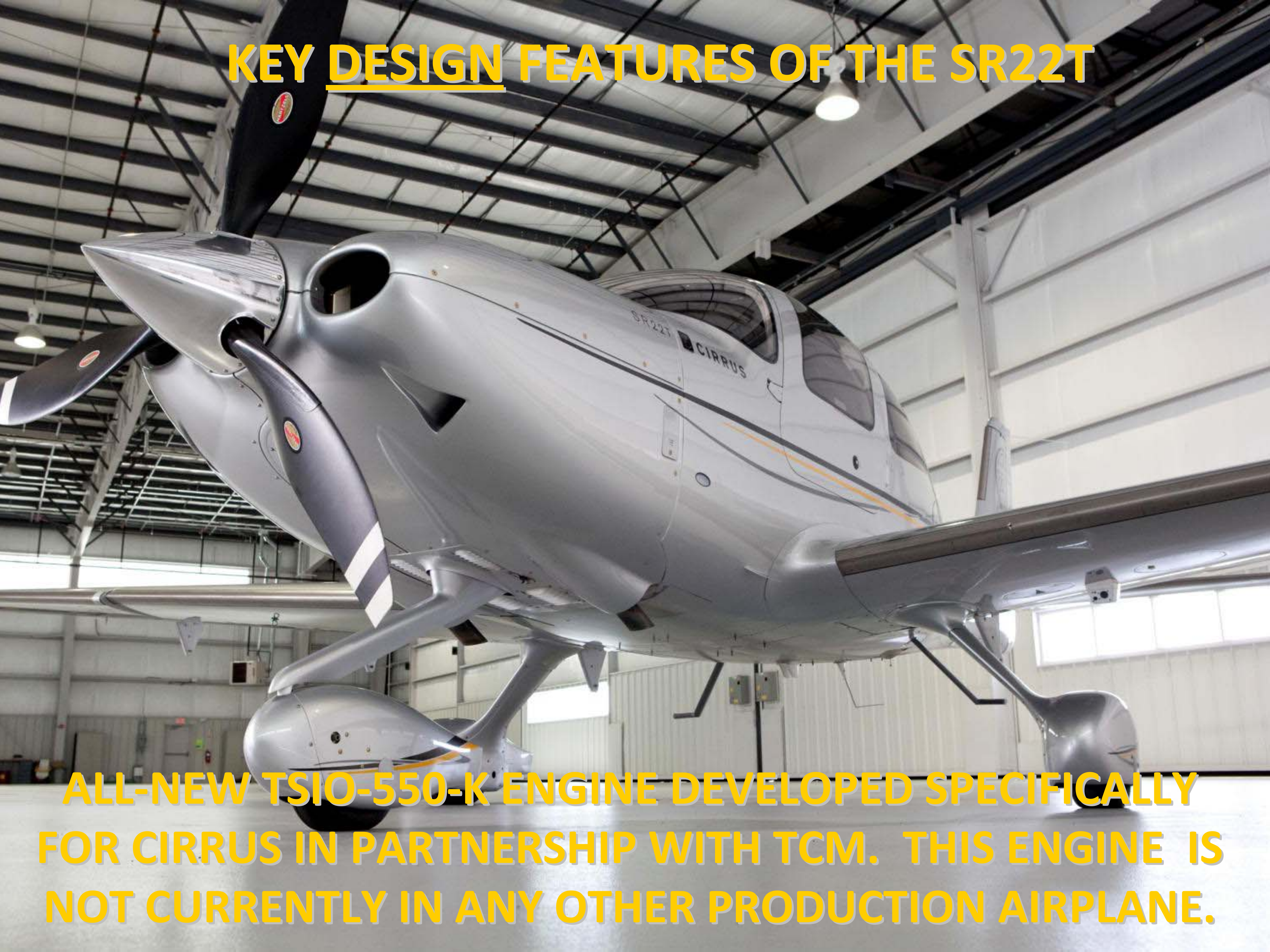
CIRRUS SR22T

SYSTEM PRESENTATION

- System Description
- Turbo Limitations
- Normal Operating Procedures/Engine Management
- Emergency Operating Procedures

KEY DESIGN FEATURES OF THE SR22T



ALL-NEW TSIO-550-K ENGINE DEVELOPED SPECIFICALLY FOR CIRRUS IN PARTNERSHIP WITH TCM. THIS ENGINE IS NOT CURRENTLY IN ANY OTHER PRODUCTION AIRPLANE.


KEY DESIGN FEATURES OF THE SR22T
ENGINE / MOUNTING SYSTEM
SR22T
CIRRUS
MODIFIED NLG – OLEO STRUT


KEY DESIGN FEATURES OF THE SR22T
ENGINE / MOUNTING SYSTEM
SR22T
CIRRUS
MODIFIED COWL
MODIFIED NLG – OLEO STRUT

KEY DESIGN FEATURES OF THE SR22T

SR22T: THE INTEGRATION

- SR22 AIRFRAME
- DESIGN DIFFERENCES:
  - TWIN-TURBOCHARGED TSIO-550-K ENGINE
  - MODIFIED NOSE LANDING GEAR - HYDRAULIC STRUT
  - MODIFIED COWL WITH DEDICATED INDUCTION INLETS, DIFFERENT COOLING EXIT DESIGN
  - MODIFIED ENVIRONMENTAL CONTROL SYSTEM CONTROLLER

CIRRUS PERSPECTIVE BY GARMIN

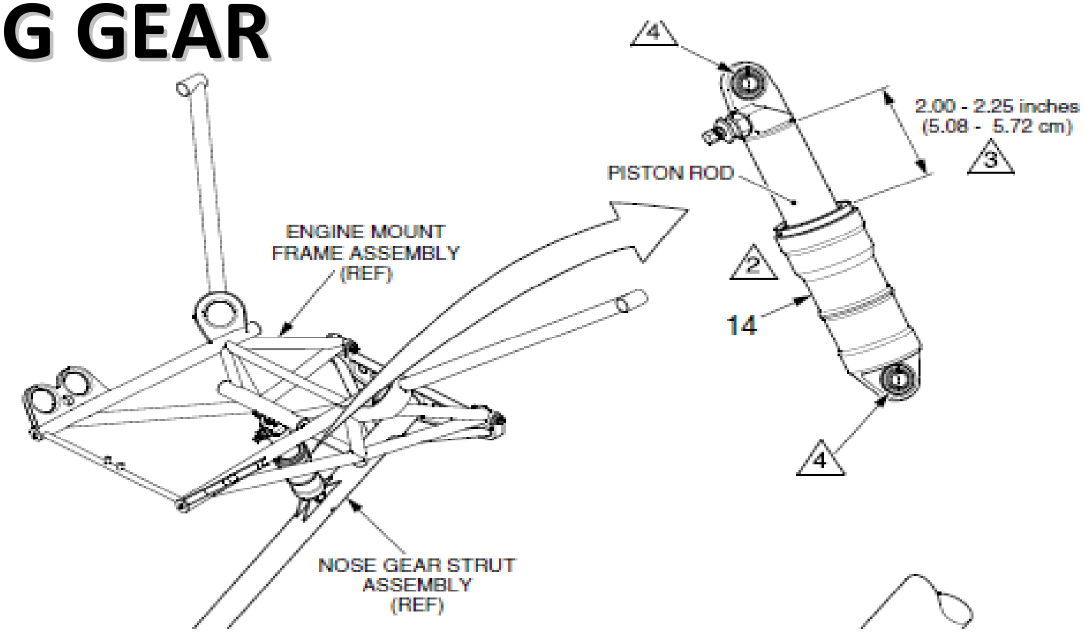
- INTEGRATES SEAMLESSLY WITH

SR22T: MODIFIED COWL

- ENGINE INDUCTION FROM NACA INLETS
- COOLING EXIT CONFIGURATION

SR22T: NOSE LANDING GEAR

- HYDRAULIC SHOCK ABSORBING STRUT
- EXCEPTIONAL LANDING "FEEL" AND DAMPING IN CASE OF POOR LANDING
- REDUCED STRESS/LOADS INTO NLG WHICH PERMITTED WEIGHT REDUCTION OF NOSE STRUT
- FACILITATES DECREASE OF TAIL BALLAST WEIGHT NECESSARY FOR CG MANAGEMENT
- NET WEIGHT REDUCTION OF 10-15 LBS



