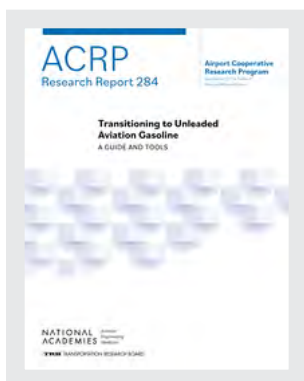


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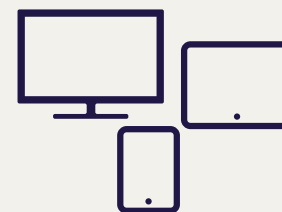
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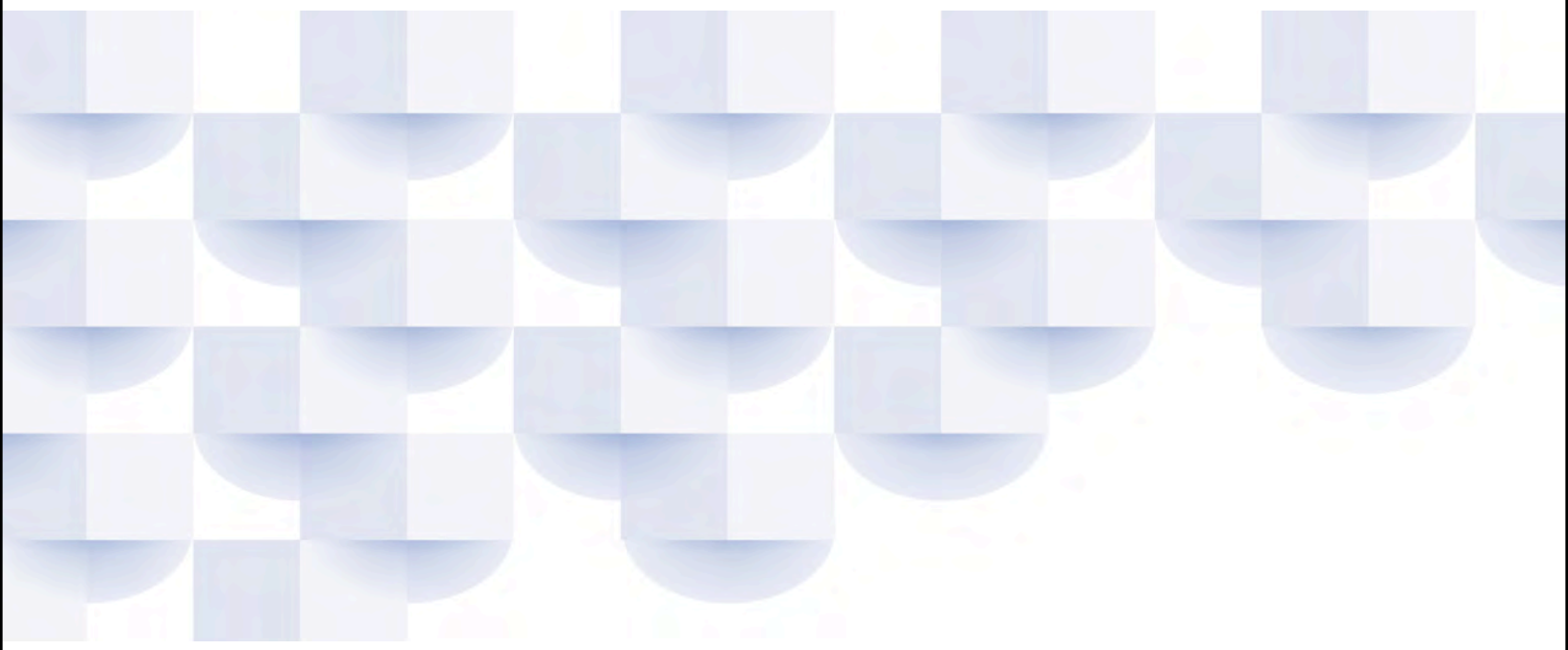
Research Report 284

**Airport Cooperative
Research Program**

Sponsored by the Federal
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Transitioning to Unleaded Aviation Gasoline

A GUIDE AND TOOLS



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ACRP RESEARCH REPORT 284

**Transitioning to Unleaded
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A GUIDE AND TOOLS

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). ACRP carries out applied research on problems that are shared by airport operating agencies and not being adequately addressed by existing federal research programs. ACRP is modeled after the successful National Cooperative Highway Research Program (NCHRP) and Transit Cooperative Research Program (TCRP). ACRP undertakes research and other technical activities in various airport subject areas, including design, construction, legal, maintenance, operations, safety, policy, planning, human resources, and administration. ACRP provides a forum where airport operators can cooperatively address common operational problems.

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ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

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Once selected, each ACRP project is assigned to an expert panel appointed by TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended users of the research: airport operating agencies, service providers, and academic institutions. ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties; industry associations may arrange for workshops, training aids, field visits, webinars, and other activities to ensure that results are implemented by airport industry practitioners.

