Condensed from two articles on this subject

Many Lycoming engines designated as low compression engines were originally certified to use Grade 80 aviation gasoline. The fuel was rated at 80 octane when the engine was leaned for cruise, and at 87 octane when it was set at rich for takeoff and climb. This aviation gasoline contained one half milliliter of lead per gallon. Owners of aircraft that use engines certified to use Grade 80 fuel occasionally have questions about the use of higher leaded fuels.

During the mid-1970s, announcement of a single grade aviation fuel for all reciprocating aircraft engines created a furor which gradually faded away as pilots and mechanics became more knowledgeable of the actual effects of using the new fuel, Grade 100LL. Grade 100LL has two milliliters of lead per gallon and is rated at 100 octane when the engine is leaned for cruise, and at 130 octane when the mixture is set at rich. The fuel is designated as "low lead" because the previous fuel with a 100/130 octane rating contained twice as much lead, four milliliters per gallon.

For all practical purposes, Grade 80 fuel with one half milliliter of lead has been phased out and is no longer available. Use of Grade 100LL fuel in engines certified for 80 octane fuel can result in increased engine deposits both in the combustion chamber and in the engine oil. It may require increased spark plug maintenance and more frequent oil changes. The frequency of spark plug maintenance and oil drain periods will be governed by the type of operation. Operation at full rich mixture requires more frequent maintenance periods; therefore it is important to use approved mixture leaning procedures.

To reduce or keep engine deposits at a minimum when using the leaded fuel available today, it is essential that the following four conditions of operation and maintenance are applied. These procedures are taken directly from Service Letter No. L185.

A. GENERAL RULES

1. Never lean the mixture from full rich during take-off, climb, or high performance cruise operation unless the airplane owners manual advises otherwise. However, during takeoff from high elevation airports or during climb at higher altitudes, roughness or reduction of power may occur at full rich mixture. In such a case the mixture may be adjusted only enough to obtain smooth engine operation. Careful observation of temperature instruments should be practiced.

2. Operate the engine at maximum power mixture for performance cruise powers and at best economy mixture for economy cruise power; unless otherwise specified in the airplane owners manual.

3. Always return the mixture to full rich before increasing power settings.

4. During let-down and reduced power flight operations, it may be necessary to manually lean or leave mixture setting at cruise position prior to landing. During the landing sequence the mixture control should then be placed in the full rich position, unless

landing at high elevation fields where operation at a lean setting may be necessary.

5. Methods for manually setting maximum power or best economy mixture.

a. Engine Tachometer - Airspeed Indicator Method: The tachometer and/or the airspeed indicator may be used to locate, approximately, maximum power and best economy mixture ranges. When a fixed-pitch propeller is used, either or both instruments are useful indicators. When the airplane uses a constant speed propeller, the airspeed indicator is useful. Regardless of the propeller type, set the controls for the desired cruise power as shown in the owners manual. Gradually lean the mixture from full rich until either the tachometer or the airspeed indicator are reading peaks. At peak indication the engine is operating in the maximum power range.

b. For Cruise Power: Where best economy operation is allowed by the manufacturer, the mixture is first leaned from full rich to maximum power, then leaning is slowly continued until engine operation becomes rough or until engine power is rapidly diminishing 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 slight engine power and airspeed must be sacrificed to gain a best economy mixture setting.

c. Exhaust Gas Temperature Method (EGT): Refer to the article on this subject in the Operations section of this book.

Recommended fuel management—manual leaning will not only result in less engine deposits and reduced maintenance cost, but will provide more economical operation and fuel saving.

B. ENGINE GROUND OPERATION

The engine ground operation greatly influences formation of lead salt deposits on spark plugs and exhaust valve stems. Proper operation of the engine on the ground (warm-up, landing, taxi and engine shut-down) can greatly reduce the deposition rate and deposit formation which cause spark plug fouling and exhaust valve sticking.