MODIFIED ECS CONTROLLER

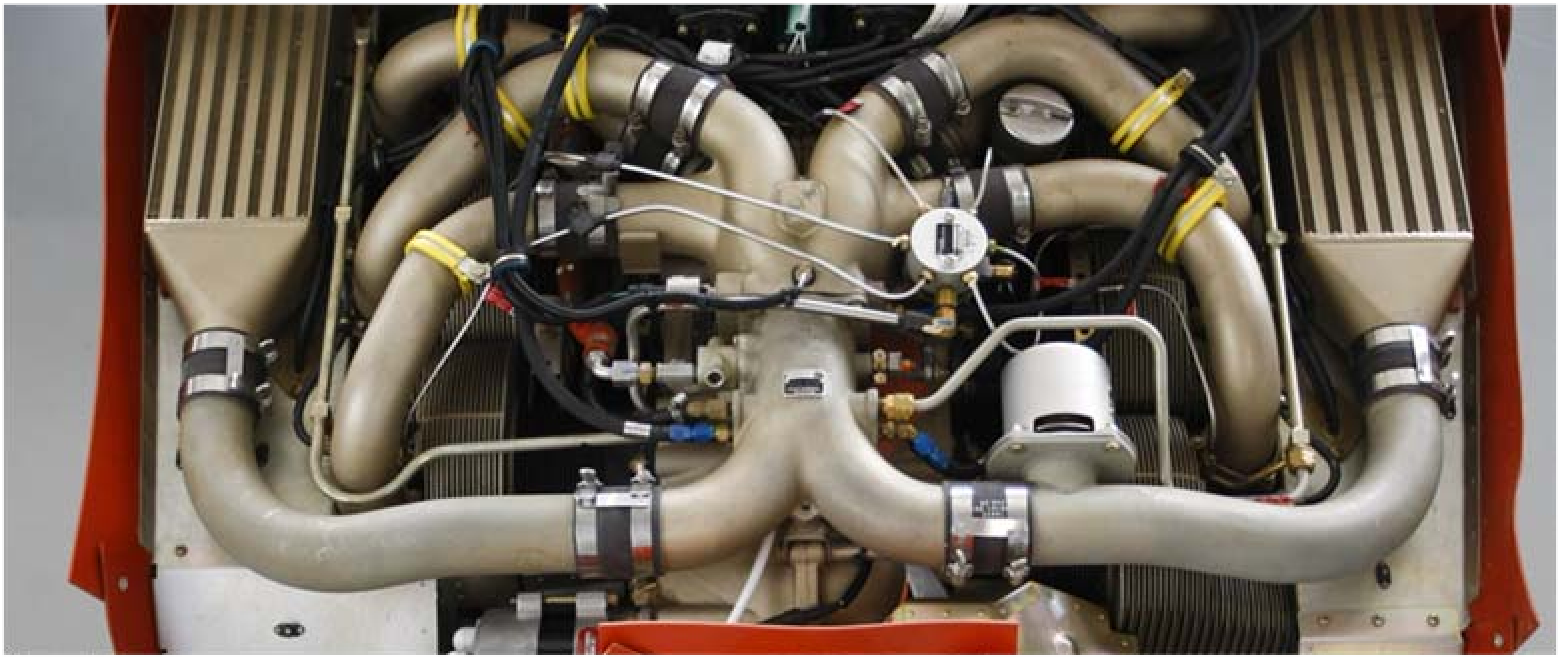
- SR22T
  - LARGER HEAT EXCHANGER ON CROSSOVER TUBE, 50°F HIGHER HEAT RISE
  - USES ELECTRONIC CONTROL TO ACTIVELY MONITOR AND BIAS VALVES IF HOT AIR TEMP EXCEEDS LIMITS
  - BENEFITS AR … AT LOW AND HIGH A

SR22T: TSIO-550-K ENGINE

- TCM TYPE CERTIFIED ENGINE
- 315 RATED HP @ 2500 RPM / 36.5” MAP
  - ADDITIONAL TAKEOFF HP RESULTS IN NOMINAL IMPROVEMENT IN TAKEOFF AND CLIMB PERFORMANCE
- ENGINE COMPRESSION RATIO: 7.5:1
  - PROVIDES HIGHER DETONATION PROTECTION, ENABLES ENGINE TO BE FLEXIBLE TO LOWER OCTANE UNLEADED FUELS

SR22T: TSIO-550-K ENGINE

- SINGLE WASTEGATE
  - SMALL WEIGHT REDUCTION
  - RELIABILITY AND MAINTENANCE BENEFITS
- CONSISTENT 2500 RPM → FIXED GOVERNOR
  - QUIET CABIN AND FLYOVER TAKEOFF AND CLIMB NOISE
  - VERY LOW TAKEOFF AND CLIMB VIBRATION LEVELS
  - SIMPLE SYSTEM RE: MAINTENANCE, RIGGING, SETUP
  - WEIGHT SAVINGS: PROP CONTROL CABLE AND APPARATUS ~1.5 LBS
  - PROP BRAKING: AT HIGH SPEED, LOW POWER → BETTER DECELERATION



so how does this all work?

PUTTING IT TOGETHER

Air Intakes

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

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

CIRRUS AIRCRAFT Red Bull AIR RACE WORLD CHAMPIONSHIP

WORLD CLASS LIFESTYLE MEETS WORLD CLASS RACING

Air Intakes

- 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

Intercooler (Aftercooler)

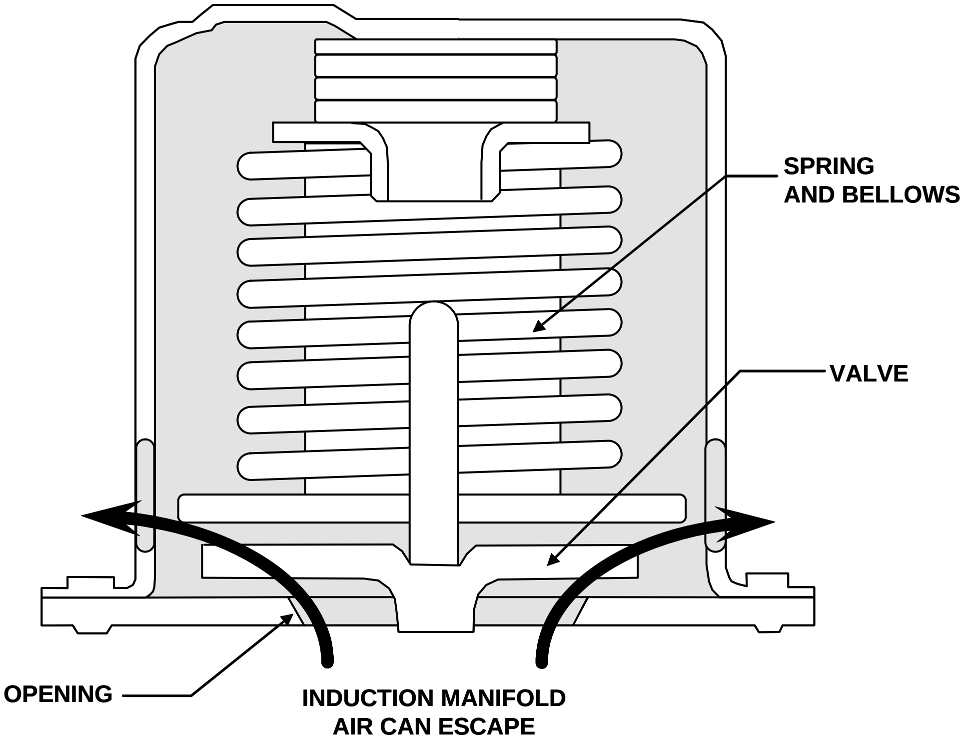
- As the air is compressed in the turbo, it also warms up (up to 5 times as hot)
- Intercooler is installed in the induction air path between the compressor and the throttle plate
- The function is to cool down the compressed air, which improves the performance of the engine