ACRP RESEARCH REPORT 284

Project 03-73

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FOREWORD

By **Matthew J. Griffin**

Staff Officer

Transportation Research Board

ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools provides airports with an overview and actionable guidance for transitioning to unleaded aviation gasoline (avgas). A coordination plan was developed to understand ongoing efforts at the Federal Aviation Administration (FAA), the Environmental Protection Agency (EPA), and within the general aviation industry, and a case study plan was developed to identify pertinent airports and stakeholders. This guide and the additional resources will be useful to the United States aviation industry, with an emphasis towards airports that are transitioning to unleaded avgas.

The EPA has announced a proposed determination that emissions of lead from aircraft that operate on leaded fuel cause or contribute to air pollution that may reasonably be anticipated to endanger public health and welfare. The FAA and the aviation industry have set a goal and made a commitment to eliminate the use of leaded avgas by the end of 2030 without adversely affecting the safe and efficient operation of the existing piston-engine fleet. Achieving this goal will require airports to play a significant role, namely, taking steps to accommodate and offer unleaded avgas while maintaining 100-octane low-lead availability.

In early 2022, a government-industry partnership named Eliminate Aviation Gasoline Lead Emissions (EAGLE) was formed with a broad range of activities, including developing fuel infrastructure and access viability; supporting research, development, and innovation; evaluating and authorizing safe fuels; and establishing necessary policies. To complement the broad scope of the EAGLE initiative, a more focused research effort was also needed to help individual airports transition to unleaded avgas in a manner that was safe, efficient, and cost-effective and that did not disrupt piston-engine activity.

Under ACRP Project 03-73, “Airport Guide for Transitioning to Unleaded Aviation Gasoline,” Trinity Consultants was asked to produce a primer, guide, tools, and resources to help airports conduct a safe and efficient transition to unleaded avgas while maintaining continuity of service. An assessment of the future leaded avgas needs of the United States piston-engine aircraft fleet was performed, as well as a review of any available incentives, grants, and other funding mechanisms that could be leveraged for the development, distribution, and use of unleaded gasoline. A critical assessment of these findings, along with the findings of the case study plan, was performed, and the results were summarized in *ACRP Research Report 284* and used to develop the additional tools.

In addition to *ACRP Research Report 284*, the following materials are available at nationalacademies.org/publications by searching for *ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools*:

- Tool 1. Transition Process Checklist Tool.
- Tool 2. Individual Aircraft Unleaded Fuel Survey Tool.
- Tool 3. Multiple Aircraft Unleaded Fuel Survey Tool.
- Tool 4. Airport Unleaded Fuel Aircraft Inventory Tool.
- Tool 5. Unleaded Fuel Cost Evaluation Tool.

A Primer intended to provide airports with concise information about the transition to unleaded avgas accompanies this publication and can be found at nationalacademies.org/publications by searching for *Understanding the Transition to Unleaded Aviation Gasoline: A Primer*.



C O N T E N T S

1	Chapter 1	Introduction
1		Overview
3		Available Unleaded Aviation Gasolines and Determining Aircraft Compatible with Their Use
6	Chapter 2	Ten Steps for Transitioning to Supplying Unleaded Aviation Gasoline Alongside 100LL Through 2030
6		Step 1. Communicate with Fuel Suppliers and FBOs
7		Step 2. Characterize the Airport Fleet for Unleaded Fuel Compatibility
9		Step 3. Estimate Unleaded Fuel Demand and Evaluate Refueling Infrastructure
10		Step 4. Identify Potential Transition Funding Sources
11		Step 5. Perform Financial Analysis of Transition Options
12		Step 6. Decide on the Transition to Unleaded Fuel and Select the Fuel Type
12		Step 7. Implement Transition Plans to Unleaded Fuel
13		Step 8. Develop Safety Procedures
13		Step 9. Conduct Training, Outreach, and Education
14		Step 10. Monitor the Transition, Identify Issues, and Make Adjustments
15	Chapter 3	Tools to Assist with Transition Activities
16		References
18	Appendix A	Airport Summaries
39	Appendix B	Naples Airport UL94 Unleaded Fuel SOP

Introduction

The Airport Cooperative Research Program (ACRP), funded by the Federal Aviation Administration (FAA), initiated ACRP Project 03-73 to answer a broad, foundational question: What can be learned from airports that have transitioned or are planning to transition to unleaded aviation gasoline while continuing to provide 100-octane low-lead (100LL) aviation gasoline? This guide and the associated spreadsheet tools are based on information developed from the experiences of airports that have already made this transition or were in the process of doing so and is intended to share best practices and lessons learned from those experiences.

Overview

The need for high-octane fuels like 100LL in gasoline-fueled aircraft engines is the result of some manufacturers designing high-performance, high-compression ratio engines to maximize the work the engine can perform per volume of fuel consumed, and to optimize the power-to-weight ratio of the engine. However, other gasoline-fueled aircraft engine designs can safely operate on fuels with octane ratings as low as 80 while also being capable of utilizing 100LL fuels. To put these octane ratings into context, unleaded gasolines used in on-road vehicles generally have octane ratings ranging from 87 (regular) to 91 (premium). This research was initiated to answer a broad, foundational question: What can be learned from airports that have transitioned or are planning to transition to unleaded aviation fuel, while continuing to provide 100LL? This guide is organized around that intent, with the goal of sharing best practices and lessons learned to support other airports as they plan and implement their own transitions. As a result of the fact that some engines require 100-octane fuel and all engines can operate using that fuel, aviation gasoline producers and airports have historically elected to produce only one fuel that meets the needs of all aircraft, 100LL gasoline.

