FLYING 20 CLUB, Inc.

LEANING LYCOMINGS

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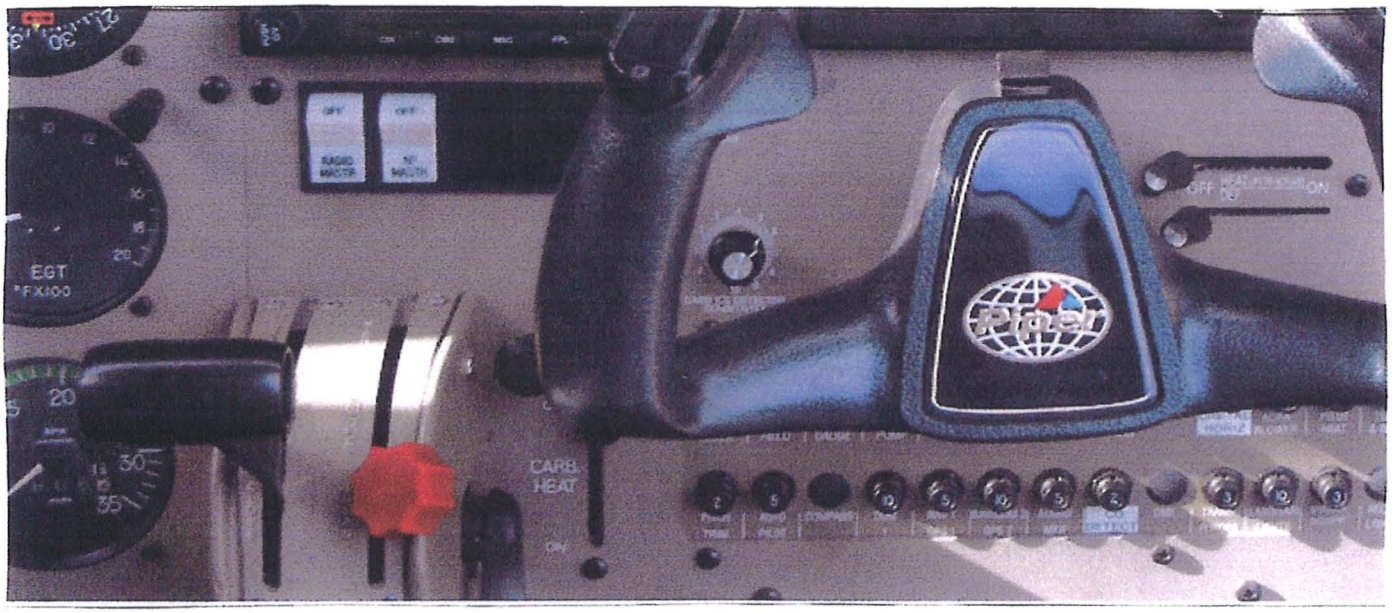
Presentation to members of the Flying 20 Club

September 14, 2011



A Brief Explanation of Plug Fouling

Per Steve DiSorbo, our Chief Mechanic, the threat of plug fouling will always be present when engines burn leaded fuel (Tetra Ethyl Lead or TTL).

According to Shell Aviation, the Tetra Ethyl Lead used in the fuel naturally degrades to form Lead Oxide when it is burned.