OVER-BOOST VALVE

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

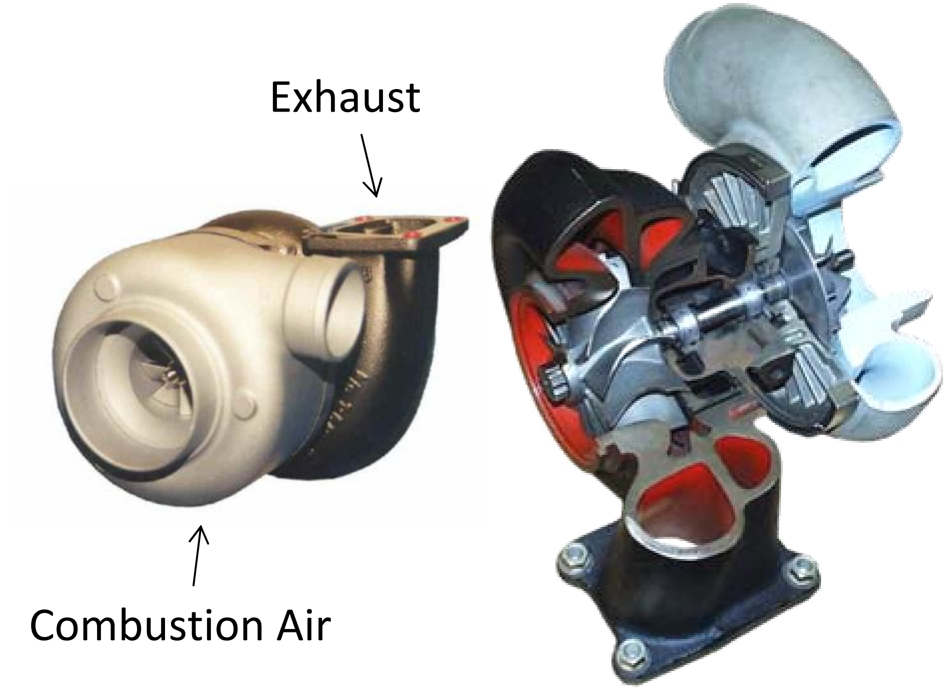
- The overboost pressure relieve valve is set to open at roughly 2 to 4 inches of mercury above the rated maximum manifold pressure of the engine

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



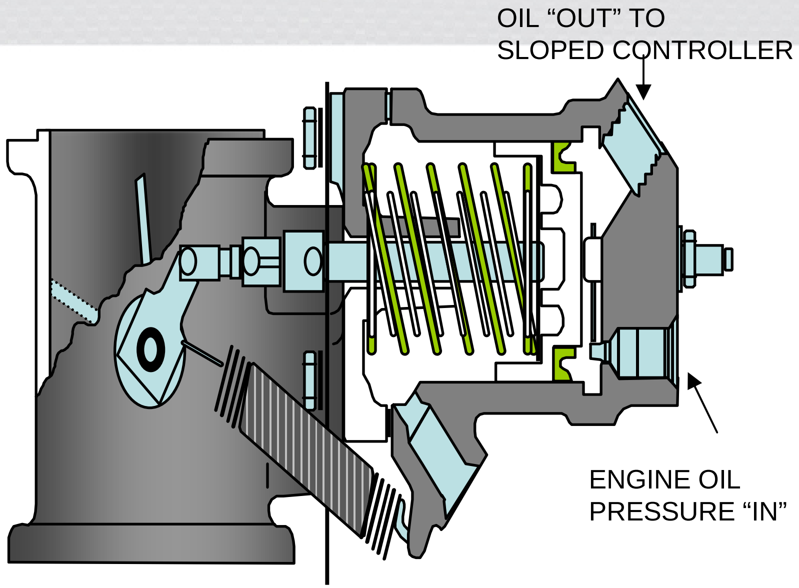
Turbo-Supercharger

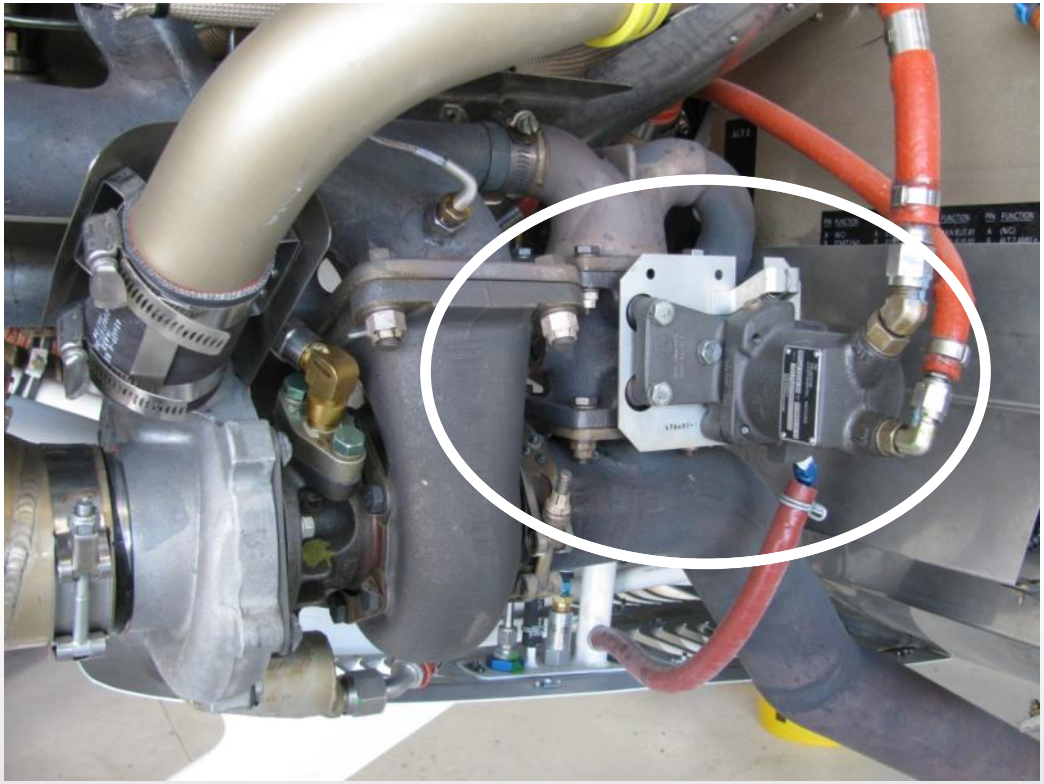
- Turbo uses accelerated exhaust gases to spin a compressor which increases the pressure in the upper deck
- Capable of +100,000 RPM
- Maximum Normal Turbo Inlet Temperature (TIT) is 1750°F, seen on MFD
- Turbo is lubricated via the engine oil system



Wastegate

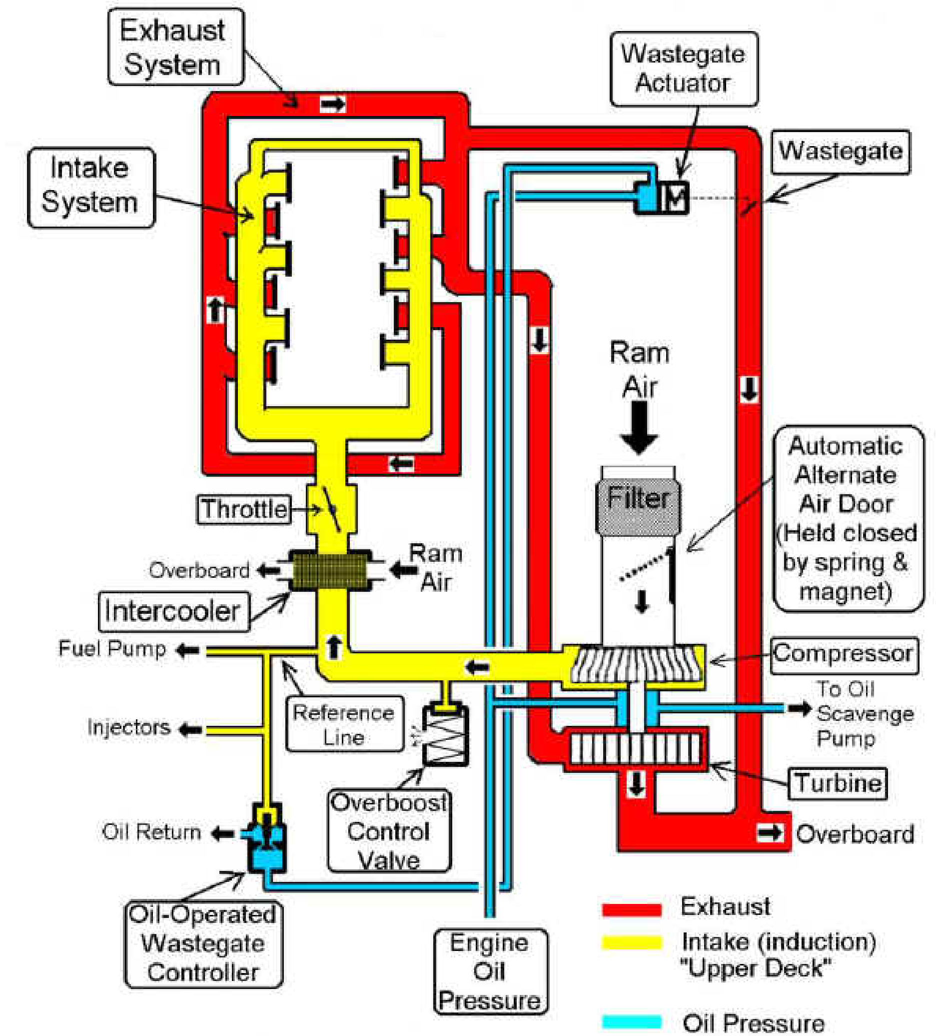
- The waste-gate is a hydraulically controlled device using engine oil pressure, to close a butterfly valve that will direct exhaust gasses to the turbocharger





