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SERVICE INSTRUCTION

DATE: July 16, 2010

Service Instruction No. 1070Q
(Supersedes Service Instruction No. 1070P)
Engineering Aspects are
FAA (DER) Approved

SUBJECT: Specified Fuels

MODELS AFFECTED: All Lycoming aircraft engine models

TIME OF COMPLIANCE: When refueling aircraft

This service instruction specifies the fuels that are to be used when refueling Lycoming aircraft engines. Acceptable fuels for Lycoming Engines are listed in the following sections in this Service Instruction:

- Section A - Aviation fuels
- Section B - Unleaded automotive fuels

 CAUTION

Any mixture of unapproved fuels and additive materials that results in a lower than specified octane rating can cause engine damage. Use of lower-than-required octane may cause detonation and mechanical damage to the engine.

 CAUTION

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



General Aviation
Manufacturers Association

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Section A - Aviation Fuels

Domestic and foreign leaded aviation fuel grades listed in Table A-1 are still applicable for use in all Lycoming engines. Leaded aviation fuel grades 91/96 and 115/145 have been discontinued and have been replaced by the low lead grade fuel: 100LL. Leaded aviation fuel grade 80/87 has limited availability in the U.S. as well as overseas. Commercial fuel grades 100 and 100/130 having Tetraethyl Lead (TEL) content of up to 4ml/U.S. gallons are approved for use in all engines certified for use with grade 100/130 fuel.

TABLE A-1
AVIATION GASOLINE FUELS

ASTM-D910 Fuel Grades			ASTM-D910 (Revision A) Fuel Grades			Alternate Specification Fuel Grades		
Grade	Color	Max. TEL M1/U.S. gal.	Grade	Color	Max. TEL M1/U.S. gal.	Grade	Color	Max. TEL M1/U.S. gal.
80/87	Red	0.5	80	Red	0.5	AVGAS 91/96UL*	None	0
91/96	Blue	2.0	100LL	Blue	2.0	B91/115**	Green	★
100/130	Green	3.0	100	Green	3.0	91**	Yellow	★
115/145	Purple	4.6				B95/130**	Amber	★

* Trade name for colorless unleaded fuel produced by Hjelmcö Oil, Inc. of Sollentuna, Sweden and stated by the company to conform to ASTM D910 specifications except for the lead content and colorant. Specification of Hjelmcö AVCAS 91/96UL (or any other brand/trade name) does not constitute a commercial endorsement by Lycoming.

** B91/115 and B95/130 are available for use in the Commonwealth of Independent States (CIS). Fuel currently designated 91 is available for use in the Ukraine. These fuels are specified by GOST1012-72. Max. TEL content is 2.5g/kg (B91/115) and 3.1g/kg (B95/130). Ukrainian 91 is specified by TU38.5901481-96. Max. TEL content is 2.5g/kg.

In some overseas countries, grade 100LL fuel is colored green and designated as “100L”.

If fuels specified in Table A-1 are not available, a higher grade leaded aviation fuel listed in Table A-2, as an alternative, may be used and are subject to the restrictions described in the footnotes. Although Table A-1 lists specified and alternate fuels that can be used safely, this list in no instance permits use of fuels of a lower grade. Any fuel used in Lycoming engines must conform to Specifications ASTM-D910 and MIL-G-5572F.

NOTE

Isopropyl alcohol in amounts not to exceed 1% by volume may be added to the **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 recommended by the aircraft manufacturer.

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TABLE A-2
ENGINE MODELS APPROVED FOR AVIATION FUELS

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	80	AVGAS 91/96 UL 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	80	AVGAS 91/96 UL 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; O-435-A2; GO-435-C2*; O-480-A; O-540-A, -D, -E, -F, -G, -H; IO-540-C, -D, -E, -N, -T; AEIO-540-D	91/96	100LL or 100	AVGAS 91/96UL or ④B91/115 or ④91 or ④100/130 or ④115/145
O-235-F, -G, -J, -K, -L; IO-320-C, -F; LIO-320-C1A; IO-360-A, -C, -D, -F; LIO-360-C; AEIO-360-A; AIO-360-A, -B; HIO-360-A, -C, -D, -E; LIO-360-A; VO-435-A, -B; GO-480-C, -G; IGO-480- A; IO-540-A, -B, -E, -G, -J, -K, -L, -M, -P, -R, -S, -U, -V, -W, AB, -AC, -AE; HIO-540-A; VO-540-C; IVO-540-A; IGO-540-A, -B; IO-580-B; IO-720-A, -B, -C, -D; AEIO-580-B	100/130	100LL or 100	④100/130 or ④B95/130 or ④115/145
TO-360-A, -C; TIO-360-A; TVO-435-A, -B, -C, -D, -E, -F, -G; GSO-480-A, -B; IGSO-480-A; TIO-540-A, -C, -D, -E, -F, -G, -H, -J, -N, -R, -S, -U, -V, -W, -AA, -AB, -AE, -AF, -AG, -AH, -AJ, -AK; LTIO-540-F, -J, -N, -R, -U, -V; TIVO- 540-A; IGSO-540-A, -B; TIO-541-A, -E; TIGO-541-B, -C, -D, -E, -G	100/130	100LL or 100	④100/130 or ④115/145
O-320-H; O-360-E; LO-360-E; O-540-J, -L; HIO-360-F1AD	100LL or 100	100LL or 100	④100/130 or ④115/145

* - GO-435-C2 engines with Marvel-Schebler carburetor No. 10-3991 are certificated to use 91/96 fuel.

