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# SERVICE INSTRUCTION

DATE: April 16, 2012

Service Instruction No. 1070R  
(Supersedes Service Instruction No. 1070Q and  
Service Letter L199)  
Engineering Aspects are  
FAA Approved

SUBJECT: Specified Fuels

MODELS AFFECTED: All Lycoming aircraft engine models

TIME OF COMPLIANCE: When refueling aircraft with Lycoming engines.

### NOTE

Incomplete review of all the information in this document can cause errors. Read the entire Service Instruction to make sure you have a complete understanding of the requirements.

This Service Instruction identifies the fuels that are to be used when refueling aircraft with Lycoming engines. Acceptable fuels for use in Lycoming engines are in the following sections of this Service Instruction:

- Section A – Leaded Aviation Fuels
- Section B - Unleaded Aviation Fuels
- Section C – Unleaded Automotive Fuels

### CAUTION

Any mixture of unapproved fuels and additive materials that makes a lower than specified octane rating, can cause engine damage. Use of lower-than-specified octane fuel could cause detonation and mechanical damage to the engine.

### CAUTION

If incorrect fuel or additives are used, refer to the latest revision of Service Bulletin No. 398 for instructions to correct the fuel contamination.



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## Section A – Leaded Aviation Fuels

Domestic and foreign aviation fuel grades identified in Table A-1 are applicable for use in Lycoming engines. Leaded aviation fuel grades 80/87, 91/96 and 115/145 are no longer available and have been replaced by the low lead grade fuel: 100LL. Commercial fuel grades 100 and 100/130 having Tetraethyl Lead (TEL) content of up to 4 ml/U.S. gallons are approved for use in engines certified for use with grade 100/130 fuel.

<b>TABLE A-1</b>					
<b>LEADED AVIATION GASOLINE FUELS</b>					
<b>ASTM D910 (Revision A)</b>			<b>Alternative Specification</b>		
<b>Fuel Grades</b>			<b>Fuel Grades</b>		
<b>Grade</b>	<b>Color</b>	<b>Max. TEL mL/L</b>	<b>Grade</b>	<b>Color</b>	<b>Max. TEL g/kg</b>
80	Red	0.13	----	----	----
91	Brown	0.53	----	----	----
100	Green	1.06	91❖	Yellow	2.5
100LL*	Blue	.056	B91/115 ♦	Green	2.5
100VLL**	Blue	.045	B95/130 ‡	Amber	3.1
<p>* - LL – Low lead; In some overseas countries, grade 100LL fuel has a green color and is identified as “100L.”</p> <p>** - VLL – Very low lead</p>					

- ❖ 91: (Leaded fuel) Available in the Ukraine in compliance with TU38.5901481-96.
- ♦ B91/115: (Leaded fuel) Available in the Commonwealth of Independent States (CIS) in compliance with GOST1012-72.
- ‡ B95/130: (Leaded fuel) Available in the Commonwealth of Independent States (CIS) in compliance with GOST1012-72.

In some overseas countries, grade 100LL fuel has a green color and is identified as “100L.”

If the specified fuels in Table A-2 are not available, use a higher grade leaded aviation fuel, identified in Table A-2 as an alternative. Fuels of a lower grade are not acceptable and, therefore, are not to be used.

### NOTE

Isopropyl alcohol in amounts not to exceed 1% by volume can be added only to **aviation fuel** (not automotive fuel) to prevent ice formation in fuel lines and tanks. Although approved for use in Lycoming engines, do not use isopropyl alcohol in the aircraft fuel systems unless approved by the aircraft manufacturer.

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**TABLE A-2**  
**LYCOMING ENGINE MODELS APPROVED FOR LEADED AVIATION FUELS**

Lycoming Engine Models	SPECIFIED FUELS ASTM D910		Alternate Military and Commercial Grades
	Certificated For Use With Grade	Commercial Grade Designation	
O-235-C, -E, -H O-290-D O-435-A, -C	80 (No longer available)	80	④B91/115 or ④91 or ①⑤100LL or ⑤②③100 or ⑤④②③100/130
O-290-D2 O-320-A, -C, -E IO-320-A, -E AEIO-320-E O-340-B O-360-B, -D GO-435-C2* VO-435-A GO-480-B, -D, -F O-540-B VO-540-A, -B	80/87 (No longer available)	80	④B91/115 or ④91 or ①⑤100LL or ⑤②③100 or ⑤④②③100/130
O-320-B, -D IO-320-B, -D LIO-320-B1A AEIO-320-D AIO-320-A, -B, -C O-360-A, -C, -F, -G, -J IO-360-B, -E, -L, -M LO-360-A AEIO-360-B, -H VO-360-A, -B IVO-360-A HO-360-A, -B, -C HIO-360-B, -G1A O-435-A2 GO-435-C2* O-480-A O-540-A, -D, -E, -F, -G, -H IO-540-C, -D, -N, -T, -V AEIO-540-D	91/96 (No longer available)	100LL ④100VLL 100	④B91/115 or ④91 or ④100/130 or ④115/145