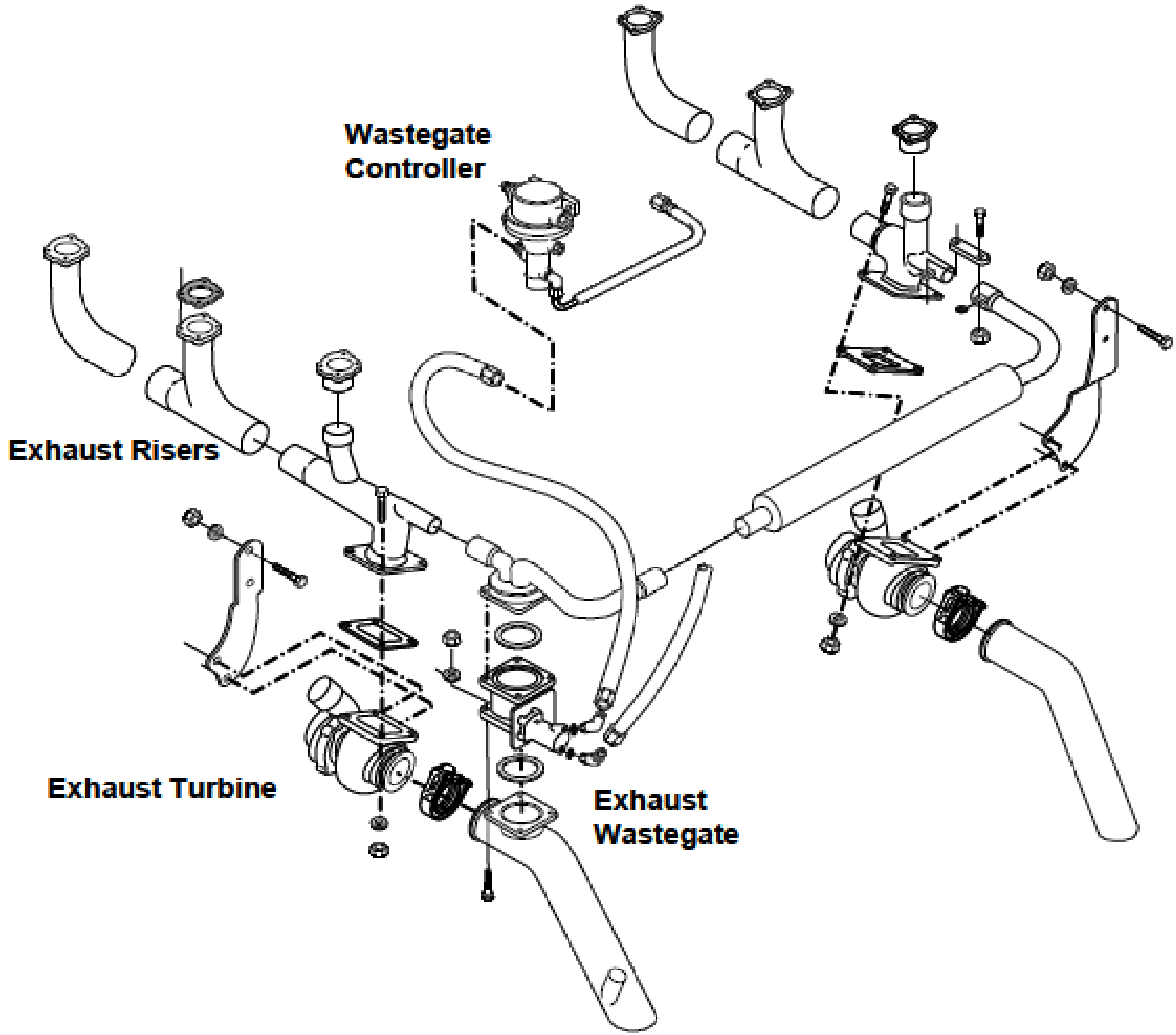
Wastegate

- 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



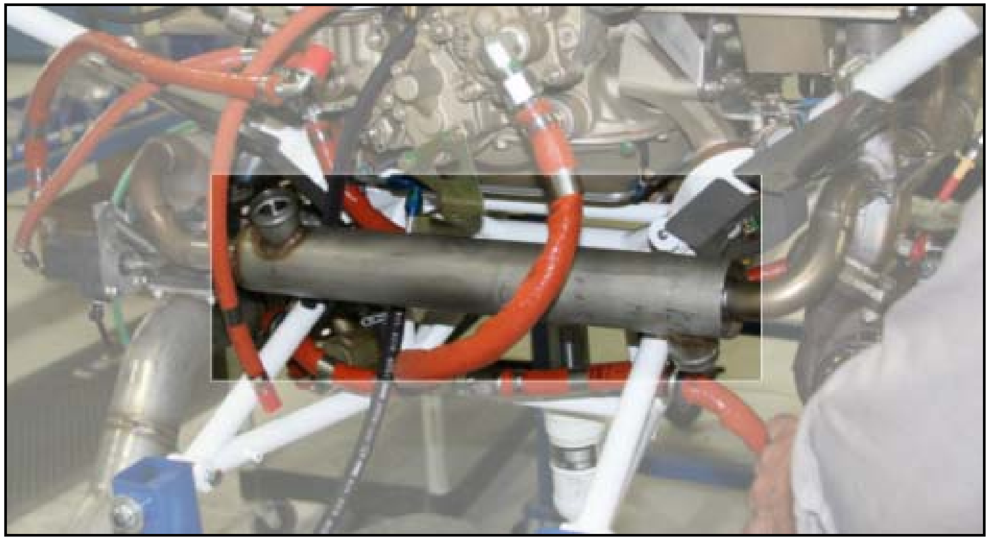
TYPICAL TURBO-SUPERCHARGER OR TURBONORMALIZER SYSTEM

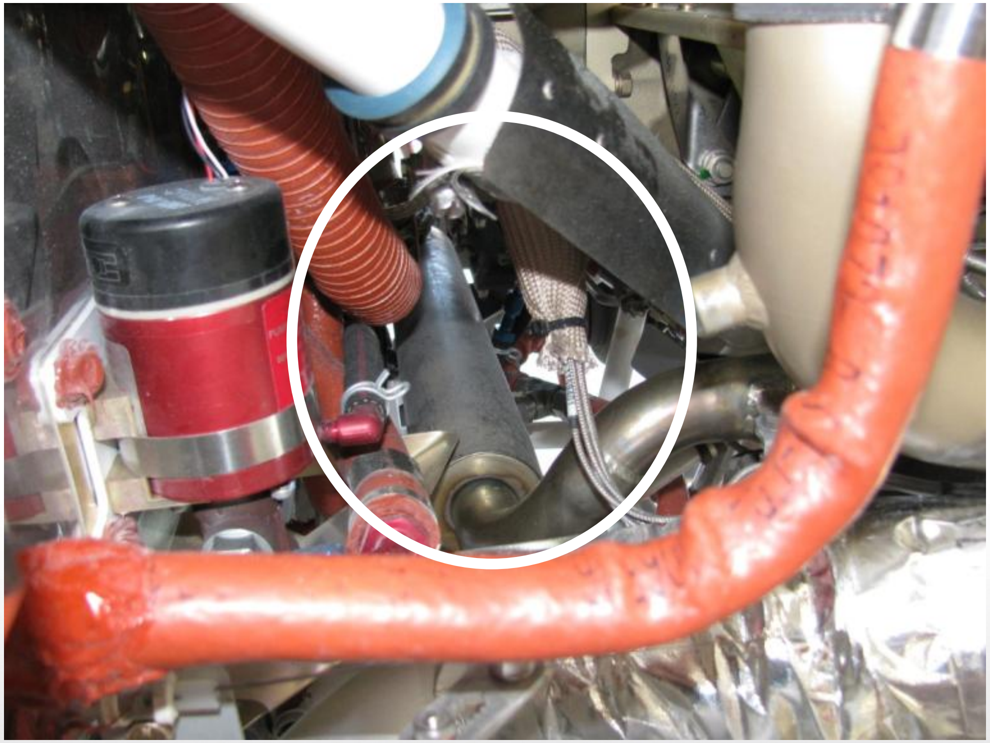
CIRRUS AIRCRAFT Red Bull AIR RACE WORLD CHAMPIONSHIP


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

