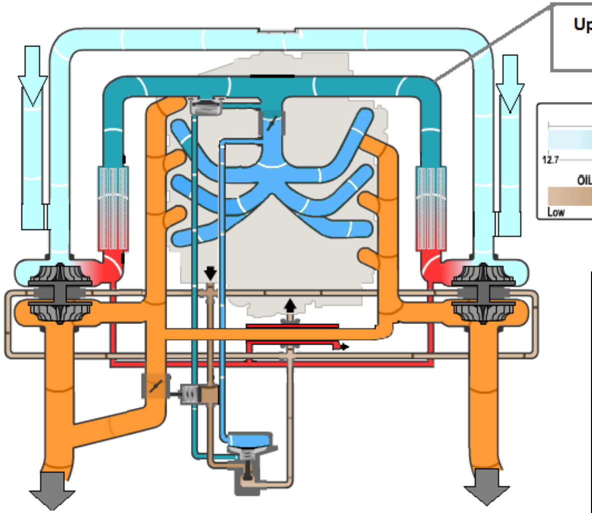
- When the turbo’s RPMs increase the compressor will also start to spin faster
- An increase in compressor RPMs will result in an increase in the Upper Deck manifold pressure
- The upper deck manifold pressure will be regulated to maintain 36.5” up to about 18,000ft (critical altitude)



Climb at 15,000ft

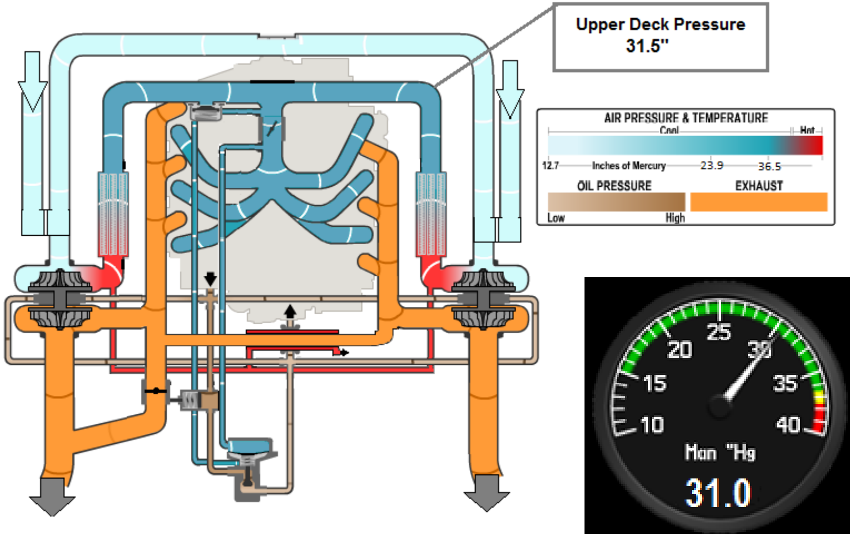
Cruise

- Manifold Pressure set to 30.5 or less (power lever)
- The Slope Controller maintains upper deck pressure 4” higher (~34.5”) than the intake manifold
  - Allows for immediate power response
    - No need to wait for turbos to spool up if additional power is needed



Climb to 25,000ft

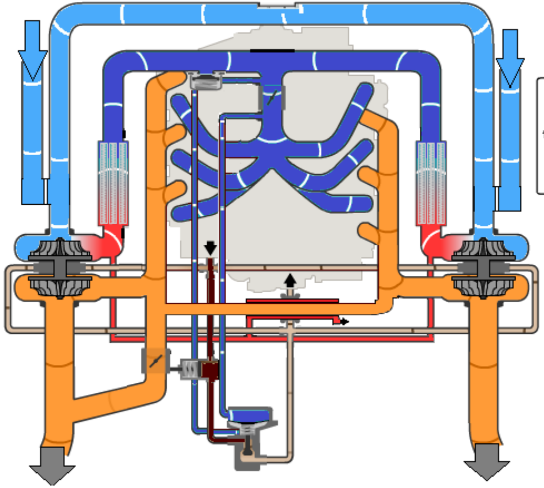
- Wastegates will be fully closed above 19,000ft (Critical Altitude)
- All possible exhaust gas is directed through the turbos
- As you climb above the critical altitude intake manifold pressure will begin to decrease
- Engine should still be able to maintain 31” MAP and 85% power at 25,000 ft

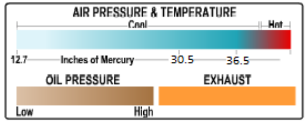


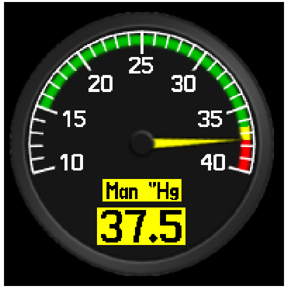
Climb to 25,000ft/Full Throttle

Cold Weather Takeoff

- Pressure in the oil line to the wastegates may increase more than normal if the engine oil is not properly warmed before takeoff
- The wastegate may close prematurely causing higher upperdeck pressures than desired
- The pilot should reduce the power lever until MAP is below 37”
- The pilot should increase throttle as the oil warms during the climb