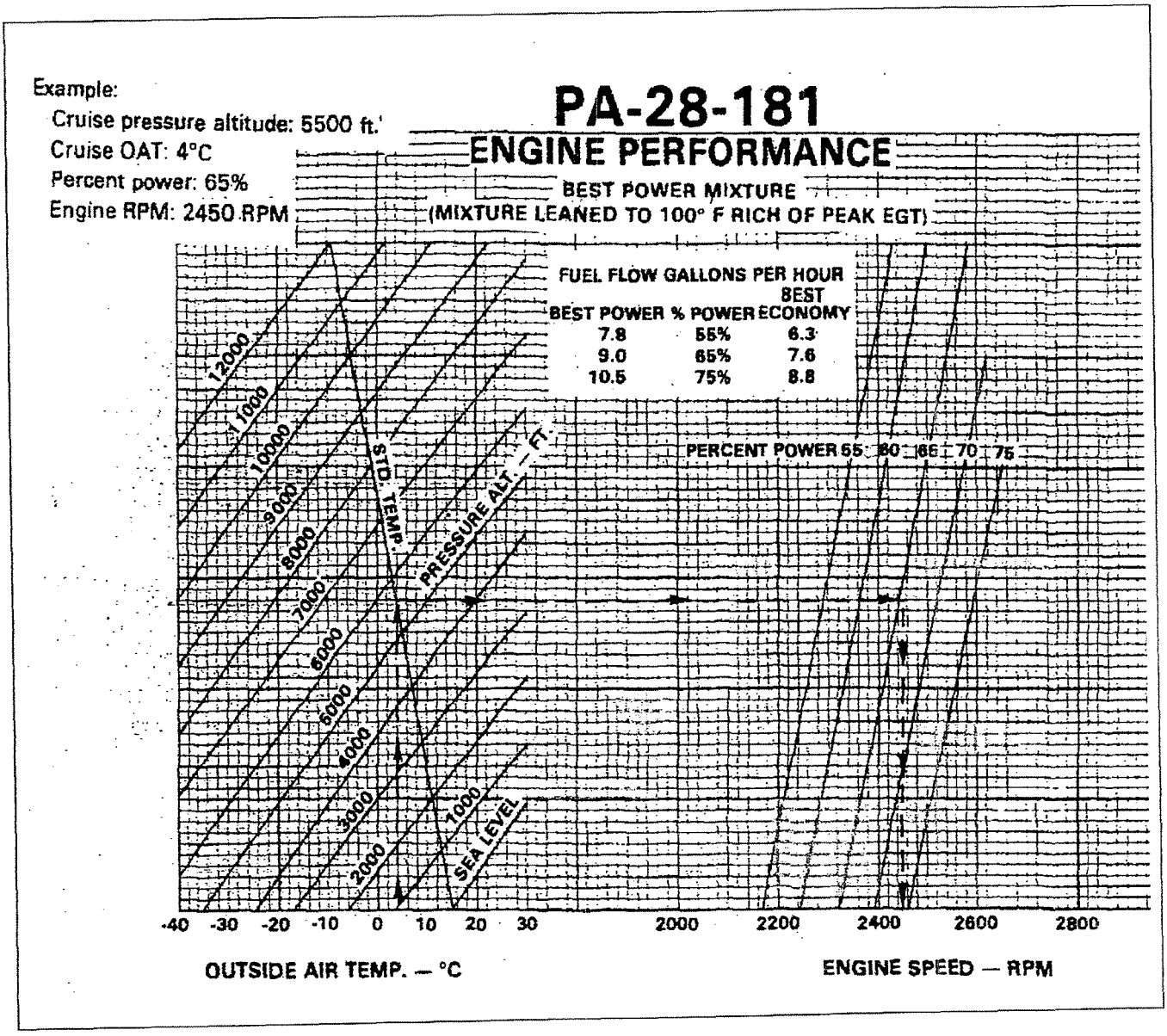
The problem is that Lead Oxide is a solid up to about 900 deg C which is well within the wall temperatures inside a piston engine. In order to prevent these deposits from forming, a lead scavenging compound is added to Avgas 100LL - this compound is Ethylene Dibromide.

This scavenger is designed to react with the Lead Oxide to form Lead Bromide which is more volatile - becoming a gas at around 200 - 250 deg C. This is a low enough temperature to ensure that the lead is removed from the engine as a gas and it subsequently goes back to the solid phase as the exhaust gas cools in the atmosphere.

Steve stated that pilots can minimize plug fouling situations by leaning aggressively on the ground and keeping the RPM at around 1200.

These two techniques will keep the spark plug tip above 800 degrees, thereby making the lead scavenging agent in the fuel more efficient.

You should also consider aggressive leaning on the ground at your DESTINATION. This is especially true if you have had a long low power approach and/or long wait/taxi times on the ground upon arrival at your destination.



WHY LEAN OUR ENGINES

Notice that even at only 5500 Ft. on a standard day it will take almost 2600 RPM for our engine to attain a power setting of 75%. At this power level and any level below 75% we may safely lean the engine to peak EGT. So, high RPMs do not automatically equate to very high power settings that would preclude aggressive leaning. This relationship holds at any altitude, even at sea level, so long as we use an RPM setting that yields 75% power or less. From the chart above we see that these lean power settings will result in considerable savings of fuel consumed. In the case of 75% operation, the saving is 1.8 Gal. per hour. This saving results in an increase in endurance of more than an hour which translates to an additional range of well over 100 miles.

An extra benefit of aggressive leaning is the almost complete elimination of plug fouling. To gain the full benefit of reduced plug fouling we must lean in all flight regimes, even on Prolonged descents and, especially, when taxiing.

Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes. The mixture should be leaned during cruising operation above 5000 ft. altitude and at pilot's discretion at lower altitudes when 75% power or less is being used. If any doubt exists as to the amount of power being used, the mixture should be in the full RICH position for all operations under 5000 feet.

To lean the mixture, disengage the lock and pull the mixture control until the engine becomes rough, indicating that the lean mixture limit has been reached in the leaner cylinders. Then enrich the mixture by pushing the control towards the instrument panel until engine operation becomes smooth.

If the airplane is equipped with the optional exhaust gas temperature (EGT) gauge, a more accurate means of leaning is available to the pilot. Best economy mixture is obtained by moving the mixture control aft until peak EGT is reached. Best power mixture is obtained by leaning to peak EC and then enrichening until the EGT is 100° F. rich of the peak value. Under some conditions of altitude and throttle position, the engine may exhibit roughness before peak EGT is reached. If this occurs, the EGT corresponding to the onset of engine roughness should be used as the peak reference value.

Always remember that the electric fuel pump should be turned ON before switching tanks, and should be left on for a short period thereafter, in order to keep the airplane in best lateral trim during cruising flight the fuel should be used alternately from each tank, it is recommended that one tank be used for one hour after takeoff, then the other tank be used for two hours; then return to the first tank, which will have approximately one and one half hours of fuel remaining if the tanks were full at takeoff. The second tank will contain approximately one half hour of fuel. Do not run tanks completely dry in flight. The electric fuel pump should be normally OFF so that any malfunction of the engine driven fuel pump is immediately apparent. If signs of fuel starvation should occur at any time during flight, fuel exhaustion should he suspected, at which time the fuel selector should be immediately positioned to the other tank and the electric fuel pump switched to the ON position.

4.29 DESCENT NORMAL

To achieve the performance on Figure 5-29 the power on descent must be used. The throttle should be set for 2500 RPM, mixture full rich and maintain an airspeed of 122 KIAS. in case carburetor ice is encountered apply full carburetor heat.

4.25 CLIMB

The best rate of climb at gross weight will be obtained at 85 KIAS. The best angle of climb may be obtained at 73 KIAS. At lighter than gross weight these speeds are reduced somewhat*. For climbing en route, a speed of 100 KIAS is recommended. This will produce better forward speed and increased visibility over the nose during the climb.

When reaching the desired altitude, the electric fuel pump may be turned off.

4.27 CRUISING

The cruising speed is determined by many factors, including power setting, altitude, temperature, loading and equipment installed in the airplane.

The normal maximum cruising power is 75% of the rated horsepower of the engine. When selecting cruising RPM below 2300, limiting manifold pressure for continuous operation, as specified by the appropriate "Avco-Lycoming Operator's Manual," should be observed.

To obtain the desired power, set the manifold pressure and RPM according to the power setting table in this manual.

Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes. The mixture should be leaned during cruising operation above 5000 ft. altitude and at pilot's discretion at lower altitudes when 75% power or less is being used. If any doubt exists as to the amount of power being used, the mixture should be in the full RICH position for all operations under 5000 feet.

To lean the mixture, disengage the lock and pull the mixture control until the engine becomes rough, indicating that the lean mixture limit has been reached in the leaner cylinders. Then enrich the mixture by pushing the control towards the instrument panel until engine operation becomes smooth.

*To obtain the performance presented in the Performance Section of this handbook, full power (full throttle and 2400 RPM) must be used. Above 8000 feet I.S.A., reduce airspeed one knot per 1000 feet altitude and lean mixture to 125°F rich of peak EGT.

If the airplane is equipped with the optional exhaust gas temperature (EGT) gauge, a more accurate means of leaning is available to the pilot. For this procedure, refer to the "Avco-Lycoming Operator's Manual."

The continuous use of carburetor heat during cruising flight decreases engine efficiency. Unless icing conditions in the carburetor are severe, do not cruise with the heat on. Apply full carburetor heat slowly and only for a few seconds at intervals determined by icing severity. Use of partial carburetor heat is not recommended.

In order to keep the airplane in best lateral trim during cruise flight, the fuel should be used alternately from each main tank. It is recommended that one main tank be used for one hour after takeoff, the other main tank used until nearly exhausted, then return to the first main tank.