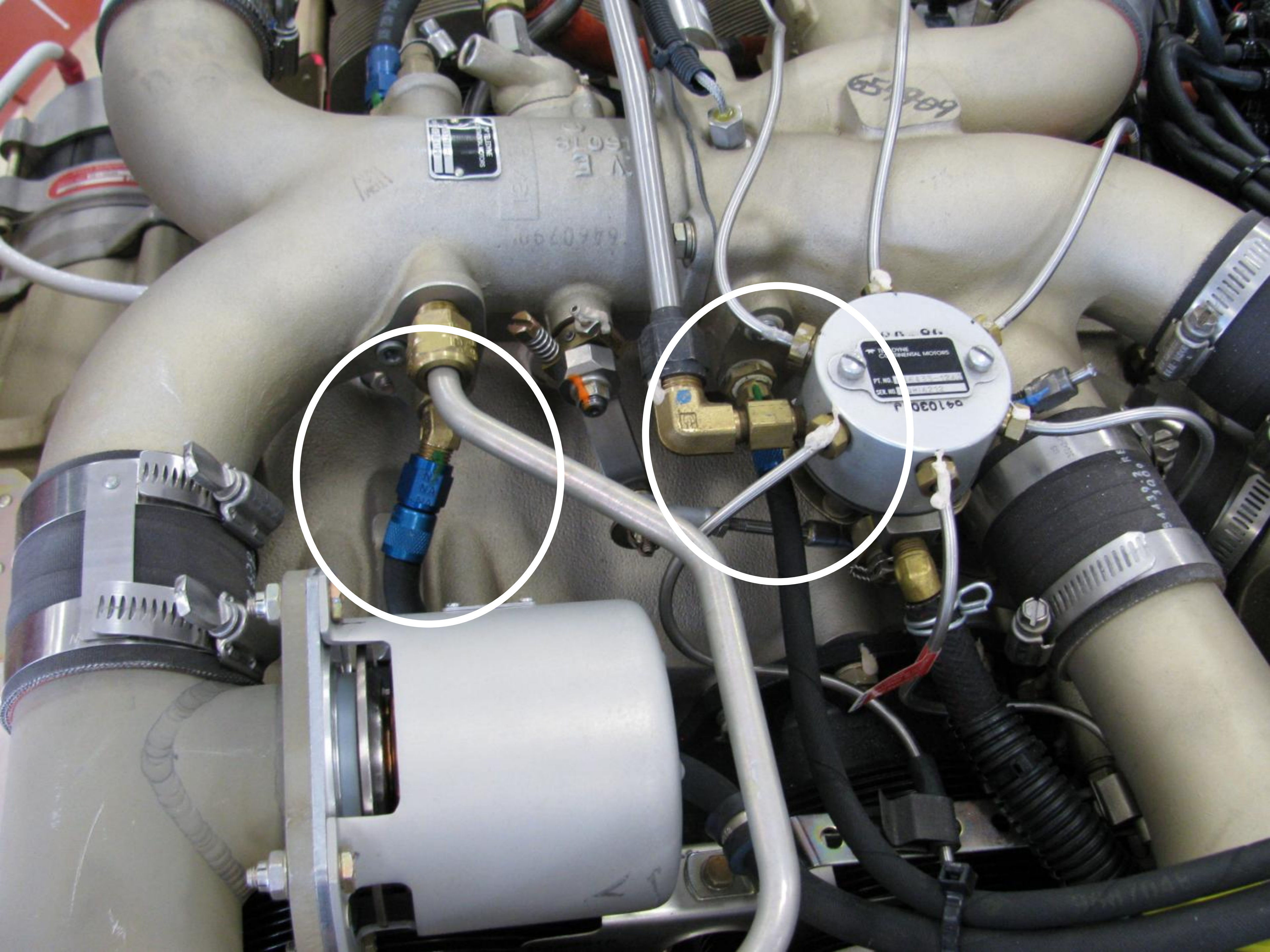




SLOPE CONTROLLER

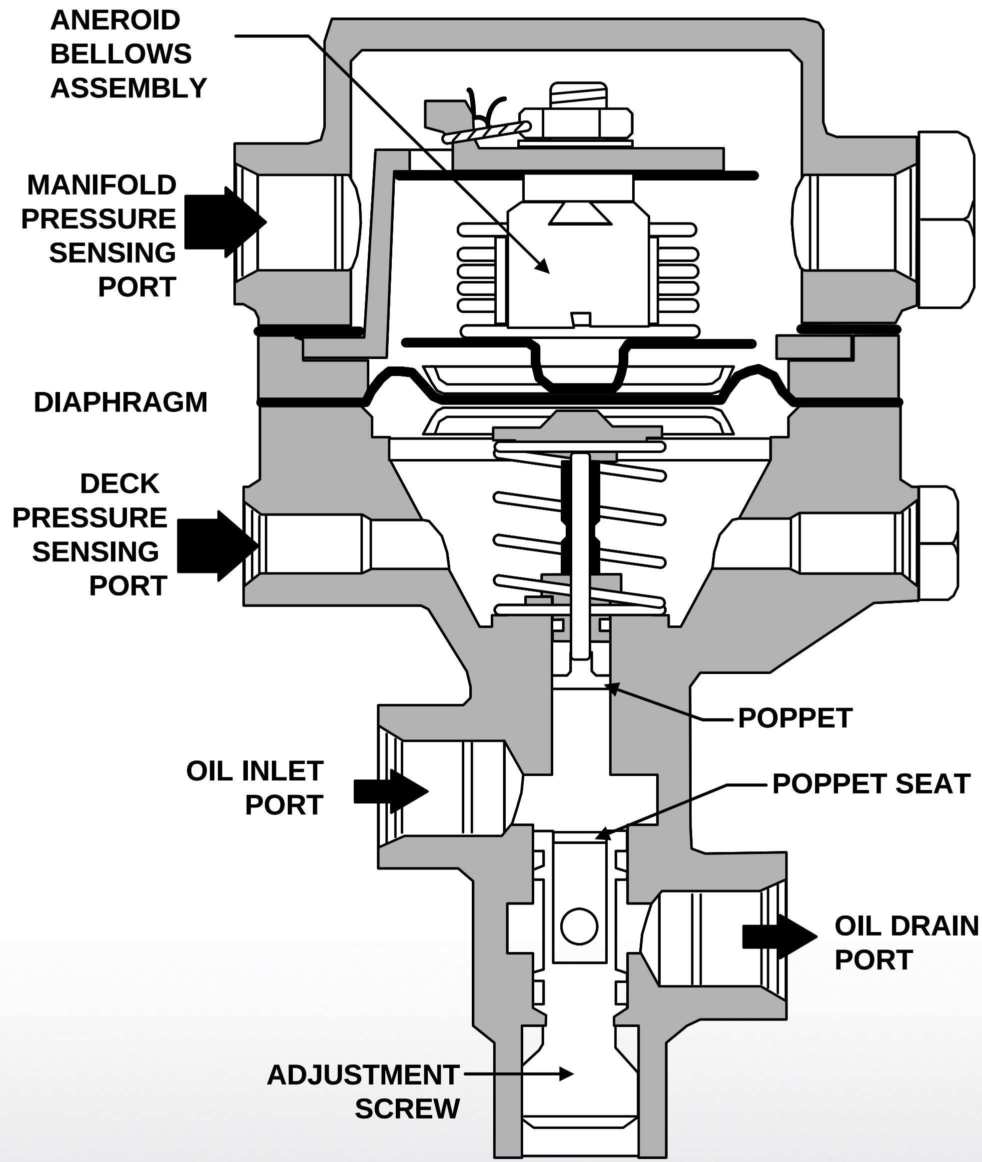
- Moves the wastegate to manage the pressure created by the turbo

- 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


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



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.

