# “Hot Topics in General Aviation: Sustainable Aviation Gasoline Alternatives”

## ABSTRACT

### Why Is There Lead In Fuel?

Tetra-ethyl lead is an octane-enhancing metal additive used in piston-driven aircraft to prevent knocking or detonation and increase performance without increasing the size and thus weight of an aircraft engine. Its addition to petroleum products began back in the mid-1920s to serve both as an anti-knock additive and as a method to prolong oil reserves even though its manufacture caused evident degradation to its handlers. Lead allowed for aircraft engine and airframe manufacturers to be able to design faster and more powerful engines such as those found on WWII aircraft like the P-51 Mustang or Supermarine Spitfire. Lead is inexpensive and it doesn’t take a large quantity in order to get the desired result. It does attack engine parts and foul up spark plugs, so a lead scavenger called ethylene dibromide is necessary to evacuate the excess resulting in a toxic and now banned pollutant: lead bromide.

### Why Take The Lead Out?

Studies have shown that lead causes brain damage in children reducing their IQ and cardiovascular difficulties and/or kidney failure in adults. The environmentalist group in the U.S. the Friends of the Earth (FOE) petitioned the Environmental Protection Agency (EPA) in 2006 to make a finding that lead emissions from general aviation (GA) aircraft cause or contribute to public health endangerment or if the EPA didn’t think they had enough data to make such conclusions, to carry out studies and issue a report on its findings. Then if the EPA were to find that lead emissions from aircraft are in fact a danger to the public, to pass emission standards for its use. Although the EPA has achieved a 96% decrease in lead emissions from the early 1980s to 2005, GA aircraft are credited for producing 45% of the lead emissions in the ambient air lead inventory and are the largest source category.

### How?

Lead removal while retaining octane levels has proven difficult to attain. Industry-led committees as well as individual companies are still working on finding an additive or fuel formulation that performs exactly like tetra-ethyl lead while not creating more toxic emissions. Testing has been ongoing for years and while some formulations look promising, nothing has reached 100 octane, unleaded, and been certified yet.

### What’s A Drop-In Solution?

A drop-in solution is one in which a fuel behaves exactly like 100LL but without the lead and without other more harmful substances. It should be a transparent solution which does not require any hardware changes to aircraft and their engines.

A drop-in solution would allow for the eventuality that the FAA issue a blanket approval for all engines and aircraft currently using 100LL to use the new fuel.

**What Other Major Difficulties Are There?**

Certifying a new fuel formula can take years and hundreds or thousands of hours of testing per engine and airframe combination. If a new formula is proposed, but it doesn't follow a current specification standard, it must have a new one created for it. This is done through standardization boards around the world, of which two major ones are ASTM International or the UK's Def Stan. With ASTM International, a new fuel is presented to the board and via consensus, they decide if the standardization process can begin. The members determine how much testing must be done in order to fully demonstrate the new fuel's characteristics after which approval can be granted and a specification issued. Then the FAA must approve the data produced during testing in each engine and airframe using the new fuel. The FAA shows that the data is acceptable via certification. If the aircraft is new, this certification would be found on the new aircraft's original type certificate. As the average age of the current GA aircraft fleet in the U.S. is 39 years, many would need to accomplish a supplemental type certification (STC) program that generally lasts 150 hours or more before applying for approval. To get both fuel standardization and certification is bound to be a lengthy and expensive process for both industry and the consumer.

**What Sustainable Options Exist?**

Some sustainable options exist, however demand is lacking or other threats menace their viability. For example, mogas, a.k.a. automotive gasoline, has been a solution for a number of low performance piston-powered aircraft since the early 1980s. With recent energy security and independence legislation, ethanol has become somewhat of a mandatory additive in automotive gasoline. The majority of aircraft engines cannot consume mogas with ethanol as ethanol is incompatible with fuel storage and delivery systems among other issues.

Hjelmco Oil, Inc., in Sweden has a number of years of experience (19) using a 91/96 unleaded fuel. However, in the U.S., FBOs do not have much incentive to put in a second avgas fuel tank on their fields as it is expensive to put in this infrastructure, and there is not enough demand to make a return on investment.

82UL is a low-octane unleaded fuel specification. It has never been produced as it would only cover 70% of the piston-driven aircraft fleet which consume just 30% of the total amount of avgas being produced today. This also means that the remaining 30% of aircraft really need 100 octane and they consume the majority of the avgas at 70%.

Several fuel formulas are in the works to offer 100 octane unleaded fuel: Swift Fuel's 100SF, GAMI's G100UL/ULL, and another ultra-low lead 100 fuel with bio-

derivative ethyl tertiary butyl ether (ETBE). Some industry members back a 94UL fuel which should have standardization soon too, as it is said that roughly 90% of the GA piston-driven avgas-consuming fleet should be able to run on this lower octane fuel which is essentially 100LL but without the lead. Hardware applications may be necessary to use this last formula like with the addition of spark ignition management systems or FADEC.

Another option is to replace the avgas-consuming engine by a jet-fuel consuming, piston-driven or small turbine one. It is certainly viable in the long run, but very few of these engine models are type certificated/STC'd in very many airframes. There are several pros and cons to this solution, and until production levels increase in this category of engine models, acquisition costs will continue to remain high.

Production and distribution are issues that cannot be ignored either and will also play a role in the decision as to which fuel will be the next sustainable version for the future of GA.

**What Does The Future Hold?**

The EPA has recently (28 April 2010) released an Advanced Notice of Proposed Rule Making (ANPRM) summarizing the issues surrounding the use of leaded avgas and what actions likely will take place in order to remove lead from the pumps. The comment period closes on 28 June 2010 after which a decision will be made as to what types of restrictions will be placed on the use of leaded avgas if the EPA finds that leaded avgas emissions cause or contribute to air pollution that may reasonably endanger public health. The FAA will then be required to create and apply regulations to control lead emissions from avgas-consuming aircraft.

**How Can I Learn More?**

Click on the pdf link on the right to read one student's thesis on a summary of the issues surrounding aviation gasoline including a list of **Sustainable Aviation Gasoline Alternatives**. You can also check out the ANPRM at this link: http://edocket.access.gpo.gov/2010/2010-9603.htm . Please note that all references related to the assertions and statistics mentioned above can be found in the reference list pages 103 to 129 in the thesis and all but the latest information about the ANPRM which can be accessed via the link in the previous sentence are described in more detail in the text.

**Notes about the author and disclaimer**. The thesis entitled "Hot Topics in General Aviation: Sustainable Aviation Gasoline Alternatives" was accomplished for educational purposes only. The paper was done for the International School of Management in Paris, France, a non-aviation business school, in the course of completing a Masters in Business Administration in International Business. The focus of the paper is on the U.S. market, but the issue is an international one. The author is a pilot, not an engineer nor a mechanic nor a petrochemical engineer, and she

wanted to make this short summary accessible to the novice pilot who is curious about this thirty-year ongoing avgas saga. This thesis was accepted, the MBA granted, and the student graduated with honors.