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Unleaded Avgas Emerging Trends

FDOT | 2043 FASP FLORIDA AVIATION SYSTEM PLAN

Appendix J

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For years, attempts have been made to remove lead from aviation gasoline (avgas) used to power piston engines on fixed- and rotary-wing aircraft. With unleaded aviation fuels entering the market, airports will need to make changes to accommodate this emerging trend. The following provides background information on leaded aviation fuels and the efforts to approve unleaded aviation fuel for the market. How this emerging trend will affect Florida airports and what the Aviation Office of the Florida Department of Transportation (FDOT AO) can do to accommodate its implementation is also discussed.

Background

Avgas containing tetraethyllead (lead) has been used to power piston engines on aircraft since the advent of aviation in the early 20th century. The presence of lead in avgas is used to boost the octane rating of fuel while preventing engine knocking, also known as premature detonation, a phenomenon caused when combustion of some of the air/fuel mixture in engine cylinders does not occur at the precise point in the piston stroke cycle. This resulting detonation can increase pressure within the engine cylinder significantly, resulting in potential damage and engine failure. Since engine failure in aviation is a significant safety concern, inclusion of lead in avgas has been seen as necessary to improve the reliability and performance of piston engines used to power aircraft.

Humans can be exposed to lead in many ways; however, inhalation of fumes with lead is considered a significant risk. Efforts began in the 1970s to limit and eliminate methods of human exposure to lead from engine emissions. Through the 1980s and 1990s, use of lead as an additive was lessened, removed, and eventually banned in most forms of gasoline; however, additives of lead were still permitted for use in aviation gasolines due to their trusted performance reliability in aviation piston engines and the lack of a suitable unleaded alternative. Though still allowed, the United States Environmental Protection Agency (EPA) has taken steps towards eliminating the lead in avgas. These steps are expected to culminate in the banning of 100-octane low lead aviation fuel (100LL). In fact, some communities in other states, such as Santa Clara County, sponsor of the Reid-Hillview Airport near San Jose, California, have already enacted local regulations banning the sale of avgas with lead additives.

The aviation industry has made multiple efforts, driven by the environmental protection regulatory community, to develop a reliable unleaded avgas that can deliver an adequate octane rating to avoid engine knocking and can be used as a “drop-in” replacement for existing leaded aviation fuels. In 2010, General Aviation Modifications, Inc. (GAMI) announced that it was in the process of developing a “drop-in” replacement for 100LL avgas with an unleaded aviation fuel that was eventually named G100UL. Taking over 12 years to refine, and after multiple reviews by the Federal Aviation Administration (FAA), G100UL was approved for use for all piston-engine aircraft and engine combinations through supplemental type

certificates (STCs) in 2022. Likewise, in 2015, the FAA certified an additional unleaded blend of 94-octane aviation fuel named UL94 that was developed by Swift Fuels, which was also approved for use by the FAA through an STC. It is important to note that UL94 and G100UL are not interchangeable with each other as each has different octane levels. Use of these fuels will depend on the fuel octane rating specified by the aircraft engine manufacturer.

In addition to these approved fuels, the FAA announced in early 2022 the initiation of a public-private partnership with aviation and petroleum industry stakeholders to develop and evaluate additional unleaded aviation fuels for piston-engine aircraft by the end of 2030. This initiative, called the Eliminate Aviation Gasoline Lead Emissions (EAGLE), will also develop the infrastructure and access viability needed for unleaded aviation fuels, as well as establish necessary related regulations and policies. These recent developments, along with at least two other unleaded aviation fuels that are undergoing approval testing, have accelerated the industry's interest in the use of unleaded aviation fuel.

Next Steps and Challenges

With the success of UL94 and G100UL fuel, the industry is considering the next steps and challenges in how it will move forward with the larger industry-scale use and implementation. UL94 and G100UL have achieved success as a drop-in replacement for leaded fuels because modifications to engines are not required other than obtaining an STC and placarding the approved engine for its use. To be successful, other fuels under development will also need to be drop-in replacements free of engine modifications and able to be used with other blends of unleaded aviation fuel for larger scale industry implementation.

Large scale production and distribution of these fuels are challenges the industry is working to resolve. For example, it is anticipated to take at least 12 months to establish and refine the logistics of production and distribution for G100UL, with greater availability of the fuel not expected to be achieved until 2024. GAMI has entered into an agreement with AvFuel, a global supplier of aviation fuel and related services, to assist with logistics in coordinating large scale production and industry distribution of the fuel. Other fuel manufacturers will face a similar challenge to bring product to the market since infrastructure is currently lacking for large scale manufacturing and distribution. Compounding this are supply chain issues and labor shortages that have been affecting all aspects of the economy since the COVID-19 pandemic in 2020.