\* - GO-435-C2 engine models equipped with carburetor setting 10-3391 only 91/98 grade fuel must be used; for carburetor setting 10-3391-1 either 80/87 or 91/98 grade fuel can be used. Either 80/87 or 91/98 grade fuel can be used with PS-5BD model carburetor.

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**TABLE A-2**

**LYCOMING ENGINE MODELS APPROVED FOR LEADED AVIATION FUELS**

Lycoming Engine Models	SPECIFIED FUELS ASTM D910		Alternate Military and Commercial Grades
	Certificated For Use With Grade	Commercial Grade Designation	
<b>O-235-F, -G, -J, -K, -L, -N</b> <b>IO-320-C, -F</b> <b>LIO-320-C1A</b> <b>IO-360-A, -C, -D, -F</b> <b>LIO-360-C</b> <b>AEIO-360-A</b> <b>AIO-360-A,-B</b> <b>HIO-360-A, -C, -D, -E, -F</b> <b>LIO-360-A</b> <b>IO-390-A</b> <b>VO-435-A, -B</b> <b>GO-480-C, -G</b> <b>IGO-480-A</b> <b>IO-540-A, -B, -E, -G, -J, -K, -L, -M, -P,</b> <b>-R, -S, -U, -V, -W, -AB, -AC, -AE</b> <b>HIO-540-A</b> <b>VO-540-C</b> <b>IVO-540-A</b> <b>IGO-540-A, -B</b> <b>IO-580-B</b> <b>AEIO-580-B</b> <b>IO-720-A, -B, -C, -D</b>	100/130	100LL 100VLL 100	④100/130 or ④B95/130 or ④115/145
<b>TO-360-A, -C</b> <b>TIO-360-A</b> <b>TVO-435-A, -B, -C, -D, -E, -F, -G</b> <b>GSO-480-A, -B</b> <b>IGSO-480-A</b> <b>TIO-540-A, -C, -D, -E, -F,-G, -H, -J, -N,</b> <b>-R, -S, -U, -V, -W, -AA, -AB, -AE, -AF,</b> <b>-AG, -AH, -AJ, -AK</b> <b>LTIO-540-F, -J, -N, -R, -U, -V</b> <b>TIVO-540-A</b> <b>IGSO-540-A, -B</b> <b>TIO-541-A, -E</b> <b>TIGO-541-B, -C, -D, -E, -G</b>	100/130	100LL 100VLL 100	④100/130 or ④115/145
<b>O-320-H</b> <b>O-360-E</b> <b>HIO-360-F1AD</b> <b>LO-360-E</b> <b>O-540-J, -L</b>	100LL 100	100LL 100VLL 100	④100/130 or ④115/145

- ① - Grade 100LL, 100L, and VLL with lead content up to 0.6 oz. (2 ml). of TEL per gallon can be used in all Lycoming engines identified herein. Inspection procedures identified in the following footnotes are not necessary for engines using this fuel.
- ② - O-235-C, O-290-D, -D2, and O-435-A2, -K1 (O-435-4) engines were built with solid stem exhaust valves. The use of fuels with higher lead content of more than 0.6 oz. (2 ml) of TEL per U.S. gallon (3.8 liter) must be limited to 25% of the operating time. If specified fuel is not available and usage with high leaded fuel exceeds 25% of the operating time, examine the valve stems at every 150 hours of engine operation for erosion or “necking.” This inspection is done by removing the exhaust manifold and

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visually examining the valves through exhaust ports. To identify solid stem exhaust valves, remove the rocker cover and look for valve rotor caps which are used with sodium-cooled valves but not with solid stem valves. A conversion can be done on O-235-C and O-290-D engine models to use sodium-cooled exhaust valves. See the latest revision of Service Instruction No. 1246 for procedure.