As is discussed in *Understanding the Transition to Unleaded Aviation Gasoline: A Primer*, public health concerns regarding lead emissions from the combustion of 100LL are driving a transition to unleaded aviation fuels in all gasoline-fueled aircraft by the end of 2030.

This guide is organized around that intent, with the goal of sharing best practices and lessons learned to support other airports as they plan and implement their own transitions. The guide is accompanied by five standalone tools that are intended to assist airports with different aspects of the transition process. These tools are described in Chapter 3 of the guide and are available at nationalacademies.org/publications by searching for *ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools* and looking under “Additional materials.”

The purpose of this guide is to provide a summary of the general steps and best practices that airports seeking to supply unleaded aviation gasoline should follow, and to highlight important

2 Transitioning to Unleaded Aviation Gasoline: A Guide and Tools

sources of information that will assist in the process. It is strongly suggested that those interested in the transition to unleaded aviation gasoline first read the Primer, as it provides additional background information.

The guide is based on what is considered to be the best publicly available information at the time of its completion in January 2025, particularly the information available from the Eliminate Aviation Gasoline Lead Emissions (EAGLE) initiative website, which is frequently referred to throughout this document (EAGLE n.d.). As described in more detail in the Primer, EAGLE is a government-industry partnership, working toward the transition to lead-free aviation fuels for piston engine aircraft by the end of 2030 without compromising the safety or economic health of the general aviation industry.

In addition to information and data available from EAGLE and other publicly available sources, this guide also relies on findings from an analysis of information collected through case studies of seven airports that had already begun or were in the process of being able to supply unleaded gasoline along with 100LL gasoline during the spring and summer of 2024 when interviews were conducted. Summaries of these case studies, as well as results of interviews related to the transition at Alaskan airports are provided in Appendix A of this guide. The case studies were performed using a set of standardized survey questions.

Beyond this guide, there are several other sources of information regarding transitioning to unleaded aviation gasoline that need to be considered, which are described as follows:

- Information and reports from the FAA, including Building an Unleaded Future by 2030 (FAA 2024b) as well as Frequently Asked Questions and Definitions (FAA 2024e).
- EAGLE Guidance on Transitioning a Flight School to Unleaded Avgas (FAA 2023), which covers many of the same steps to transition and issues presented and could serve as a companion to the guide.
- White papers prepared by the National Air Transportation Association (NATA), including *Unleaded Avgas Conversion Considerations for Aviation Fuel Providers* and *Factors Affecting the Commercial Sale of Emerging Unleaded Aviation Fuels* (NATA 2022, 2024a).

It is strongly suggested that those involved in planning and executing airport transitions to unleaded aviation gasoline obtain and review these materials in addition to the ACRP Project 03-73 deliverables.

Following this background section, the next section presents a summary of the latest information regarding the status of unleaded aviation gasoline availability and requirements for use in aircraft. The subsequent sections of this guide discuss in some detail the suggested general approach to transitioning. This approach is based on a 10-step process intended to allow airports to transition to supplying unleaded aviation gasoline along with 100LL fuel through 2030. The guidance is based on information available as of January 2025 but also attempts to address the possibility of new and perhaps unforeseen developments related to unleaded aviation gasoline between now and the end of 2030. At a high level, these 10 steps are:

1. **Communicate with fuel suppliers and fixed-base operators (FBOs).** Conduct initial communications with fuel suppliers and FBOs as appropriate to determine what types of unleaded aviation gasolines are available to the airport, which aircraft can use them, if there are applicable ASTM International standards for the fuel, and if there are any compatibility issues associated with mixing each unleaded fuel with 100LL or other unleaded aviation gasolines. At airports with sponsor-owned FBOs, communications would be directly with fuel suppliers.
2. **Characterize the airport fleet for unleaded fuel compatibility.** Identify the aircraft in the airport fleet that can use the different types of unleaded aviation gasolines expected to be available to the airport at the time of transition and determine if they will need supplemental type certificates (STCs).

3. **Estimate unleaded fuel demand and evaluate refueling infrastructure.** Analyze the expected volumes of the available unleaded aviation gasoline(s) under consideration and determine if they can be provided using existing airport fueling infrastructure while continuing to provide 100LL, or if new infrastructure and/or new fuel delivery methods are needed.
4. **Identify potential transition funding sources.** Determine whether funding is available from the FAA, state sources, sponsors, or other organizations to assist with infrastructure changes and/or to provide subsidies for the cost of the available unleaded aviation gasoline(s) and, if necessary, STCs.
5. **Perform financial analysis of transition options.** Use the information gathered in Steps 1 through 4 to assess the financial implications, such as potential revenues and costs associated with each unleaded aviation gasoline under consideration.
6. **Decide on the transition to unleaded fuel and select the fuel type.** Use the results of the analysis in Step 5 in combination with the airport's Primary Management Compliance Documents (PMCDs) that include minimum standards/rules and regulations for compliance as part of the airport's decision-making process to determine if the airport will begin the transition to supplying one or more unleaded aviation gasoline(s) while continuing to provide 100LL.
7. **Implement transition plans to unleaded fuel.** Make the necessary arrangements to develop the required refueling infrastructure, including securing grant and incentive funding, to provide the selected unleaded aviation gasoline(s) and to work with the fuel supplier that will provide the fuel(s).
8. **Develop safety procedures.** To prevent misfueling of aircraft, develop procedures to ensure that unleaded aviation gasoline(s) either have FAA fleet authorization or are only used in aircraft that are type certified or hold STCs for their use.
9. **Conduct training, outreach, and education.** Ensure all personnel involved in the supply and use of the selected unleaded aviation gasoline(s) are informed of proper procedures and safety protocols through targeted outreach, education, and training before fuel distribution begins.
10. **Monitor the transition, identify issues, and make adjustments.** Begin using the selected unleaded aviation gasoline(s), monitor the progress of the transition, and evaluate and adjust as needed to address any issues that arise.

