Unleaded Aviation Gasoline FAQs

Introduction

For decades, Phillips 66 and Ethyl Corporation have been doing their part to provide the highest quality Grade 100LL aviation gasoline (100LL) to the piston aviation industry. Phillips 66 and Afton Chemical (Afton), sister company to Ethyl, have teamed up to develop an unleaded Grade 100 aviation gasoline (UL100) to replace 100LL to meet future industry needs. The following Q&As pertain to the research and development (R&D) and use of the Phillips 66/Afton UL100.

Q 1. What are the key characteristics of UL100?

A. Our vision for UL100 is that it be fully compatible with 100LL and the 100LL distribution network:

- Service the entire fleet of general aviation aircraft
- Meet or exceed the performance and quality characteristics of 100LL as specified in ASTM D910
- Less hazardous engine emissions compared to 100LL
- Minimize any cost increases

Q 2. How does UL100 differ from 100LL?

A. The petroleum components of UL100 are the same as 100LL sold today, and a new manganese-based additive package replaces the lead package. The new additive package is comprised of manganese, a proprietary scavenger formulation, and an antioxidant. The relative percentage of petroleum components have been adjusted to optimize performance with the new additive package.

Q 3. What are some of the biggest challenges of replacing 100LL with UL100?

A. There are many challenges in developing a new fuel, some of which include the need to satisfy the engine requirements of the general aviation fleet, develop manufacturing and distribution plans, define a pathway with the FAA to achieve authorization of UL100 for the entire fleet of general aviation aircraft, and ultimately deployment.

In addition to the Phillips66/Afton UL100 R&D program, we are also heavily involved with the Piston Aviation Fuel Initiative (PAFI) Unleaded Avgas Deployment teams listed below that are working to ensure a successful deployment of any new unleaded avgas.

- State & Federal Legislative
- Aircraft Fuels Regulations & Standards
- Fuel Manufacturing Capability
- Distribution System (led by Phillips 66)
- Airport
- Aircraft Modifications
- Communication & Training
- International Communications
- Safety Assurance

Q 4. When will UL100 be available?

A. We are targeting commercialization of UL100 in 2025/2026.

Q 5. Will Phillips 66 manufacture UL100?

A. Work is underway to evaluate manufacturing and distribution options which includes third party manufacturers.

Q 6. What do you think of the Piston Aviation Fuel Initiative (PAFI)?

A. The FAA PAFI has been instrumental in working to develop a fuel evaluation and authorization process where none existed. Without this process it would be difficult for the General Aviation industry to succeed in developing an unleaded replacement for 100LL.

Q 7. What do you think of the other fuels being evaluated by the PAFI?

A. Phillips 66 is committed to the future of aviation gasoline, and as a member of ASTM and the PAFI Technical Evaluation Committee (TEC), we are working to define fuel specifications for any candidate's unleaded aviation gasoline.

Q 8. What is your opinion of lower octane unleaded fuel as an alternative to 100LL? (e.g. premium gasoline, 94 octane unleaded aviation gasoline, etc.)

A. While low octane unleaded fuels – less than 100 motor octane number (MON) – are a satisfactory alternative for many aircraft, they increase misfuelling risks and are generally impractical due to the following:

- Low octane unleaded fuels do not provide sufficient detonation protection for the portion of the fleet requiring 100LL; therefore the problem of finding a replacement fuel for these aircraft would remain unsolved.
- Increased capital and maintenance costs associated with providing multiple grades of aviation gasoline at airports, e.g. additional tanks, filtration systems, dispensers, refuelers, etc.

Q 9. Do you expect UL100 to meet the octane demands of all aviation engines, particularly high output engines?

A. Preliminary testing of UL100 has shown equivalent octane and detonation performance compared to 100LL. Testing will continue to demonstrate performance in the most demanding engines.

Q 10. Do you expect that any aircraft modifications will be needed to use UL100?

A. Our goal is to avoid the need for any aircraft modifications, and we're on target based on test results to date. We will continue to evaluate potential issues as they are identified during the R&D program and authorization processes.

Q 11. Do you expect any change in service intervals when using UL100?