Always remember that the electric fuel pump should be turned ON before switching tanks, and should be left on for a short period thereafter. To preclude making a hasty selection, and to provide continuity of flow, the selector should be changed to another tank before fuel is exhausted from the tank in use. The electric fuel pump should be normally OFF so that any malfunction of the engine driven fuel pump is immediately apparent. If signs of fuel starvation should occur at any time during flight, fuel exhaustion should be suspected, at which time the fuel selector should be immediately positioned to a full tank and the electric fuel pump switched to the ON position. Fuel tank selection at low altitude is not recommended, since little recovery time is available in the event of an error in tank selection. When switching tanks, make sure that the selector drops into a detent and is lined up with the desired tank.

4.28 DESCENT

NORMAL

To achieve the performance on Figure 5-31 the power on descent must be used. The throttle should be set for 1000 FPM descent, propeller 2400 RPM, mixture full rich and maintain an airspeed of 137 KIAS. In case carburetor ice is encountered apply full carburetor heat.

POWER OFF

If a prolonged power off descent is to be made, apply full carburetor heat prior to power reduction if icing conditions are suspected. Throttle should be

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SERVICE INSTRUCTION

Service Instruction No. 1094D
(Supersedes Service Instruction No. 1094C)
Engineering Aspects are
FAA Approved

DATE: March 25, 1994

SUBJECT: Fuel Mixture Leaning Procedures

MODELS AFFECTED: All Textron Lycoming Opposed Series Engines

TIME OF COMPLIANCE: As required during aircraft operation.

Revision "D" to Service Instruction on No. 1094 supersedes all previous recommendations and should be used for engine leaning during normal flight operations. **ALL LEANING RECOMMENDATIONS ARE BASED ON CALIBRATED INSTRUMENTATION.**

Textron Lycoming strongly recommends that all engine instrumentation be calibrated annually. All instrumentation for manifold pressure, engine RPM, oil temperature, cylinder head temperature, exhaust gas temperature, and turbine inlet temperature in the aircraft should be included in this annual calibration.

Regardless of the fuel metering device, fuel management of normally aspirated engines is primarily dependant on the instrumentation available. The method is the same for both fixed and controllable pitch propellers.

Textron Lycoming recommendations for leaning turbocharged engines in this Service Instruction refers to Textron Lycoming supplied turbocharged engines. For aftermarket turbocharger installations, contact STC holder for proper leaning instructions.

CHT (cylinder head temperature) and TIT (turbine inlet temperature) probes are required for leaning turbocharged engines. Refer to latest edition of Service Instruction No. 1422 for proper TIT probe locations and depth.

A. GENERAL RULES.

1. Without exception, observe the red line temperature limits during take-off, climb and high performance cruise power operation.

(a) Cylinder head temperature-maximum limit listed in the Textron Lycoming operator's manual.

(b) Oil temperature limit - maximum limit listed in the Textron Lycoming operator's manual.

(c) TIT - maximum allowable limit specified in the Textron Lycoming operator's manual.

2. Whenever mixture is adjusted, rich or lean, it should be done slowly.

3. ALWAYS RETURN MIXTURE SLOWLY TO FULL RICH BEFORE INCREASING POWER SETTINGS.

4. At all times, caution must be taken not to shock cool the cylinders. The maximum recommended temperature change should not exceed 50°F. per minute.

B. LEANING THE NORMALLY ASPIRATED ENGINES.

1. Use full rich mixture during take-off or climb. Careful observation of engine temperature instruments should be practiced to ensure limits specified in Textron Lycoming operator's manual are never exceeded. Refer to the aircraft POH (pilot's operating handbook) or AFM (aircraft flight manual) for more specific instructions.

2 For 5000 ft. density altitude and above or high ambient temperatures, roughness or reduction of power may occur at full rich mixture. The mixture may be adjusted to obtain smooth engine operation. For fixed pitch propeller, lean to maximum RPM at full throttle prior to take-off where airports are 5000 ft. density altitude or higher. Limit operation at full throttle on the ground to a minimum. For direct drive normally aspirated engine with a prop governor but without fuel flow or EGT, set throttle at full power and lean mixture at maximum RPM with smooth operation of the engine as a deciding factor.

3. For cruise powers where best power mixture operation is allowed, slowly lean the mixture from full rich to maximum power. Best power mixture operation provides the most miles per hour for a given power setting. For engines equipped with fixed pitch propellers, gradually lean the mixture until either the tachometer or the airspeed indicator reading peaks. For engines equipped with controllable pitch propellers, lean until a slight increase of airspeed is noted.

4. For a given power setting, best economy mixture provides the most miles per gallon. Slowly lean the mixture until engine operation becomes rough or until engine power rapidly diminishes as noted by an undesirable decrease in airspeed. When either condition occurs, enrich the mixture sufficiently to obtain an evenly firing engine or to regain most of the lost airspeed or engine **RPM.** Some engine power and airspeed must be sacrificed to gain a best economy mixture setting.