While the 10 steps outlined above are intended to encompass all the activities needed for an airport to transition to providing one or more unleaded aviation gasoline alongside 100LL through 2030, the guide is not intended to be exhaustive and there will undoubtedly be airport-specific issues that arise and need to be addressed. In addition, airports will also need to ensure that all actions comply with PMCDs and/or other applicable rules, regulations, minimum standards, and policies that govern the airport.

To assist airports with tracking their progress through the transition process, an Excel spreadsheet tool titled "Transition Process Checklist Tool" has been developed and is available on the National Academies Press website (nationalacademies.org/publications) by searching for *ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools*.

Available Unleaded Aviation Gasolines and Determining Aircraft Compatible with Their Use

Although the suggested steps for an airport to transition to providing unleaded aviation gasoline along with 100LL are generally the same regardless of the unleaded aviation gasoline (or potentially gasolines) selected, it is important for airports to understand the issues associated with each unleaded aviation gasoline fuel, how to determine the engines and aircraft that are authorized by FAA to use each fuel, the compatibility of fuels with 100LL, and the status of the fuel with respect to being covered by an ASTM International standard. In addition to this guide, NATA's white

4 Transitioning to Unleaded Aviation Gasoline: A Guide and Tools

paper, *Unleaded Avgas Conversion Considerations for Aviation Fuel Providers*, is suggested as a source of information on some of the key issues raised in this section as well as others raised in the discussion of the suggested transition steps (NATA 2022).

ASTM International standards are voluntary, consensus-based standards developed by technical committees of industry experts and intended to ensure, in the case of aviation gasoline fuels, that commercial fuels meet the requirements of gasoline-fueled aircraft engines. The status of the various unleaded aviation gasolines with respect to ASTM International standards is addressed here because that status may play a role in whether an aviation gasoline will be allowed to be dispensed by a particular entity or, potentially, if the use of an unleaded fuel is considered to be compatible with the warranties provided by engine and aircraft manufacturers.

There are four types of unleaded aviation gasolines that are or are becoming commercially available as of this report's writing in January 2025. These are:

1. Non-oxygenated motor gasoline (mogas), to which the latest version of ASTM International Standard D4814 "Standard Specification for Automotive Spark-Ignition Engine Fuel" applies.
2. Swift Fuels UL94, to which the latest version of ASTM International Standard D7547 "Standard Specification for Hydrocarbon Unleaded Aviation Gasoline" applies.
3. General Aviation Modifications, Inc. (GAMI) G100UL, for which no ASTM International standard currently exists. However, GAMI has developed its own proprietary fuel specification as part of the FAA STC approval process (GAMI 2024a).
4. Swift 100R, for which an ASTM International standard is in development (Swift Fuels 2024).

In addition, a fifth unleaded fuel (UL100E), is being developed by LyondellBasell and VP Racing Fuels, but it is still undergoing testing under the FAA's Piston Engine Aviation Fuels Initiative (PAFI) and, at present, would not be covered by an ASTM International standard, although an ASTM International standard is under development (FAA 2022b).

There are three basic mechanisms by which unleaded aviation gasoline can be authorized for use in specific types of gasoline-powered engines and aircraft. These are:

1. Through the FAA's Type Certification process by the original engine/aircraft manufacturers.
2. Through the FAA's STC process by fuel producers via an authorized models list.
3. Through the FAA's Fleet Authorization process under PAFI, which requires both testing and the development of an ASTM International standard for the fuel.

Currently, mogas, Swift UL94, Swift 100R, and GAMI G100UL can only be used in aircraft that have acquired STCs specific to each fuel. It should be noted that the STC process does not generally apply to experimental or amateur-built aircraft.

Mogas, without the oxygenate ethanol that is added to most automotive fuels in the United States, can be used in gasoline aircraft engines designed for use with octane ratings in the 80 to 87 range and has been in use for a considerable period. Use of mogas requires the aircraft owner to complete all steps required to obtain an appropriate STC, including having any mandatory inspections and modifications performed. Mogas or Auto Fuel STCs are available from the Auto Fuel STC website (Auto Fuel STC n.d.). Many gasoline-fueled aircraft in the United States can use mogas. At the time of this publication, according to the FAA's Airport Data and Information Portal (FAA n.d.), 172 airports in the country currently supply mogas. As noted above, mogas specifications are established through an ASTM International standard. In addition, provided the aircraft has a mogas STC, that fuel can be added to existing 100LL fuel that is already present in the aircraft during refueling, and vice versa.

Swift UL94 can be used in about two-thirds of gasoline-fueled aircraft in the United States [Swift Fuels n.d.(b)]. Again, this requires the aircraft owner to complete all steps required to obtain an appropriate STC, including having any mandatory inspections and modifications performed.