The cost of unleaded aviation fuels is also a challenge. Its price is higher per gallon than aviation fuels with lead additives. This increased cost may discourage pilots and aircraft operators from using it if cheaper leaded fuels remain available. The increase, however, may be offset over the long run by reduced maintenance costs since unleaded aviation fuels have been found to reduce spark plug fouling and valve contamination.

Though unleaded aviation fuels are intended to be a drop-in replacement, another challenge is that airports may need to construct separate fuel storage and distribution systems. Multiple factors could drive this need. First, pilots and aircraft operators may desire to purchase one fuel over the other if both remain available. Next, there will likely be a need for separate storage and distribution of unleaded fuel to assist airports and

fuel providers with inventory and sales. Also, state and federal regulations may dictate that the product be stored separately from those tanks used to store leaded fuels in the past. Finally, the fuel manufacturers themselves may require separate storage and distribution, and airports may also prefer separate storage.

Lengthy testing and certification processes are also potential challenges. Fuel reliability testing in different types of piston engines in varying operating environments and conditions is necessary; however, such testing impacts the timing of supply and demand relative to the overall industry desire to use these fuels.

Finally, in addition to the production, supply chain, and distribution logistic considerations, communication presents a challenge. Communications must address the inquiries and concerns of pilots, mechanics, regulators, fixed based operators (FBOs), and fuel distributors about the reliability, storage, distribution, and approval process for the fuel's use. GAMI, for example, as a part of their agreement with AvFuel, have established an industry outreach and communications campaign that includes press releases, web resources, communications with customers, education sessions, personalized outreach to customers, e-mails, newsletters, videos, and trade show appearances to promote G100UL. Other unleaded aviation fuel manufacturers will likely need to take a similar approach. Without an effective communications strategy, potential customers may be confused about what is needed to use these fuels and potentially have a misguided loss of confidence in the product.

How Does This Affect Florida Airports?

Florida has one of the largest, busiest, and most dynamic state aviation systems in the country. Home to over 8,300 based aircraft and over 75,600 pilots (the most in the country), the impact of use of unleaded aviation fuel is likely to be greater on aviation and airports in Florida than other states.

In fact, unleaded aviation fuel has already been used in Florida. The flight training fleet of Embry-Riddle Aeronautical University in Daytona Beach served as a test facility for both Swift's UL94 and GAMI's G100UL. The following summarizes the potential effects this emerging trend might have on users and airports across Florida:

- **Logistical Challenges** – Initial availability of unleaded fuel is expected to be limited until production and distribution logistics have increased. Availability is anticipated to take multiple years to match the level of industry demand. As a result, airports are initially expected to face supply challenges. This could create challenges for airports in not only acquiring the fuel from distributors but also in acquiring the adequate level of supply to meet demand. Likewise, production and distribution challenges could be compounded should federal, state, or local regulations ban the use of lead in aviation fuel before sufficient supply of unleaded aviation fuel is available to meet market demands.

- **Storage and Distribution Infrastructure** – The intent is that unleaded aviation fuels will be a drop-in replacement for leaded fuel with the same octane rating, allowing the unleaded fuels to be used at any ratio or volume. While this does not require modifications to the piston engines found in fixed-

wing and rotary-wing aircraft, airports likely will need to store and distribute these fuels separately from their leaded counterparts. This will likely require installation of separate facilities. Even if existing tanks and distribution systems are emptied of leaded fuels, the lead residue within the linings of the tanks may raise contamination concerns and prevent them from being used for the unleaded fuels. Should new facilities be needed, that would add cost to airports to provide these fuels to users.

- **Cost of Unleaded Aviation Fuels** – Unleaded aviation fuels cost more per gallon than leaded fuels such as 100LL. The significant difference in cost may discourage pilots from purchasing unleaded aviation fuels if leaded fuels are still available and could lead to competing fuel prices between the two products between airports. This cost differential could affect where pilots will base aircraft and what airports itinerant operators choose to use, potentially affecting airport revenues.

- **Hesitation to Change** – Finally, should leaded aviation fuels remain on the market, the aviation community may hesitate to use unleaded aviation fuels. Price alone will likely be a barrier to convincing the aviation community to switch. Some aircraft operators may also be hesitant out of personal preference given the trusted engine reliability provided by leaded fuels. Florida airports prepared to distribute unleaded aviation fuel systems could encounter challenges if the local pilot community is not willing to use this product.

Ways that the FDOT AO Can Assist

While the FDOT AO may not have the direct ability to increase production and distribution, it does have the ability to facilitate communication among different stakeholders to resolve the implementation challenges associated with unleaded aviation fuel. The following recommendations offer methods to assist airports in the transition to the use of this fuel by its users. They are categorized into items that can be addressed through implementation of the Florida Aviation System Plan (FASP) 2043 and other broader actions that the FDOT AO can promote.

