FAA News

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Leaded Aviation Fuel and the Environment

Aircraft operating on leaded aviation gasoline (avgas) are used for many critical purposes, including business and personal travel, instructional flying, aerial surveys, agriculture, firefighting, law enforcement, medical emergencies, and express freight.

What is avgas?

Avgas is a specialized fuel used to power piston engine aircraft. Aviation gasoline is a complex mixture of relatively volatile substances known as hydrocarbons that vary widely in their physical and chemical properties. The properties of avgas must be properly balanced to give reliable and safe engine performance over an extremely wide range of aircraft operating conditions. Manufacturers typically certify their engines and aircraft to run on fuels that meet American Society of Testing Materials (ASTM) Standards, or other consensus standards such as the United Kingdom's Defense Standards, or U.S. Military Standards, which govern the chemical, physical and performance properties of avgas.

The various grades of avgas are identified using the Motor Octane Number (MON) combined with the following alpha-designations to indicate lead content: low lead (LL); very low lead (VLL); or unleaded (UL).

Although there are various ASTM Standards for avgas, almost all avgas on the U.S. market today is low lead, 100 MON avgas (100LL). This grade of avgas satisfies the requirements of all piston engines using avgas, regardless of their performance level. Jet aircraft and turbine-powered, propeller aircraft do not use avgas, but instead use fuels very similar to kerosene, which does not contain a lead additive.

Why is octane so important?

Octane is a measure of the performance of a fuel as it burns in an engine combustion chamber. It is a measure of a gasoline's ability to resist detonation, or "knock". Octane is important to the safe operation of an aircraft or automobile engine. High compression, high displacement engines, such as those found in many high performance, piston engine aircraft, require high octane fuels so that detonation, which is the uncontrolled ignition of the fuel in the combustion chamber, does not damage pistons and other engine components and result in engine failure. High performance engines allow an aircraft to operate at increased speeds and with more payload, but these engines require higher octane avgas. Operating aircraft or automotive piston engines on fuels with lower octane than they require may result in damage from knock, but it is generally safe to operate piston engines on fuels of a higher octane rating than their minimum requirement. In other words, it is safe to go up in octane, but not down.

What is Tetraethyl Lead (TEL)?

TEL is an organic compound that contains lead and, in small quantities, is very effective in boosting octane. The ban of TEL in automobile gas was phased in over a number of years and was largely completed by 1986 and resulted in significant reductions of lead emissions to the environment. TEL was has not yet been banned for use in avgas, because no operationally safe alternative is currently available.

Is TEL Toxic?

All forms of lead are toxic if inhaled or ingested. Lead can affect human health in several ways, including effects on the nervous system, red blood cells and cardiovascular and immune systems. Infants and young children are especially sensitive to even low levels of lead, which may contribute to behavioral and learning problems and lower IQ. Children have increased sensitivity due to their developing nervous systems.

How are aircraft emissions regulated?

Under the Clean Air Act (CAA), the EPA has the authority (in consultation with the FAA) to regulate emissions from aircraft. The CAA specifies that, in setting standards, the agencies must consider the time needed to develop required technology, consider cost, and must not adversely impact aircraft safety or noise. At present, there are no regulations that apply to emissions from aircraft that use leaded fuel. However, FAA enforces existing emission standards for commercial jet aircraft and engines through the certification process of engines. Commercial jet engine manufacturers have responded to requirements for emissions reductions through technology changes by improving jet engine designs and efficiency. If the EPA finds that aircraft emissions present an endangerment to public health or welfare, they can establish limits on aircraft emissions, and then the FAA has the authority to regulate aircraft emissions through the development of standards for the composition or chemical or physical properties of an aircraft fuel or fuel additive.

Why keep using leaded fuel?
First and foremost, the use of leaded fuels is an operational safety issue, because without the additive TEL, the octane levels would be too low for some engines, and use of a lower octane fuel than required could lead to engine failure. As a result, the additive TEL has not been banned from avgas. Aircraft manufacturers, the petroleum industry, and the FAA have worked for over a decade to find alternative fuels that meet the octane requirements of the piston engine aircraft fleet without the additive TEL. However, no operationally safe, suitable replacement for leaded fuel has yet been found to meet the needs of all of the piston engine aircraft fleet.

What is FAA doing about eliminating leaded aviation fuels?
Four initiatives have been established to develop a safe unleaded replacement aviation gasoline:

First and most important, the FAA sponsored an Aviation Rulemaking Committee (ARC) involving EPA and industry stakeholders, which developed the process, cost estimate, and time line to replace existing leaded aviation fuels with unleaded solutions. The final report and recommendations, known as the Unleaded Avgas Transition (UAT) Committee Final Report was published on February 17, 2012. The report is available to the public at: www.faa.gov/about/initiatives/avgas/archive. This report contains five key recommendations (and fourteen additional recommendations) to facilitate the development and deployment of a replacement unleaded aviation gasoline. The plan calls for government research and development (R&D) funding and in-kind funding from industry to identify an unleaded fuel by 2018 that could be used by aircraft currently operating on leaded avgas.

Second, the FAA has established an Agency performance metric that states: "A replacement fuel for leaded aviation gasoline is available by 2018 that is usable by most general aviation aircraft." This performance metric will guide investments and decisions taken on by FAA for the coming years.

Third, Section 910 of the 2012 FAA Modernization and Reform Act establishes an unleaded aviation gasoline R&D program with deliverable requirements for an R&D plan and report. The FAA has issued the Unleaded Avgas Transition (UAT) Action Plan that will integrate these three activities.

The fourth initiative involves private-sector companies that have applied for Supplemental Type Certificates for specific piston engine and aircraft models to operate with new, unleaded aviation gasoline formulations. The FAA is actively working to support all of these initiatives.

What is FAA doing in the short-term to reduce lead emissions from airports?
FAA's goal for an unleaded avgas by 2018 is the long term solution that will, ultimately, allow for the elimination of lead emissions from aircraft that use leaded fuel. Until such fuels can be brought to market, there are actions that FAA can coordinate with airport and aircraft owners and

operators to investigate options to reduce lead emissions at airports. Some of the measures that are being considered include:

1. Lower leaded fuel options: It may be possible for airports to supply lower leaded fuels in current fuel distribution systems. These fuels that meet ASTM standards have been approved for use in aircraft certified for their use and would be completely transparent in its distribution and use. Potential reductions in lead emissions are as much as 19 percent since these lower level fuels have approximately 19 percent less lead content than current fuels.

2. Consider unleaded automotive fuels as an option at airports: Approximately 40 percent of piston engine aircraft are either approved or eligible to obtain approval to operate on automotive fuels. This unleaded fuel could represent an option for some airports, however, any fuel used in aircraft engines must not contain ethanol; this requirement may limit the applicability of automotive fuels. This would require separate fuel systems and procedures to ensure that aircraft are fueled properly. Airport sponsors would have to make the necessary arrangements for supply, storage and distribution systems -- with due consideration of the level of demand for two different fuel types -- all of which may make this option challenging both logistically and financially.

3. Safely change aircraft operations to avoid concentrated lead emissions: Locations for engine run-up areas could be distributed over a wider area within an airport to reduce the potential for concentrated levels of lead emissions. It may also be possible to shorten taxi routes to lessen emissions. Such measures would be airport-specific and would have to consider operational safety as the highest priority.

4. Install vapor recovery systems: Vapor recovery systems, similar to those found at automotive filling stations, could be installed in bulk fuel delivery systems to minimize the release of avgas vapors which contain small concentrations of lead.

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