STCs can be obtained for authorized aircraft from Swift Fuels on their website [Swift Fuels n.d.(a)]. According to FAA's Airport Data and Information Portal, Swift UL94 is currently being supplied by 36 airports as of April 30, 2025 (FAA n.d.). As noted earlier, Swift UL94 specifications are established through an ASTM International standard. Again, provided the aircraft has a UL94 STC, that fuel can be added to the existing 100LL fuel that is present in the aircraft during refueling and vice versa.

Swift 100R is just becoming available, and at present, STC coverage remains limited. 100R is available in three airports in California, San Carlos, Half Moon Bay, and Santa Monica [County of San Mateo 2024, National Business Aviation Association (NBAA) 2024]. In addition, Swift has indicated that it is working to secure the development of an ASTM International standard for the 100R fuel. Provided the aircraft has a 100R STC, that fuel can be added to existing 100LL fuel present in the aircraft during refueling, and 100LL can also be added to Swift 100R in a similar situation. At present, Swift 100R STCs are available only for Cessna 172R/S airplanes with Lycoming IO-360-L2A engines (Swift Fuels 2024).

GAMI G100UL, like Swift 100R, is intended ultimately to be used in any gasoline-fueled aircraft after the aircraft owner completes all steps required to obtain an appropriate STC, including having any mandatory inspections and modifications performed. STCs can be obtained for authorized aircraft from GAMI on their website (GAMI 2024b). According to FAA's Airport Data and Information Portal, GAMI G100UL is currently being supplied by two airports in the country (FAA n.d.). At present, there is no ASTM International standard that applies to G100UL, and it does not appear that GAMI is pursuing the development of such a standard. Provided the aircraft has a G100UL STC, that fuel can be added to existing 100LL fuel that is present in the aircraft, and 100LL can also be added to G100UL in a similar situation.

Given that both Swift 100R and GAMI G100UL are not covered by applicable ASTM International standards, they have at present been authorized by FAA as "Company Specific Products" and the fuel producers are responsible for ensuring that commercial fuel conforms to each company's specifications for its product.

More information regarding the differences between ASTM International standards and Company Specific Product specifications is available from the EAGLE website, including through an EAGLE fact sheet (<https://flyeagle.org/wp-content/uploads/2024/11/Fact-Sheet-The-Value-of-Industry-Voluntary-Consensus-Standards.pdf>) available on the website (EAGLE 2024b).

It is also very important to note that Swift has published guidance stating that G100UL must not be used in aircraft authorized for a Swift Fuels STC [Swift Fuels n.d.(b)]. However, as stated above, fuels from both producers can be mixed with 100LL (EAGLE 2024a).

Finally, as noted earlier, a third 100-octane unleaded aviation gasoline ultimately intended for use in all gasoline-fueled aircraft, UL100E, is under development by LyondellBasell and VP Racing Fuels (VP Racing Fuels n.d.). This fuel is still undergoing testing under the FAA PAFI program and is expected to be allowed for use under an FAA Fleet Authorization rather than the STC process. The FAA Fleet Authorization process requires that the authorized fuel be subject to an applicable ASTM International standard, which would have to be developed for the 100E fuel. While 100E is compatible with 100LL, it is not known at this time if 100E will be compatible with other unleaded aviation gasolines.



CHAPTER 2

Ten Steps for Transitioning to Supplying Unleaded Aviation Gasoline Alongside 100LL Through 2030

Step 1. Communicate with Fuel Suppliers and FBOs

As summarized earlier, there are currently four types of unleaded fuels that can be used to varying degrees in gasoline-fueled aircraft, with a fifth under development. Given this, Step 1 in the transition process involves determining which types of unleaded aviation gasolines are available to the airport and gathering relevant data and information regarding those fuels. This information will be required to complete some of the later steps in the process. The fuels available to an airport may vary depending on the region in which the airport is located (particularly in Alaska, where unleaded fuel may not be available for some time), and the best points of initial contact will likely be either the fuel producers themselves (e.g., Swift or GAMI) or the fuel distributors that are currently providing 100LL for fueling operations at the airport. During this process, it is also important to recall that 100LL must continue to be offered along with unleaded aviation gasoline until the final elimination of 100LL.

For airports that own and operate their own fueling facilities, it will likely be airport staff that are best suited to make these initial contacts. This list of pertinent questions includes:

1. What unleaded fuels are commercially available to the airport both now and in the near future, given the ongoing development of unleaded aviation gasoline?
2. Which of the available fuels are required to conform to ASTM International standards and which are Company Specific Products?
3. What volumes of each fuel are available on an ongoing basis?
4. What are the available delivery options for each fuel (e.g., full or partial tanker truck loads, small-volume portable totes, drums, etc.)?
5. What is the pricing structure for each available fuel on a dollar-per-gallon basis, as a function of the monthly or annual average throughput of the fuel at the airport and the type of delivery option?
6. For each available unleaded fuel, what types of gasoline-powered aircraft is it authorized for? Please include differences between fixed-wing and rotorcraft, and between certified, experimental, and amateur-built aircraft.
7. Which unleaded fuels, if any, are covered by FAA Fleet Authorizations, and what aircraft are authorized?
8. If STCs are required for a specific fuel, how can one access the list of aircraft for which STCs are available?
9. If STCs are required, what is the pricing structure for purchasing the STCs?
10. Are there any compatibility issues with any of the available fuels that could create safety concerns if they were mixed with 100LL or any other unleaded fuel (even if that fuel is not supplied at the airport)?