SR22T

LIMITATIONS

Airspeed Limitations

Speed	KIAS	Remarks
Vne up to 17,500 MSL	200	Never Exceed
Vne at 25,000 MSL	170	Vne is reduced linearly from 17,500 to 25,000
Vno up to 17,500 MSL	177	Maximum Structural Cruising Speed
Vno at 25,000 MSL	151	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

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 is 18,000 ft
- Aircraft will still be able to maintain 31” MAP and 85% power at 25,000 ft

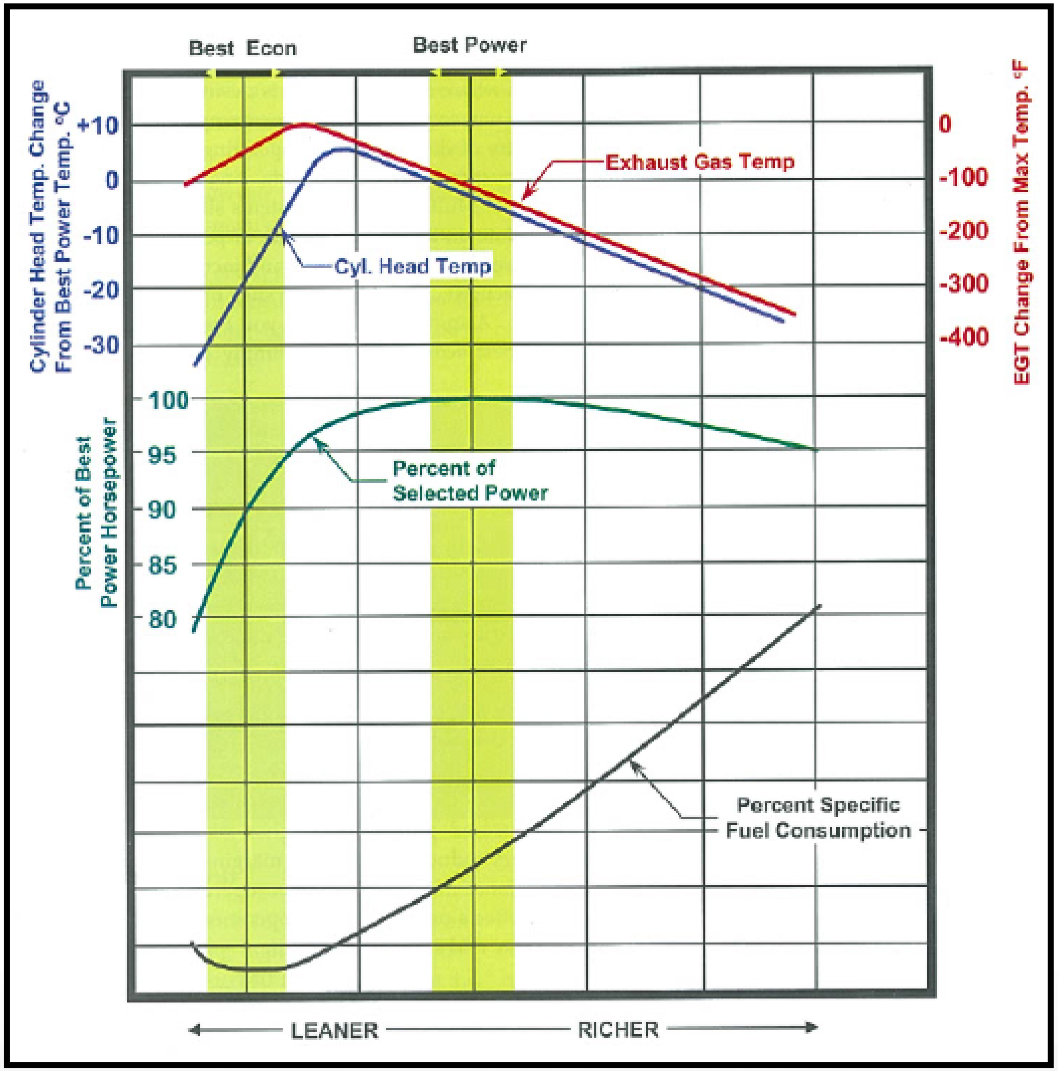
lean of peak operations

ENGINE MANAGEMENT

Operations Lean of Peak (EGT)

Note:

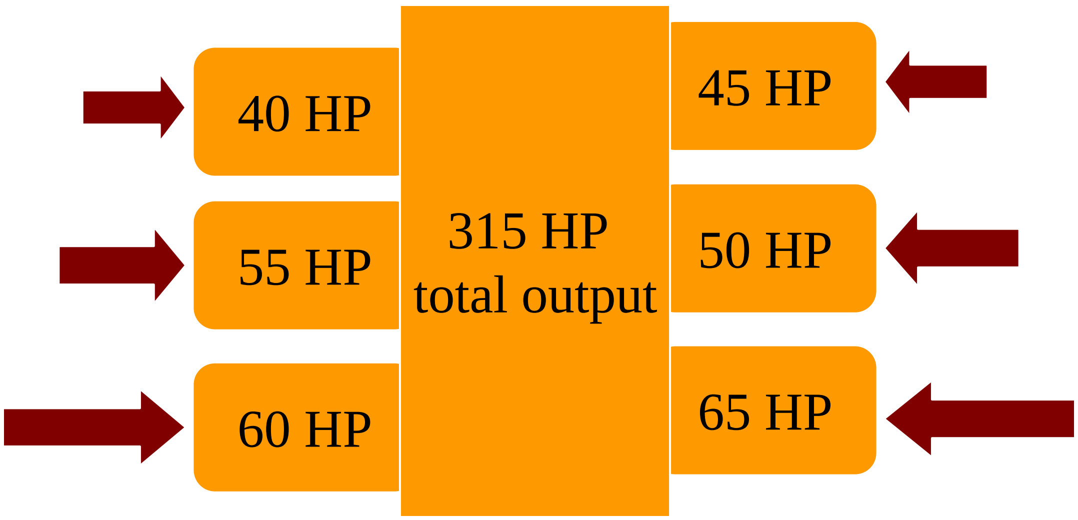
- Close relationship of CHT, ICP, HP
- Order of peaks- HP, ICP, CHT, EGT
- Curvature of peaks on the rich and lean side of peak
- Rich of peak
  - Leaner increases CHT
- Lean of peak
  - Leaner decreases CHT