NOTE

When leaned, engine roughness is caused by misfiring due to a lean fuel-air mixture which will not support combustion. Roughness is eliminated by enriching slightly until the engine is smooth.

4. The exhaust gas temperature (EGT) offers little improvement in leaning the float-type carburetor over the procedures outlined above because of imperfect mixture distribution. However, if the EGT probe is installed, lean the mixture to 100°F. on the rich side of peak EGT for best power operation. For best economy cruise, operate at peak EGT. If roughness is encountered, enrich the mixture slightly for smooth engine operation.

5. When installing an EGT probe, the probe must be installed in the leanest cylinder. Contact the airframe or kit manufacturer for the correct location. In experimental or custom applications, multiple probe instrumentation is required and several power settings should be checked in order to determine the leanest cylinder for the specific application.

6. During normal operation, maintain the following recommended temperature limits:

   (a) Cylinder head temperature - limit listed in the Textron Lycoming operator's manual.

   (b) Oil temperature - limit listed in the Textron Lycoming operator's manual.

7. **For maximum service life, maintain the following recommended limits for continuous cruise operation:**

   (a) Engine Power Setting - 65% of rated or less.

   (b) **Cylinder head temperatures - 400°F. or below.**

   (c) **Oil temperature - 165°F. - 220°F.**

C. LEANING THE TURBOCHARGED TEXTRON LYCOMING POWERPLANT.

1. The cylinder head temperature (CHT) and turbine inlet temperature (TIT) gages are required instruments for leaning with turbocharging by Textron Lycoming. EGT probes on individual cylinders should not be used for leaning.

2. During manual leaning, the maximum allowable TIT for a particular engine must not be exceeded. Check the POH/AFM or the Textron Lycoming operator's manual to determine these temperatures and fuel flow limits.

3. Maintaining engine temperature limits may require adjustments to fuel flow, cowl flaps, or airspeed for cooling.

4. All normal take-offs, with turbocharged powerplants must be at full rich mixture regardless of airport elevation.

5. If manual leaning of the mixture is permitted at take-off, climb power, or high performance cruise, it will be specified in the POH/AFM and will list required ranges for fuel flow, power settings, and temperature limitations.

6. Leaning to best economy mixture.

(a) Set manifold pressure and RPM for the desired cruise power setting per the aircraft POH/AFM.

(b) Lean slowly in small steps, while monitoring instrumentation, to peak TIT or maximum allowable TIT whichever occurs first.

7. Leaning to best power mixture.

Before leaning to best power mixture, it is necessary to establish a TTT reference point. This is accomplished as follows:

(a) Set manifold pressure and RPM for the highest cruise power setting where leaning to best economy is permitted per the aircraft POH/AFM.

(b) Lean slowly in small steps until peak TIT or maximum allowable is reached. Record peak TIT as a reference point.

(c) Deduct 125°F. from this reference and thus establish the TIT temperature for best power mixture operation.

(d) Return the mixture to full rich and adjust manifold pressure and RPM for the desired cruise conditions.

(e) Lean mixture to the TIT temperature for best power mixture operation established in step (c).

8. During normal operation, maintain the following limits:

(a) Engine power setting - rating listed in the Textron Lycoming operator's manual.

(b) Cylinder head temperature - limit listed in the Textron Lycoming operator's manual.

(c) Oil temperature - limit listed in the Textron Lycoming operator's manual.

(d) Turbine inlet temperature - limit listed in the Textron Lycoming operator's manual.

9. **For maximum service life, maintain the following recommended limits for continuous operation:**

   (a) Engine power setting - 65% of rated or less.

   (b) Cylinder head temperature - 400°F. or below.

   (c) Oil temperature - 165°F. - 220°F.

   (d) Turbine inlet temperature - maintain 100°F. on rich side of maximum allowable.