- ③ - Early production O-320-A, -C, -D; GO-435; VO-435-A and GO-480-B, -D, -F engine models were built with solid stem exhaust valves and their use with fuels that have a lead content of more than 0.6 oz. (2 ml) of TEL per U.S. gallon (3.8 liter) is limited to 25% of the operating time. If specified fuel is not available and usage with high leaded fuel exceeds 25% of the operating time, examine the valve stems at 150 hours of engine operation for erosion or “necking.” This inspection is done by removing the exhaust manifold and visually examining the valves through the exhaust ports. To identify solid stem exhaust valves, remove the rocker cover and look for valve rotor caps which are used with sodium-cooled valves but not with solid stem valves.
- ④ - Continuous use of high lead fuels can cause increased lead deposits both in combustion chambers and spark plugs causing roughness in engine operation and scored cylinder walls. It is recommended that the use of this fuel be limited wherever possible. However, when high lead fuel is used, do periodic inspections of combustion chambers, valves, and valve ports more frequently and rotate or clean spark plugs whenever lead fouling is found. See the latest revision of Service Letter No. L192.
- ⑤ - For operating recommendations, see the latest revision of Service Letter No. L185.

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## Section B – Unleaded Aviation Fuels

Unleaded aviation fuel grades identified in Table B-1 are applicable for use in Lycoming engines.

<b>TABLE B-1 UNLEADED AVIATION FUELS</b>			
<b>ASTM D7547 Fuel Grades</b>		<b>Alternative Specification Fuel Grades</b>	
<b>Grade</b>	<b>Color</b>	<b>Grade</b>	<b>Color</b>
UL 91	None	--	----
--	--	HJELMCO 91/96 UL *	None

\* HJELMCO 91/96 UL is the registered trade name for colorless unleaded fuel made by HJELMCO Oil, Inc. of Sollentuna, Sweden and, as per the company, is in conformance with ASTM D910 specifications except for the lead content and colorant. Specification of HJELMCO 91/96 UL (or any other brand/trade name) is not a commercial endorsement by Lycoming Engines.

When using the unleaded fuels identified in Table B-1, Lycoming oil additive P/N LW-16702, or an equivalent finished product such as Aeroshell 15W-50, must be used.

### NOTE

Isopropyl alcohol in amounts not to exceed 1% by volume can be added to the unleaded **aviation fuel** (not automotive fuel) to prevent ice formation in fuel lines and tanks. Although approved for use in Lycoming engines, do not use isopropyl alcohol in the aircraft fuel systems unless approved by the aircraft manufacturer.

<b>TABLE B-2 ENGINE MODELS APPROVED FOR UNLEADED AVIATION FUELS</b>		
<b>Lycoming Engine Models</b>	<b>SPECIFIED FUELS ASTM D7547 Certificated For Use With Grade</b>	<b>Military And Commercial Grades</b>
<b>O-235-C, -E, -H O-290-D O-435-A, -C O-290-D2 O-320-A, -C, -E IO-320-A, -E AEIO-320-E O-340-B O-360-A, -B, -C -D, -F, -G, -J IO-360-B, -E, -L, -M LIO-360-M1A LO-360-A1H6 IVO-360-A1A GO-435-C2</b>	<b>UL 91</b>	<b>HJELMCO 91/96 UL</b>

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**TABLE B-2  
ENGINE MODELS APPROVED FOR UNLEADED AVIATION FUELS**

Lycoming Engine Models	SPECIFIED FUELS ASTM D7547	Military And Commercial Grades
	Certificated For Use With Grade	
(Contd.) GO-480-B, -D, -F O-540-B VO-540-A, -B	UL 91	HJELMCO 91/96 UL
O-320-B, -D IO-320-B, -D LIO-320-B1A AEIO-320-D AIO-320-A, -B, -C HO-360-A, -B, -C HIO-360-B VO-360-A, -B IVO-360-A AEIO-360-B, -H O-435-A2 GO-435-C2 O-480-A O-540-A, -D, -E, -F, -G, -H IO-540-C, -D, -N, -T, -V AEIO-540-D		HJELMCO 91/96 UL

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## Section C - Unleaded Automotive Fuels

Section C supplies critical details on the use of automotive fuel in aircraft engines.

Premium or Super Premium grade unleaded automotive gasoline fuels compliant with the requirements identified in Table C-1 of this Service Instruction are acceptable for use only on the engine models identified in Table C-2. Unleaded automotive gasoline that is not in conformance with the specifications in Tables C-1 and C-2 is not to be used.

### CAUTION

Automotive ground transportation fuels available direct to consumers (e.g. “pump gas”) usually do not have labels with sufficient information to identify compliance with the requirements in Table C-1. While indicated octane is generally necessary for display at retail points of sale, octane rating methods, fuel vapor pressure, oxygenate content and ethanol content can vary widely and are generally known only at the wholesale terminal. In compliance with this Service Instruction, the automotive fuel must agree with all specifications in Table C-1.