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

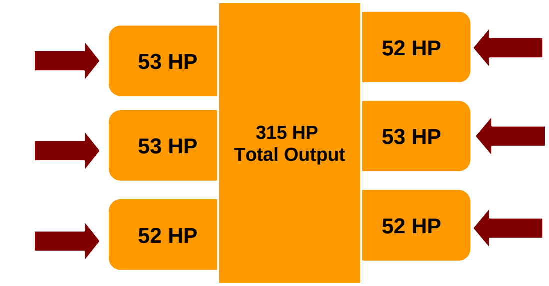
Unbalanced Injectors



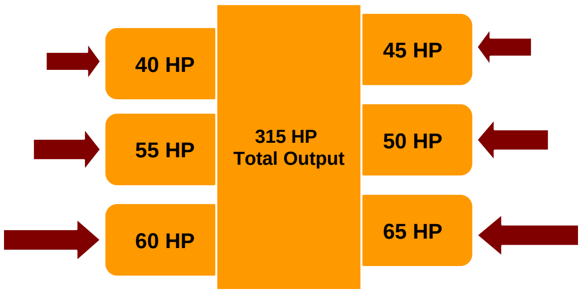
Unbalanced Fuel/Air Ratios

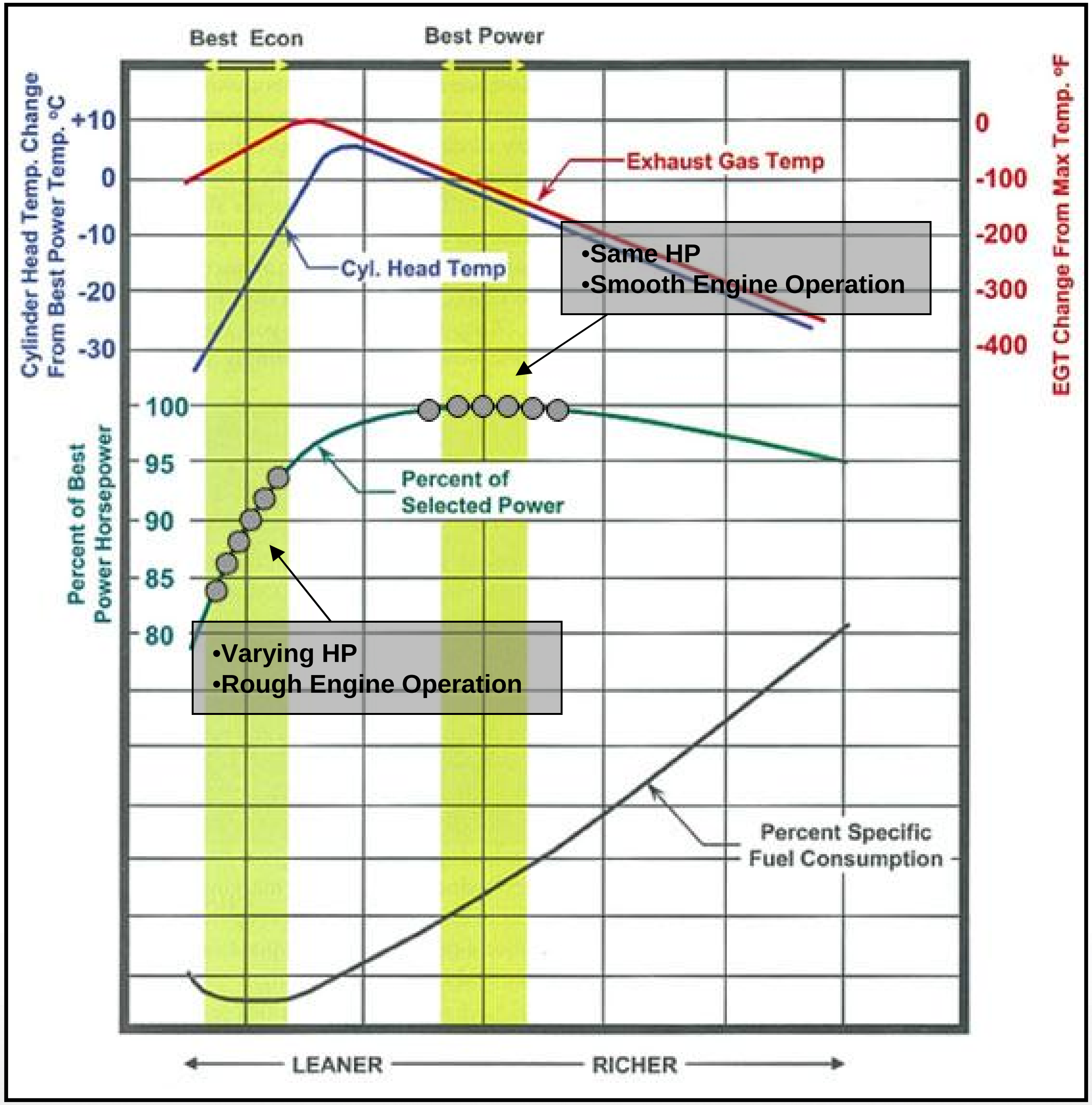
- Some cylinders receive more fuel than others
  - ROP, Same HP / Smooth
  - LOP, Varying HP / Rough