The fuel pricing data obtained under Step 1 will be important for the financial analysis performed under Step 5.

For airports where one or more FBOs operate the fueling facilities, the process will likely need to be a collaborative effort involving both airport staff and FBO employees. In general, the same list of questions presented above will need to be addressed. These include:

1. Are the FBOs willing to consider supplying unleaded aviation gasoline alongside 100LL, at least until the end of 2030?
2. Do the FBOs require that the fuels they provide conform with an applicable ASTM International standard?

To the extent that FBOs are unaware of the U.S. Environmental Protection Agency (EPA) Endangerment Finding or the end of 2030 target for the elimination of 100LL, it is recommended that their employees be directed to the EAGLE website where they can find information regarding the necessity of transitioning to providing only unleaded aviation gasoline (EPA 2025a, EAGLE n.d.). In this case, it may be beneficial to follow up with the FBO once they have gained a better understanding of the issue.

In both cases, it will also be important for airports to determine or ask FBOs for the annual volume of 100LL dispensed at the airport so it can be compared in later steps to the estimated demand for unleaded aviation gasoline. Another key factor requiring data is the proportion of annual aviation gasoline volume dispensed to aircraft that are not based at the airport.

Based on the information received, the airport may be able to make some preliminary decisions regarding which unleaded aviation gasolines should be considered in more detail as candidates in later steps of the transition process. For example, if an airport or FBO requires, either by policy or for liability reasons, that fuels conform to ASTM International standards, then unleaded aviation gasolines classified as Company Specific Products can be eliminated from consideration. Similarly, if the airport's objectives include supplying an unleaded fuel suitable for high-performance aircraft, only a 100-octane unleaded fuel may be acceptable. Another example might be eliminating an unleaded fuel that cannot be mixed with other authorized unleaded fuels that are already widely used at other airports in the region.

The result of Step 1 should be the final determination of the unleaded fuel(s) of interest to the airport or a list of candidates for unleaded fuels, as this information is required for several of the subsequent steps. While it is very likely that an airport will choose to dispense only one type of unleaded aviation gasoline, given the current uncertainty in the development of unleaded aviation fuels, this guide and its associated tools were designed to assist airports in evaluating up to four different types of unleaded gasoline. Though this gives airports the ability to consider multiple fuels, it is suggested that they evaluate only the fuels that are both available and of interest to them.

Step 2. Characterize the Airport Fleet for Unleaded Fuel Compatibility

Step 2 in the transition process involves characterizing the fleet of gasoline-fueled aircraft based at the airport. The purposes of Step 2 include:

1. Determining the approximate number of aircraft based at the airport that are authorized to use the unleaded fuel(s) being considered by characterizing the fleet in terms of aircraft type and model, as well as engine make and model.
2. Obtaining an estimate of the annual fuel use of each aircraft.
3. Determining each aircraft operator's general interest in using unleaded fuel.

8 Transitioning to Unleaded Aviation Gasoline: A Guide and Tools

4. Determining whether each aircraft has already received an STC that allows it to operate on unleaded aviation gasoline, and if so, which one(s).

As discussed later, it is suggested that these objectives be met through a survey of operators of aircraft based at the airport. In order to improve the results of the survey, it is proposed to include all stakeholders at the airport in outreach discussing the planned transition to maximize awareness and understanding. At airports with flight school operations, special attention should be paid to outreach and communications with flight school personnel before conducting the survey. This is important because flight school aircraft may constitute the majority of the fleet based at the airport and are likely to consume larger quantities of fuel than other aircraft.

As noted above, EAGLE has published a guidance document on flight school transitions, which may be useful to airport staff in their outreach to flight schools. Additionally, the fact that the airport is considering a transition to supplying unleaded aviation gasoline along with 100LL should also be communicated to the operators of airport-based aircraft before conducting the actual survey. This can be done through direct meetings with aircraft owners, direct mailings, email campaigns, or other means. Airport staff may also consider offering some sort of incentive to aircraft operators to increase their participation in the survey.

The survey itself is straightforward, and a tool has been developed under ACRP Project 03-73 as a fillable PDF file titled “Individual Aircraft Unleaded Fuel Survey Tool” for use with individual aircraft operators. This survey can also be distributed in printed form if necessary. Additionally, a separate Excel-based tool, “Multiple Aircraft Unleaded Fuel Survey Tool” has been developed for flight schools and other organizations operating multiple gasoline-fueled aircraft to reduce their level of effort in completing the survey. These tools are available on the National Academies Press website (nationalacademies.org/publications) by searching for *ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools*.

The surveyed aircraft population should be directed to all gasoline-fueled aircraft, including rotorcraft, historic, experimental, and amateur-built aircraft, which do not have STCs. It is recommended that the survey collect the following information, though some airports may already have access to parts of this data:

- Aircraft owner details, including contact information.
- Aircraft type and N-Number.
- Engine type and model.
- Interest in using unleaded aviation gasoline if it were made available at the airport.
- Unleaded fuel STC status, and if an STC has been acquired, identification of the applicable fuel.
- Estimated annual fuel consumption of the aircraft.