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- ① - Grade 100LL or 100L in which the lead content is limited to 2 ml. of TEL per gallon are approved for continuous use in all Lycoming engines listed herein. Inspection procedures described in the following footnotes are not required 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 2 ml. of TEL per U.S. gallon 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, inspect the valve stems at every 150 hours of engine operation for erosion or “necking”. This inspection is accomplished by removing the exhaust manifold and visually inspecting the valves through exhaust ports. To determine if an engine has 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 in these particular engines. O-235-C and O-290-D models can be converted to use sodium cooled exhaust valves. See 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 were built with solid stem exhaust valves and their use with fuels having lead content of more than 2 ml. of TEL per U.S. gallon 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, inspect the valve stems at 150 hours of engine operation for erosion or “necking”. This inspection is accomplished by removing the exhaust manifold and visually inspecting the valves through exhaust ports. To determine if an engine has 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 in these particular engines.
- ④ - Continuous use of high lead fuels can result in increased lead deposits both in combustion chambers and spark plugs causing engine roughness and scored cylinder walls. It is recommended that the use of this fuel be limited wherever possible; however, when high lead fuel is used, conduct periodic inspections of combustion chambers, valves and valve ports more frequently and rotate or clean spark plugs whenever lead fouling is experienced. See latest revision of Service Letter No. L192.
- ⑤ - See latest revision of Service Letter No. L185 for operating recommendations.

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Section B - Unleaded Automotive Fuels

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

Premium or Super Premium grade unleaded automotive gasoline fuels meeting the requirements identified in Table B-1 of this Service Instruction are approved for use only on the engine models listed in Table B-2. Usage of automotive gasoline that does not conform to the parameters described in Tables B-1 and B-2 is not permitted.



Automotive ground transportation fuels available direct to consumers (e.g. “pump gas”) are typically not labeled sufficiently to determine compliance with the requirements stipulated in Table B-1. While indicated octane is generally required 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. To ensure compliance with Service Instruction No. 1070Q, all parameters listed in Table B-1 must be satisfied.

Background

Automotive ground transportation fuels have previously been prohibited for use in all Lycoming engines. The primary reason for this prohibition is the fact that ground transportation fuels (gasoline and diesel) are generally formulated to optimize engine emissions and ease-of-starting. These formulations are heavily influenced by environmental regulations and vary by geographic region and season.

Automotive fuel specifications have evolved in recent years such that ASTM/EN standard fuel ordering parameters may be utilized to stipulate the necessary properties to enable usage as an aviation fuel for aircraft engines with low octane requirements. The control parameters that must be specified and examined for compliance in aviation use are the same as the parameters that must be specified in automotive ground transport use.

NOTE

Although the automotive fuel listed in Table B-1 is approved for use in the Lycoming engine models listed in Table B-2, further approval is required via a Supplemental Type Certificate (STC) or Type Certificate (TC) to permit the use of this fuel in the airframe.

Description

The clear, colorless unleaded automotive fuels listed in Table B-1 must conform to ASTM D4814-09b or EN 228:2008:E. In these specifications, the automotive fuel is classified by an Anti-Knock Index (AKI) or in the case of EN228 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).

$$(RON + MON)/2 = AKI$$

The AKI or EN228 grade value must be as specified in Table B-2 or higher. The AKI or grade value is critical to engine performance. Table B- 2 lists the selected Lycoming engine models and the minimum AKI or grade requirement.

As per ASTM D4814-09b, the vapor pressure of the fuel must be rated as Class A-4 for vapor lock protection. The letter “A” in this rating refers to the volatility of the fuel and the number specifies 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 resulting in diminished fuel flow to the engine causing loss of engine power, rough engine operation, or engine stoppage.

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 CAUTION

Automotive fuels typically have Reid Vapor Pressure (RVP) values between 7 and 9.3 psi (0.48 and 0.64 kPa) in summer seasons. Automotive fuel specifications allow 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 is not allowed. Ethanol-based fuels may not be compatible with some fuel system components. In cases of materials 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 be free of undissolved water, sediment, and suspended matter.

TABLE B-1

UNLEADED AUTOMOTIVE FUEL SPECIFICATION REQUIREMENTS

ASTM D4814-09b* Unleaded Automotive Fuel		EN 228:2008:E** Unleaded Automotive Fuel	
Grade	Color	Grade	Color
See Table B-2	Clear	See Table B-2	Clear
*ASTM D4814-09b, Approved September 2009, must conform to the following requirements: Octane: See Table B-2 Vapor Pressure: Class A-4 Oxygenates: Less than 1% (NO ETHANOL)			
**EN 228:2008:E, Approved July 2008, must conform to the following requirements: Octane: See Table B-2 Vapor Pressure: Class A Oxygenates: Less than 1% (NO ETHANOL)			

TABLE B-2

ENGINE MODELS APPROVED FOR UNLEADED (TABLE 1) AUTOMOTIVE FUEL

Lycoming Engine Models	ASTM D4814 Minimum AKI Required (RON+MON)/2	EN228 Minimum Grade Required
O-360 series A, C, F, G & J engines	93	NB.3
HO-360-C1A	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

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