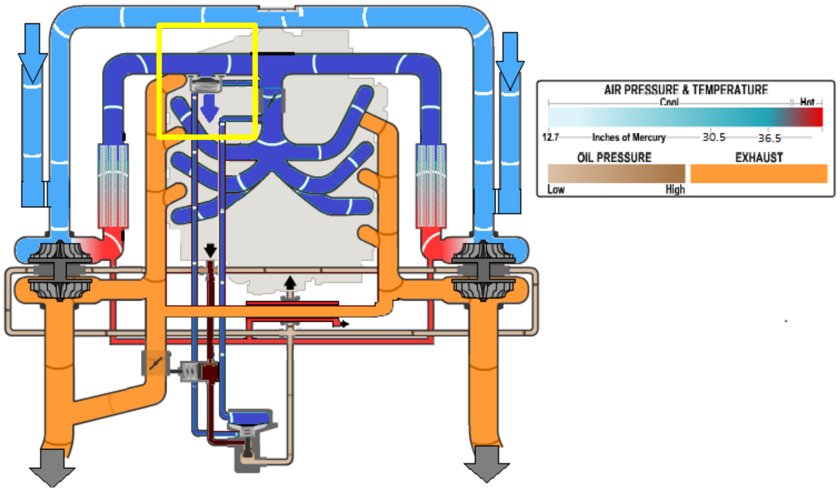






Cold Weather Departure

- If the upperdeck pressure is allowed to reach too high of a level (2” to 4” above max rated) the over-boost valve will open reducing the pressure in the upperdeck



CIRRUS AIRCRAFT

SR22T

LIMITATIONS

CIRRUS AIRCRAFT

Airspeed Limitations

Speed	KIAS	Remarks
Vne up to 17,500 MSL	200 (205 G5)	Never Exceed
Vne at 25,000 MSL	170 (175 G5)	Vne is reduced linearly from 17,500 to 25,000
Vno up to 17,500 MSL	177 (176 G5)	Maximum Structural Cruising Speed
Vno at 25,000 MSL	151 (150 G5)	Vno is reduced linearly from 17,500 to 25,000

Note: Vno and Vne can be interpolated for altitudes between 17,500 and 25,000. The PFD airspeed tape will change with altitude to reflect the difference in Vne / Vno

System Limitations

- Altitude Limits
  - Maximum Takeoff Altitude…...…………………..10,000 MSL
  - Maximum Operating Altitude...........................25,000 MSL
- Flap Limitation
  - Do not use flaps above………………….............17,500 MSL
- Environmental Conditions
  - Do not operate the aircraft below an outside air temperature of -40°C
- Do not reduce manifold pressure below 15” when above 18,000 ft MSL

CIRRUS AIRCRAFT

Critical Altitude

- Critical altitude is defined as the altitude at which the wastegate is completely closed and as the aircraft continues to climb, MAP will begin to decrease

- Critical altitude ~19,000 ft

- Aircraft will still be able to maintain 31” MAP and 85% power at 25,000 ft

CIRRUS AIRCRAFT

SR22T Operations

REVIEW

True or False?

- Leaning the engine will cause the CHT’s to rise when operating lean of peak.

Scenario

During a lean of peak climb while climbing at 120 KIAS the CHT's exceed 420° F

- What is the appropriate response?

- What if that does not work?

- What if that does not work?

Scenario

After setting cruise power at 85% (2500RPM / 30.5” MP and 18.3 GPH) the CHT’s remain at 420° F.

– What is the appropriate action?

Specific to Turbo Operations

Emergency Procedures

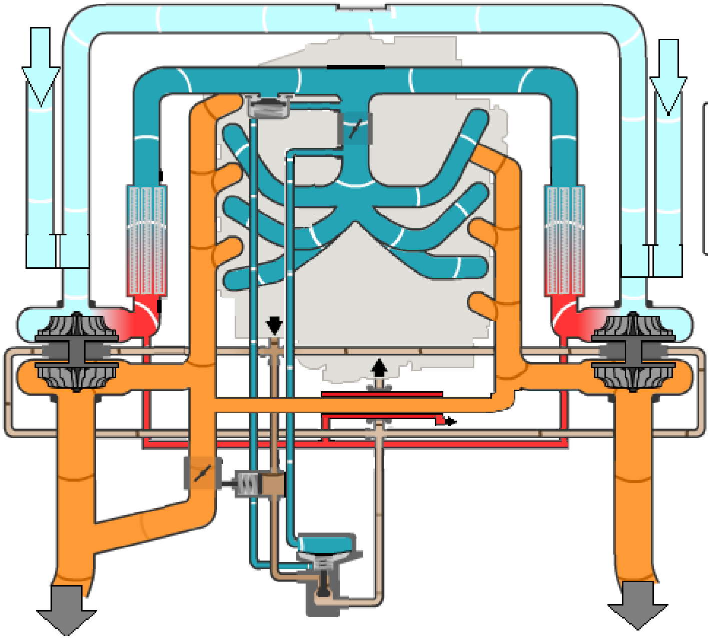
Scenario

- While cruising at 17,000ft you notice a sudden loss of manifold pressure.
  - What do you do now?

Unexpected Loss of Manifold Pressure

Four Most Probable Causes

1. Leak in the induction system
   - Behaves like a normally aspirated airplane
2. Leak in the exhaust system
   - Possible fire hazard
3. Loss of oil pressure to wastegate actuator
   - Due to general loss of engine oil
4. Failure of internal component in turbocharger
   - May be accompanied by loss of oil pressure



CIRRUS AIRCRAFT

Unexpected Loss of Manifold Pressure

Emergency Procedure:

1. Power- Adjust to minimum required
2. Mixture-Adjust for EGT’s between 1300 ° to 1400 °F
3. Descend to Minimum Safe Altitude from which a landing may be safely accomplished
4. Divert to nearest suitable airfield
5. Radio-121.5 advise ATC
6. Oil Pressure-Monitor
7. Land as soon as possible