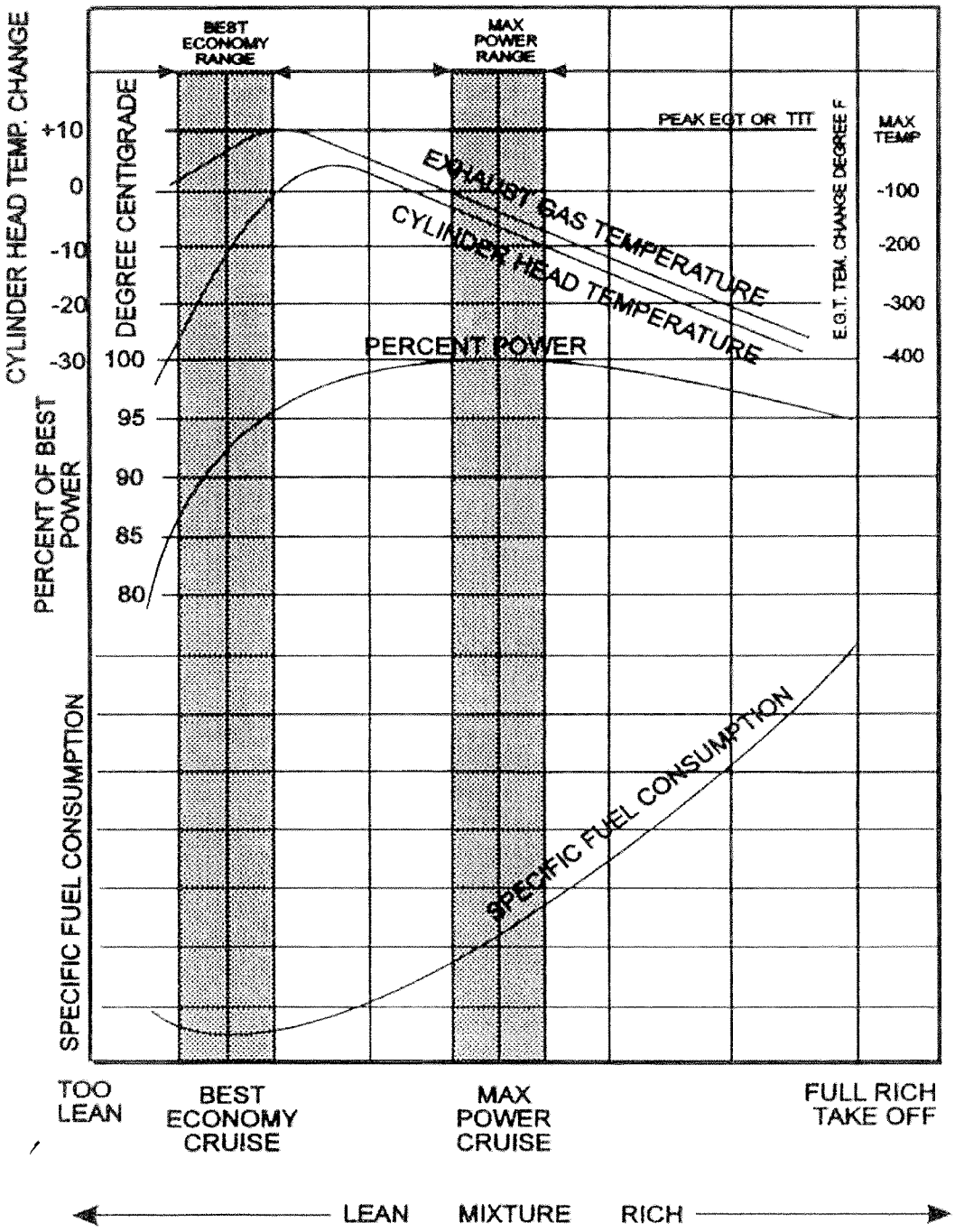
D. LEANING THE SUPERCHARGED TEXTRON LYCOMING POWERPLANTS.

1. All take-offs with supercharged powerplants must be at full rich mixture regardless of the airport elevation.

2. If manual leaning of the mixture is permitted at climb power, it will be specified in the POH/ AFM and will list required ranges for fuel flow, power settings, and temperature limitations.

3. Recommended standard cruise power for the supercharged engine is 65%. At 65% power or less, this type of engine may be leaned as desired as long as the engine operates smoothly, and temperatures and pressures are within manufacturer's prescribed limit.

4. The exhaust gas temperature (EGT) gage is a helpful instrument for leaning the supercharged engine at cruise power with a manual mixture control.



THIS REPRESENTATIVE DIAGRAM SHOWS THE EFFECT OF LEANING ON: CYLINDER HEAD TEMPERATURE, EXHAUST GAS TEMPERATURE OR TIT, ENGINE POWER, AND SPECIFIC FUEL CONSUMPTION FOR A CONSTANT ENGINE RPM AND MANIFOLD PRESSURE.

NOTE

TEXTRON LYCOMING DOES NOT RECOMMEND OPERATING ON THE LEAN SIDE OF PEAK EGT.