1. Proper adjustment of the idle speed (600 to 650 RPM) fuel mixture, and maintenance of the induction air system will ensure smooth engine operation and eliminate excessively rich fuel/air mixtures at idle speeds. This will minimize the separation of the nonvolatile components of the high leaded aviation fuels greatly retarding the deposition rate.

2. The engine should be operated at engine speeds between 1000 and 1200 RPM after starting and during the initial warm-up period. Avoid prolonged closed throttle idle engine speed operation (when possible). At engine speeds from 1000 to 1200 RPM, the spark plug core temperatures are hot enough to activate the lead scavenging agents contained in the fuel which retards the formation of the lead salt deposits on the spark plugs and exhaust valve stems. Avoid rapid engine speed changes after start-up and use only the power settings required to taxi.

3. Rapid engine cool down from low power altitude changes, low power landing approach and/or engine shut-down too soon after landing or ground runs should be avoided.

4. Prior to the engine shut-down, the engine speed should be maintained between 1000 and 1200 RPM until the operating temperatures have stabilized. At this time the engine speed should be increased to approximately 1800 RPM for 15 to 20 seconds, then reduced to 1000 to 1200 RPM and shut-down immediately using the mixture control.

C. LUBRICATION RECOMMENDATIONS

Error! Not a valid filename.

Many of the engine deposits formed by combustion, regardless of the lead content of fuel used, are in suspension within the engine oil and are not removed by a full flow filter. When sufficient amounts of these contaminants in the oil reach high temperature areas of the engine they can be baked out, resulting in possible malfunctions such as in exhaust valve guides, causing sticking valves. The recommended periods of 50-hour interval oil change and filter replacement for all engines using full-flow filtration system and 25-hour intervals for oil change and screen cleaning for pressure screen systems must be followed. If valve sticking is noted, all guides should be reamed using the procedures as stated in latest editions of Service Instruction No. 1116 and/or Service Instruction No. 1425, and the time between oil and filter changes should be reduced.

D. SPARK PLUGS

The fuel management techniques outlined previously will aid in minimizing spark plug fouling. Engine operation, spark plug selection, and spark plug maintenance are all factors that help to keep engines operating smoothly with leaded fuels.

If the magneto check before or after flight reveals any roughness caused by a fouled spark plug, open the throttle slowly and smoothly to cruise RPM, and lean the mixture as far as possible (yet with a smooth engine). After several seconds leaned, return to the proper mixture position for takeoff and recheck the magneto. If two such attempts do not clear the fouled plug, then return to the line and report the problem to maintenance.

Spark plugs should be rotated from top to bottom on a 50-hour basis, and serviced on a 100-hour basis. If excessive spark plug lead fouling occurs, the selection of a hotter plug from the approved list in Service Instruction No. 1042 may be necessary. However, depending on the type of lead deposit formed, a colder plug from the approved list may better resolve the problem. Depending on the lead content of the fuel and the type of operation, more frequent cleaning of the spark plugs may be necessary. Where the majority of operation is at low power, such as patrol, a hotter plug would be advantageous. If the majority of operation is at high cruise power, a colder plug is recommended.

Spark plug fouling is not limited to engines that were certified for 80-octane aviation fuel, but which are using the higher leaded 100-octane gasoline. Therefore, the techniques recommended herein for operation and maintenance apply to all Lycoming piston engines, but with emphasis on the 80- octane engine using 100-octane fuel.

E. SUMMARY

When Grade 80 aviation gasoline was first phased out, the highly leaded Grade 100 green fuel was the only alternative for some operators. During that period of time, in the middle 1970s, exhaust valve erosion was a concern for the operators of low compression engines. There are two reasons why this should not cause concern today. First, Grade 100LL does not cause this problem, and second, the newer materials used in Textron Lycoming exhaust valves for more than 15 years are highly resistant to erosion.

In addition, Grade 100LL has proved to be a satisfactory fuel for all Textron Lycoming reciprocating aircraft engines. The higher octane level does not change engine operating temperatures, and engine deposits on the spark plugs and in the oil can be managed by using the techniques outlined in previous paragraphs.