A. Our R&D program includes a comprehensive assessment of the base fuel, additive, and other factors that potentially impact service intervals. Preliminary testing indicates that the use of UL100 may lead to reduced spark plug cleaning interval recommendations, however we are continuing research in this area to fully explore cleaning intervals that are appropriate fleetwide. Ultimately, Phillips 66 and Afton, with guidance from FAA and engine manufacturers, will define service intervals that will provide for safe and reliable aircraft operation.

Q 12. Do you expect any change in aircraft operation when using UL100?

A. Aircraft operation is not anticipated to change, but our R&D program and PAFI assessment will address this concern.

Q 13. Will UL100 be compatible with current piston engine oils?

A. Initial engine testing indicates that UL100 is compatible with SAE J1899 approved Phillips 66 lubricants. Additionally, the use of UL100 fuel in test engines with Phillips 66 piston aviation lubricants have shown equivalent wear characteristics to 100LL. Further testing is underway to validate compatibility of UL100 with other SAE J1899 approved engine oils.

Q 14 Will UL100 fuel impact oil drain intervals?

A) Initial engine testing indicates that the current recommended oil change intervals will not be impacted by the use of UL100.

Q 15. Do you expect UL100 to present concerns with health and safety?

A. Any new fuel should be evaluated using a holistic approach, focusing on the three main areas of exposure below:

Additive handling: The additives required in UL100 are produced by the additive manufacturer and shipped to the refineries. These additives, while hazardous in their pure form, present an improvement compared to the current additives used in 100LL. Further, these chemicals are handled in a controlled environment by additive handling experts and added in very small fractions to the UL100 base fuel which prevents exposure to pilots and ground handlers.

Fuel handling: UL100 does not change the Safety Data Sheet (SDS) Globally Harmonized System (GHS) rating for human health nor does it change transportation vehicle and storage tank placarding required compared to 100LL. As with any gasoline, leaded or unleaded, best handling practices still apply to minimize exposure (e.g. skin contact).

Engine Emissions: The major emission from the combustion of UL100 is carbon dioxide. Smaller fractions of nitrogen oxides and hydrocarbons will also be emitted, and yet smaller fractions of ash compounds from oil and the additive will be emitted. A study is underway to characterize both gaseous and particulate emissions and results will be shared with the FAA and EPA. It is expected that these emissions will be less hazardous than with 100LL.

Q 16. What is the active ingredient in the new manganese-based additive package?

A. Methylcyclopentadienyl Manganese Tricarbonyl (MMT), which is a metallic octane boosting additive that was invented in the late 1950's by Ethyl Corporation. MMT is known to provide engine benefits such as octane number increase, detonation protection, valve seat recession protection, and combustion improvement.

Q 17. What are the health effects of manganese exposure?

A. Manganese is an essential element to the body and is therefore regulated through the body's normal processes. Manganese is naturally occurring and abundant in the earth's crust, soil, and the food we eat, as well as a natural component in the water we drink and the air we breathe.

Manganese only becomes a concern in certain occupational (i.e. worker exposure) settings where ambient air levels reach a highly elevated level where the body can no longer regulate the amount of manganese in the bloodstream within its normal range as an essential nutrient. For example, this risk may be faced by welders working every day in enclosed spaces without respiratory protection.

Q 18. How will the air quality change if MMT replaces lead in aviation gasoline?

A. The EPA completed a study on lead emissions from aircraft using leaded aviation gasoline in the United States. The study measured ambient air levels of lead along runways of 17 airports. Using this data, we have estimated that by replacing the 100LL with UL100 containing MMT, manganese emissions would be roughly 80 to 90% lower than lead emissions. From a regulatory perspective, the average emissions of manganese from these airports would be orders of magnitude lower than the Agency for Toxic Substances and Disease Registry (ATSDR) minimum risk level, which is the same health-based reference concentration EPA currently uses to assess the risks of inhaled manganese.

Unlike lead, manganese is an essential nutrient and so the emissions from combustion of UL100 are expected to provide a great improvement over 100LL, However, a rigorous research program is being undertaken to evaluate these combustion products. This program will evaluate effects on the environment and humans and will assess gaseous exhaust emissions measurements (CO, CO2, NOx, and HC) and particulate emissions (size, count, and mass). This information will be shared with the FAA and EPA and will be used to confirm that the expected improvement in emissions is indeed achieved.