### **Background**

Automotive ground transportation fuels previously have not been acceptable for use in all Lycoming engines. The primary reason for this prohibition is the fact that ground transportation fuels (gasoline and diesel) generally have a formulation for optimized engine emissions and ease-of-starting. Environmental regulations have influence over these formulations which also can vary by geographic region and season.

Automotive fuel specifications have become more advanced in recent years such that ASTM/EN standard fuel ordering parameters can be used to identify the necessary properties to enable usage as an aviation fuel for aircraft engines with low octane requirements. The control parameters that must be identified and examined for compliance in aviation use are the same as the parameters that must be identified in automotive ground transport use.

### NOTE

Although the automotive fuel in Table C-1 can be used in the Lycoming engine models in Table C-2, further approval is necessary via a Supplemental Type Certificate (STC) or Type Certificate (TC) for acceptable use of this fuel in the airframe.

### **Description**

The clear, colorless unleaded automotive fuels in Table C-1 must be in conformance with ASTM D4814-09b or EN 228:2008:E. In these specifications, the automotive fuel is identified by an Anti-Knock Index (AKI) or in the case of EN 228 Super Premium, a grade designation. The AKI is an octane rating and is the arithmetic average of the Research Octane Number (RON) and Motor Octane Number (MON).

$$\text{(RON + MON)/2 = AKI}$$

The AKI or EN 228 grade value must be in conformance with specifications in Table C-2 or higher. The AKI or grade value is critical to engine performance. Table C-2 identifies the Lycoming engine models and the minimum AKI or grade requirement.

As per ASTM D4814-09b, the vapor pressure of the fuel must have a rating of Class A-4 for vapor lock protection. The letter “A” in this rating refers to the volatility of the fuel and the number identifies the vapor lock protection class. The ASTM D4814-09b maximum vapor pressure limit is 9.0 psi (0.62 kPa) maximum for a Class A rating. Vapor lock can occur at high operating temperatures which can cause diminished fuel flow to the engine causing loss of engine power, rough engine operation, or engine stoppage.

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 CAUTION

Automotive fuels usually have Reid Vapor Pressure (RVP) values between 7 and 9.3 psi (0.48 and 0.64 kPa) in summer seasons. Automotive fuel specifications for the RVP can be as high as 15 psi (1.03 kPa) in the winter. In some geographic regions, there is no upper limit to RVP in the winter season. As vapor pressure increases, the tendency for vapor lock will increase as well as fuel “boil off” at altitude.

 CAUTION

Ethanol cannot be used. It is possible that ethanol-based fuels could not be compatible with some fuel system components. In cases of material incompatibility, deterioration of metallic and non-metallic components can occur.

Another key aspect of using automotive fuel as aviation fuel is that the fuel must not have undissolved water, sediment, and suspended matter.

NOTE

Refer to the latest revision of Service Instruction No. 1534 for information on service recommendations for long-term storage of engines that use automotive fuel.

<b>TABLE C-1</b>			
<b>UNLEADED AUTOMOTIVE FUEL SPECIFICATION REQUIREMENTS</b>			
<b>ASTM D4814-09b*</b> Unleaded Automotive Fuel		<b>EN 228:2008:E**</b> Unleaded Automotive Fuel	
<b>Grade</b>	<b>Color</b>	<b>Grade</b>	<b>Color</b>
See Table C-2	Clear	See Table C-2	Clear
*ASTM D4814-09b, Approved September 2009, must be in conformance with the following requirements: Octane:                    See Table C-2 Vapor Pressure        Class A-4 Oxygenates:            Less than 1% (NO ETHANOL)			
**EN 228:2008:E, Approved July 2008, must be in conformance with the following requirements: Octane:                    See Table C-2 Vapor Pressure        Class A Oxygenates:            Less than 1% (NO ETHANOL)			

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**TABLE C-2**  
**LYCOMING ENGINE MODELS APPROVED FOR**  
**UNLEADED AUTOMOTIVE FUEL**

Lycoming Engine Models	ASTM D4814 Minimum Specified AKI (RON+MON)/2	EN 228 Minimum Specified Grade
O-360 series A, C, F, G & J engines	93	NB.3
HO-360-C1A	93	NB.3
HIO-360-G1A	93	NB.3
IO-360-B1B, -B1E, -B1F, -B1G6, -B2E, -L2A, -M1A, -M1B	93	NB.3
LIO-360-M1A	93	NB.3
LO-360-A1H6	93	NB.3
IVO-360-A1A	93	NB.3

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