FASP 2043 Recommendations

Provide Funding for Installation of Fuel Storage / Distribution Systems – The FDOT AO could assist airports by providing funding for the installation of fuel storage and distribution systems for unleaded aviation fuels. This could be from the establishment of a dedicated funding source or through prioritizing the installation of these systems when distributing funds from existing funding sources. This would be beneficial to airports especially when the installation of such infrastructure is not eligible for funding from other traditional sources like the FAA Airport Improvement Program (AIP).

- **Include Measurement for the Provision of Unleaded Aviation Fuel as a Part of FASP 2043 Performance Metrics** – Inclusion of how well airports across Florida are providing unleaded aviation fuels as this market grows can help airports and the FDOT AO understand where gaps

and deficiencies lie with meeting user demand. This includes the development of performance metrics to measure this emerging trend and the continual evaluation of these metrics based on changing trends each time the state aviation system is evaluated. This can help focus the development of infrastructure to provide unleaded aviation fuels as well as future financial planning efforts for both airports and the FDOT AO in accommodating this emerging trend.

Other Recommendations

- **Encourage Airports to Provide Unleaded Aviation Fuels** – The FDOT AO could encourage Florida airports to coordinate with fuel distributors to provide unleaded aviation fuel at their facilities. With initial supplies of the fuel being limited, airports will likely have to be proactive and notify their fuel distributor that they would like to be supplied the fuel. Likewise, the FDOT AO could serve as an advocate for state airports in communicating with fuel manufacturers and distributors so that Florida airports can be among the first to receive blends of unleaded aviation fuel since initial demand is expected to be high. This will be beneficial for airports in the state given the level of aviation activity that occurs in Florida and the demand for unleaded aviation fuel elsewhere in the country.

- **Encourage Production / Distribution Facilities of Unleaded Aviation Fuels to be in Florida** – Florida has one of the busiest state aviation systems in the country; thus, demand for all aspects of aviation is generally higher than compared to other states. With this level of activity, the FDOT AO could encourage the fuel producers and distributors to locate manufacturing facilities and expand distribution facilities in Florida. These efforts would potentially improve access to these fuels. Financial incentives such as tax breaks could also be used to encourage fuel producers and distributors to locate / expand operations in Florida.

- **Inform Pilots on the Application Process for STCs to Use Unleaded Aviation Fuels** – The FDOT AO could assist in the communication efforts initiated by fuel producers to inform pilots and aircraft operators how to apply for an STC to use unleaded aviation fuels. GAMI, for example, with the rollout of their unleaded G100UL fuel, published resources that include pamphlets, web resources, and trade show appearances. The FDOT AO could help facilitate this information awareness campaign by publishing information on its website, e-mailing news releases, and using social media sites to direct interested parties to the STC process.

- **Promote Benefits and Reliability of Unleaded Aviation Fuels** – The FDOT AO could encourage the users of its state aviation system to use unleaded fuel through an information campaign about its benefits and reliability. Benefits of these fuels include reduction in lead-fouled spark plugs and longer intervals between required engine maintenance. Some hesitation about use of the fuel is likely given the proven reliability of leaded aviation fuels. The FDOT AO could use e-mail, publications, social media, and other communication channels to share information about the results of performance testing and to provide resources to answer other

inquiries about their use. The FDOT AO could also provide links to the communication campaigns of unleaded aviation fuel producers to learn more about these products. Additionally, the FDOT AO could also invite producers to conferences and other events to discuss unleaded aviation fuels with attendees.

- **Coordinate with Environmental Regulators** – As unleaded aviation fuels are introduced to the market, the FDOT AO could advocate with federal and state environmental regulators regarding the time needed to transition the entire piston-engine aviation fleet to its use. Although the fuels may be approved, regulators may be unaware of duration of implementation and challenges encountered as refineries and distribution networks ramp up production. This lack of awareness could result in new regulations that further limit and ban the lead additive to aviation fuels before the industry can meet the demand / supply equilibrium for piston-powered aviation engine fuels. By communicating with regulators, the FDOT AO could help prevent potential environmental regulation from grounding the aviation fleet until supply meets demand.

Conclusion

In conclusion, the implementation of unleaded aviation fuels in Florida is a long-awaited milestone for both aviation users and the environmental regulatory community. As with any emerging trend and its transition to mainstream industry acceptance, the production and distribution of unleaded aviation fuel will take time before it can be available at Florida airports for the users of its aviation system. The FDOT AO serves an important role in helping to facilitate this industry change by leading communication efforts about its benefits to the pilots and aircraft operators of its system. Likewise, the FDOT AO also serves an important role in assisting its airports in transitioning to unleaded aviation fuels and helping them coordinate with fuel producers and distributors, including methods to communicate this change to their pilot communities. Finally, the FDOT AO could also facilitate the installation of secondary fueling systems to contain these unleaded fuels. By implementing the recommendations for the FDOT AO to promote and provide access to unleaded aviation fuel, Florida can continue to be a world-class leader in supporting the needs of its airports and aviation community.