Unbalanced Injectors ROP



Unbalanced Injectors LOP

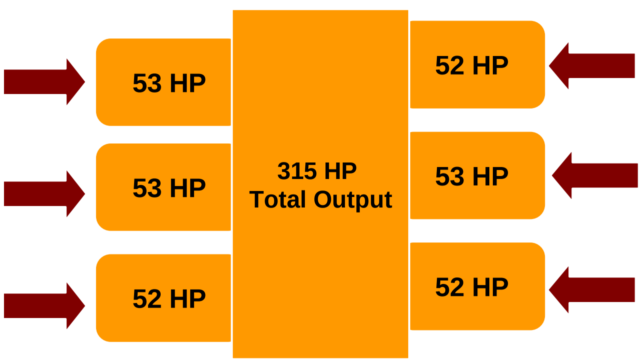


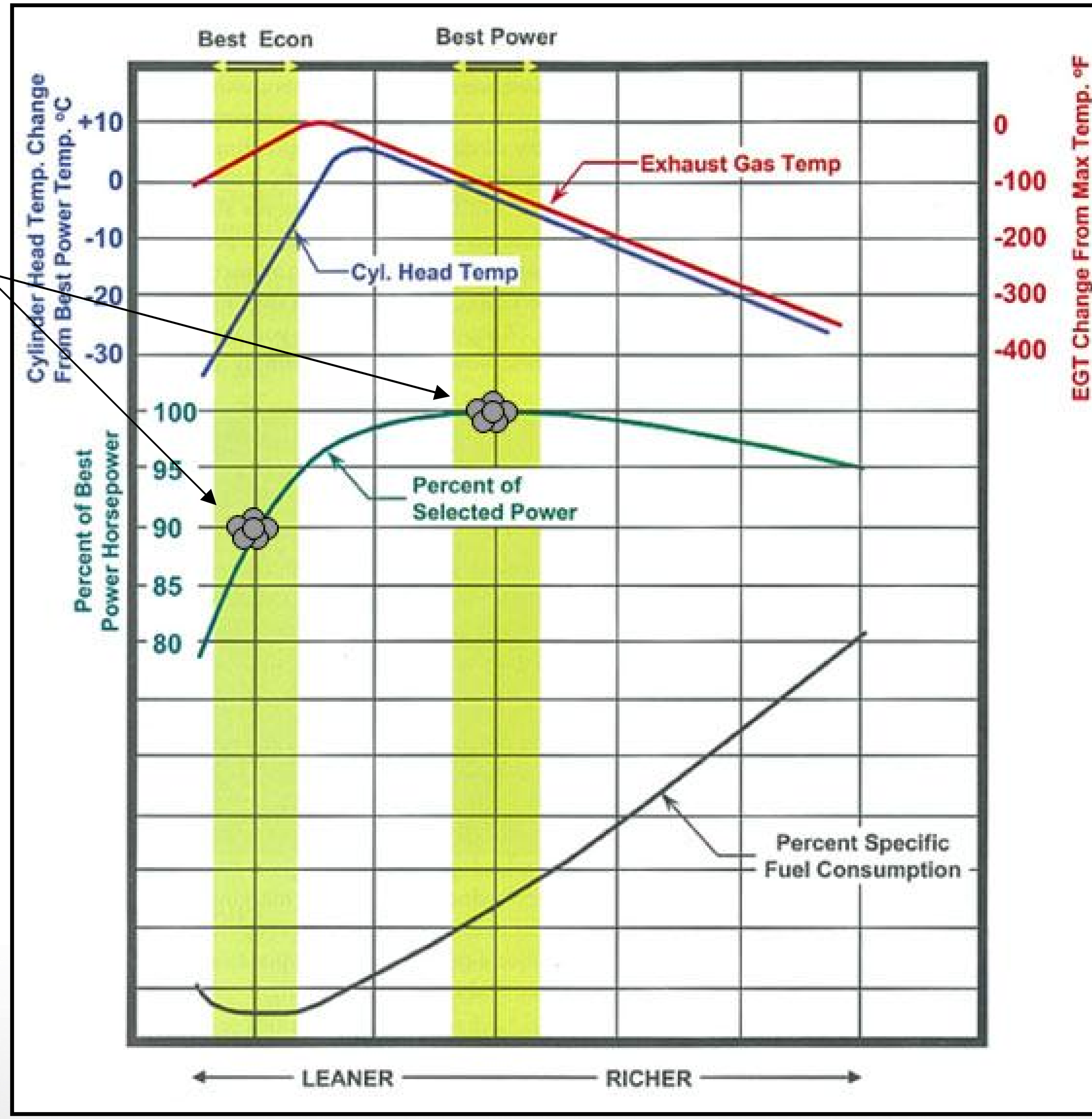


Balanced Fuel/Air Ratios

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

Balanced Injectors LOP & ROP





differences from naturally aspirated engine operations

NORMAL OPERATIONS

Preflight

- O_2 preflight
  - O_2 quantity, requirements and duration tables
  - Verify O_2 flow to each mask/cannula that will be used
- Pulse Oximeter
  - Check saturation levels on the ground and monitor during flight.
  - Adjust O_2 flow to maintain saturation levels above 90%
- Cannulas can not be used above FL180 as per FAR part 23. Masks must be worn above FL180. Plan accordingly.

Oxygen Considerations

- Do not use cannulas above FL180

- Passengers should be thoroughly briefed on the use of O_2 including:
  - Proper use of masks/cannulas and flow regulators
  - Recognition and response to hypoxia
  - Recognition and response to pilot incapacitation

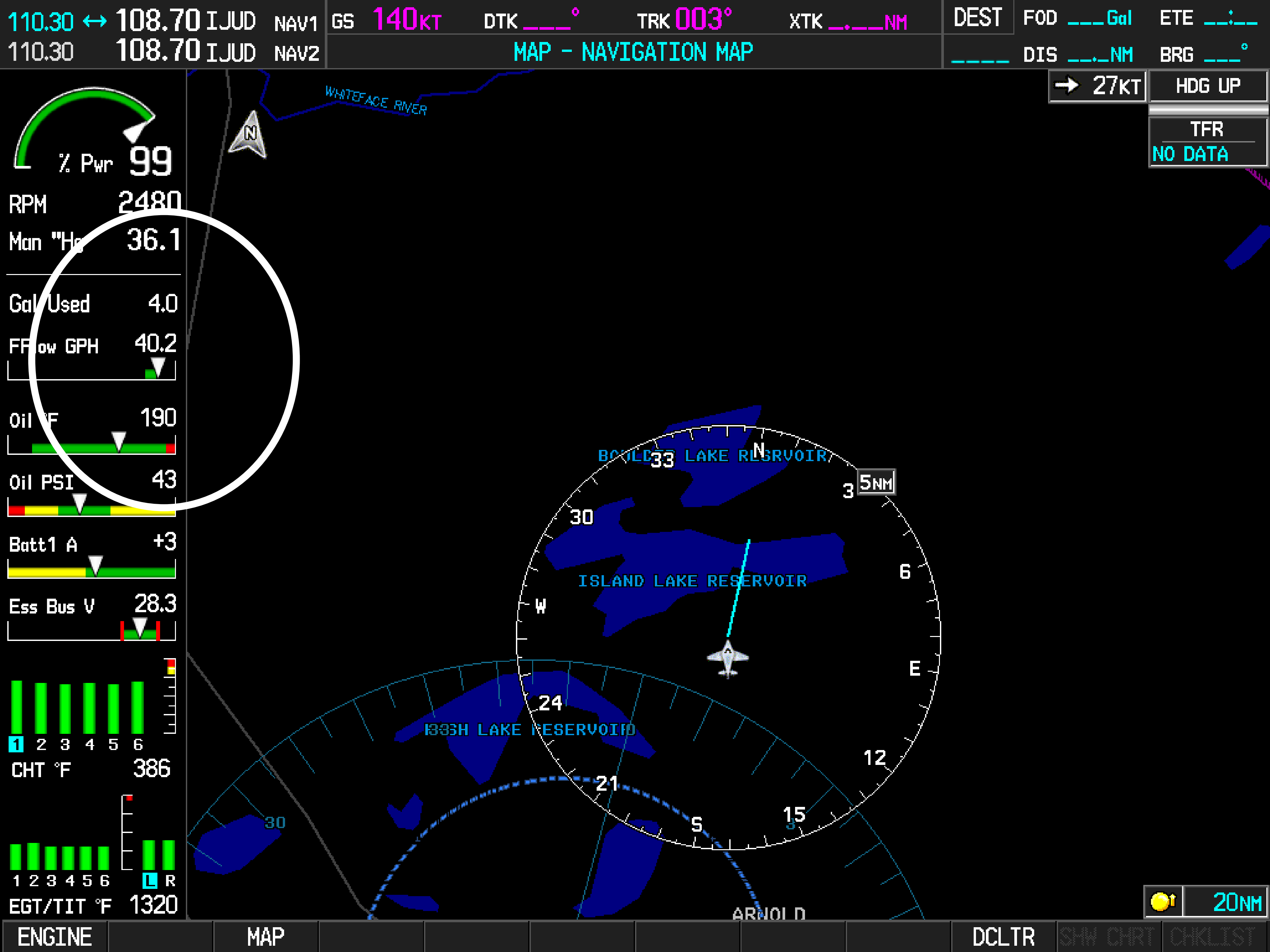
- If saturation levels decrease below 90%
  - Increase to flow of O_2
  - Increase mask seal around face
  - Descend to a lower altitude if saturation level can not be maintained above 90%

Normal Procedures

- Start
  - No Change
- Taxi
  - Lean to the “X” or max RPM
- Before takeoff
  - No Change
  - Ensure oil temperature is above 100° F before run up

Takeoff

- 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


110.30 ↔ 108.70 IJUD NAV1
110.30 108.70 IJUD NAV2
GS 140KT
DTK ___°
TRK 003°
XTK _.__NM
MAP - NAVIGATION MAP
DEST
FOD ___Gal
ETE __:__
DIS __._NM
BRG ___°
27KT
HDG UP
TFR
NO DATA
% Pwr 99
RPM 2480
Man "Hg 36.1
Gal Used 4.0
FFlow GPH 40.2
Oil °F 190
Oil PSI 43
Batt1 A +3
Ess Bus V 28.3
1 2 3 4 5 6
CHT °F 386
1 2 3 4 5 6
L R
EGT/TIT °F 1320
WHITEFACE RIVER
ISLAND LAKE RESERVOIR
5NM
20NM
ARNOLD
ENGINE
MAP
DCLTR
SHW CHRT
CHKLIST

Normal Procedures- Climb

- 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

- Cruise Climb: Lean of Peak Technique
  - Power Lever – 30.5” MAP
  - Mixture – Cyan Target or less
  - 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

Normal Procedures- Cruise

- 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

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

Normal Procedures

- Descent
  - 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”
  - Mixture – Maintain CHT’s above 240 ° F

- Approach/Landing
  - Mixture full rich prior to traffic pattern or IAF

Normal Procedures

- After Landing
  - Mixture – Lean to X or max RPM rise

- Shutdown
  - No change

True or False?

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

See speaker notes for answer.

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?

See speaker notes for answer

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?

Emergency Procedures

Specific to Turbo Operations

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

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

Scenario

Shortly after leveling out at 22,000 you set the cruise power, lean the mixture and turn your boost pump off and your engine fails.

- What do you do?
- Why did the engine fail?

See speaker notes for answer.

Engine Failure

- One cause of engine failure may be from reducing the power to idle with the mixture set near or at full rich. Altitude and fuel pump operation will affect the failure conditions.

Note: The cause of the engine failure is an excessively rich mixture of fuel and air, essentially flooding the engine.

Note: If this is not cause of the failure refer to the engine failure in flight checklist procedure.

- First reaction to failure
  - Increase throttle control
- If that does not work
  - Auxiliary fuel pump off
  - Throttle ½ open
  - Mixture control lean until engine starts
  - Throttle, mixture and fuel pump reset for normal operation.
    - Richen the mixture slowly after engine start then increase the throttle.