To the extent that airport owners do not participate in the survey, the most important aircraft data (aircraft type, model, and engine type and model) should still be generally available for aircraft covered by Type Certificates (TC), provided N-Number information is available or can be collected for aircraft based at an airport through the FAA Registry website (FAA 2024d). However, airport staff will likely have to determine whether STCs are available for these aircraft by referring to the STC lists available from the fuel manufacturers.

The data collected from the surveys under Step 2 along with data compiled by airport staff from the N-Numbers of non-participating aircraft should be used to develop an aircraft inventory for the airport’s fleet of gasoline-fueled aircraft. To assist with this, an Excel spreadsheet tool titled “Airport Unleaded Fuel Aircraft Inventory Tool” is provided as a supplement to this publication. This tool, also available on the National Academies Press website, allows airports to create aircraft inventories for up to four different candidate fuels.

Step 3. Estimate Unleaded Fuel Demand and Evaluate Refueling Infrastructure

Step 3 has two objectives: first, to estimate the potential demand for unleaded aviation gasoline(s) at the airport, and second, to evaluate the existing refueling infrastructure to determine whether modifications will be required to provide unleaded aviation gasoline along with 100LL through the end of 2030—the current target date for the elimination of 100LL. In addition to this section of the guide, NATA has developed a white paper addressing various issues related to transitioning to unleaded aviation gasoline, most notably the requirements for converting a refueling system that currently provides 100LL to one that provides unleaded aviation gasoline (NATA 2022). This resource should be read by airport staff involved in the transition.

Estimates of the annual volume of unleaded aviation gasoline demand at the airport from aircraft based at the airport can be derived from the aircraft inventory developed in Step 2 for each unleaded fuel under consideration. The Airport Unleaded Fuel Aircraft Inventory Tool developed for this guide provides multiple ways to calculate this demand. First, an upper bound estimate of the required supply can be determined by summing up the estimated annual fuel consumption of each aircraft authorized for use with each unleaded aviation gasoline being considered. However, this upper bound volume is likely to be an overestimation, as it assumes that all aircraft owners who could use a given unleaded fuel will do so.

The second suggested approach filters the inventory data to include only those aircraft for which an unleaded fuel is authorized and whose operators have expressed interest in using the fuel based on the survey responses. This approach is likely to generate a best-case estimate of unleaded fuel demand, as it assumes that all aircraft operators who express interest will take the necessary steps to use the fuel, including securing any necessary approvals.

The third and final suggested approach is based on the second but applies an additional limitation: Only the aircraft that have already secured STCs (if necessary) are counted toward unleaded fuel demand. This estimate of the volume of unleaded fuel demand could be quite low or even zero, and it likely represents the lower bound of expected unleaded aviation gasoline demand.

As noted earlier, the three volume estimates will define the likely range of potential demand for an unleaded fuel from aircraft based at the airport. This demand must be satisfied by the airport, along with a more central value that will be the closest approximation to at least the initial demand. At this point, the airport staff involved in the transition will need to use these three estimates to determine the volume that best represents the likely demand for each aviation gasoline under consideration. This value will then be used to assess how the airport's existing refueling infrastructure may need to be modified to accommodate an unleaded fuel or fuels.

A final consideration in determining the volume value is whether the amount of aviation gasoline supplied to aircraft not based at the airport is significant compared to the total volume supplied by the airport. If it is, the next question is whether any of that volume is expected to transition to unleaded aviation gasoline. If so, the volume value used in the evaluation of refueling infrastructure may need to be adjusted upward.

Once the final unleaded gasoline volume values are established for each gasoline under consideration, they should be compared to the available supply volumes obtained from the fuel supplier in Step 1. If the airport's estimated demand volume exceeds the supplier's available volume, the choice of the candidate unleaded fuel should be reevaluated.

If sufficient supply is available, the evaluation of the necessary changes to the airport's existing refueling infrastructure can begin. This process starts with identifying any unused refueling equipment, including fuel tanks, other fuel storage devices, and fuel trucks that could be

repurposed for supplying unleaded aviation gasoline. Additionally, it should be determined if the expected shift in volume from 100LL to unleaded aviation gasoline would free up infrastructure currently used for 100LL.

If the existing refueling infrastructure is sufficient to accommodate the anticipated volume of unleaded aviation gasoline, the only requirement will be the cleanup and conversion of that equipment from 100LL to unleaded gasoline. The requirements for this conversion process are outlined in the Infrastructure Considerations section of the NATA white paper (NATA 2022) reproduced below:

UL Avgas requires its own grade dedicated storage tanks, refueling trucks, and systems on airports. Aviation fuel providers who wish to convert existing 100LL refueling systems must consult with their fuel supplier(s) to confirm specific requirements necessary for converting 100LL storage tanks, self-serves, and/or mobile refuelers to UL Avgas. The following considerations are generalized and offered only in reference to conversion of airport 100LL systems to UL Avgas. Converting airport refueling systems from other fuel types will require additional measures, including:

- *Remove as much fuel as possible from fuel storage tank(s) and/or mobile refuelers of 100LL consistent with UL supplier recommended acceptable fuel mix ratio. (ASTM specifications for UL Avgas allow for a maximum of 0.0130 g Pb/l of Tetraethyl lead).*
- *Introduce UL Avgas to the tank and flush downstream piping, filter vessels, and hose(s) until nozzle end samples are visually clear and bright.*
 - *Flushing helps prevent carry-over of residual blue dye from 100LL and mitigates the risk of UL Avgas being visually misidentified as 100LL.*
 - *Typically, this requires at least 1.5 times the total volume of associated piping and hoses.*
- *Replace all filter elements.*
 - *Elements will contain residual TEL (tetraethyl lead) and require proper disposal.*
- *Update identification markings.*
 - *All 100LL Avgas identification markings (placards, labels, decals, etc.) must be removed and replaced with identification markings for the UL Avgas being dispensed.*
- *Update self-serve dispenser terminals.*
 - *Fueling terminals (i.e.: QT Pod) should be updated to include prompts for pilots to enter the Supplemental Type Certificate (STC) number for their aircraft.*

If existing refueling infrastructure is not available or is insufficient to accommodate the required volume of unleaded aviation gasoline, airport staff must determine the best approach to modifying the airport's refueling infrastructure. Depending on the volume of unleaded aviation gasoline needed, these modifications could range from using small portable fuel totes to dedicating one or more fuel trucks to unleaded fuel or constructing new fuel tanks and installing new dispensers.

Once a modification strategy has been identified, it will be necessary to determine the best method for implementation and the estimated cost. At airports where FBOs provide fueling services, their involvement in this determination may be required depending on infrastructure ownership. These cost estimates will be essential for the financial analysis conducted in Step 5.

Step 4. Identify Potential Transition Funding Sources

Step 4 in the transition process focuses on identifying funding sources to cover the cost of transitioning to unleaded aviation gasoline. The primary fixed-cost elements of the transition will likely be associated with the development of new refueling infrastructure, although there may also be significant costs associated with training, insurance, outreach, and administration. The major variable-cost elements of the transition are likely to be the price differential between unleaded aviation gasolines and 100LL as well as the costs of STCs if those are necessary.

The first step in identifying funding sources should involve a discussion with the airport sponsors to determine if they can increase funding to cover some or all of the financial impacts

through changes in the airport's operating or capital improvement budget or by providing funding for incentives to cover STC expenses and fuel price differentials.

When considering infrastructure costs, it is important to determine whether some or all of these expenses can be covered through FAA funding. As discussed in *Understanding the Transition to Unleaded Aviation Gasoline: A Primer*, FAA currently operates two funding programs: the Bipartisan Infrastructure Law (BIL) and the Airport Improvement Program (AIP) (FAA 2022a, 2024a). Airport staff should contact their FAA Regional Airports District Office for the latest information and details on grant funding opportunities for the development of refueling infrastructure for unleaded aviation gasoline.

As of January 2025, Colorado is the only state known to be offering grant funding for infrastructure costs associated with unleaded transitions. However, other states, as well as regional and local governments may provide such funding in the future, and special grants from air quality agencies may also be available [EPA 2023, EPA 2025b, California Air Resources Board (CARB) 2025, Bay Area Air Quality Management District (BAAQMD) 2025]. It is strongly suggested that airport staff explore funding sources beyond the FAA as part of Step 4. Infrastructure costs not covered by grant funding will likely need to be borne by airports, airport sponsors, and FBOs.

Based on the findings of ACRP Project 03-73, grant funding for incentive programs that cover STC costs and offset the price difference between unleaded aviation gasoline and 100LL is less likely to be available, and that which is available is likely to come from airport sponsors. However, this should still be included in the airport staff's funding investigation.

Step 5. Perform Financial Analysis of Transition Options

The purpose of Step 5 is to conduct a financial analysis of the unleaded gasoline options under consideration. To facilitate this analysis, an Excel spreadsheet tool titled "Unleaded Fuel Cost Evaluation Tool" is available from the National Academies Press website. The following fixed-cost components of the transition are assumed to be the same for each fuel in the tool:

- Fuel tanks,
- Mobile fuel storage,
- New signage,
- Training,
- Incremental insurance and fixed fuel supplier costs,
- Outreach, and
- Incremental administrative requirements.

Values for these cost estimates were either calculated in Step 4 or will need to be determined specifically for Step 5. Different cost options (new, reused, and leased) can be entered for fuel tanks and mobile fuel storage. Note that any potential grant funding for infrastructure or other aspects of these costs must be subtracted from the tool's results to estimate the net cost to the airport. If these cost estimates vary between specific unleaded fuels under consideration, multiple evaluations will need to be conducted using the tool.

Fuel-specific cost inputs, which are treated as variables in the tool depending on the unleaded fuel, include the price of the fuel and the expected revenue (profit) from its sale, price of 100LL and its expected revenue, and the per-aircraft cost of STCs. The impact of fuel price and STC subsidies available through grants can also be considered, but this requires input data on subsidy levels.

Other inputs include the estimated demand volume for unleaded aviation gasoline and the number of aircraft expected to require STCs. This latter value excludes aircraft that had already

purchased STCs at the time of the Step 2 survey. This data was generated in Step 3, and it is important to use the appropriate fuel volume estimate along with the corresponding number of aircraft expected to require STCs in the financial analysis.

The required outputs of the Unleaded Fuel Cost Evaluation Tool for each unleaded fuel under consideration are:

- Total fixed costs of the transition, accounting for any grant funding.
- Total one-time costs for STCs, accounting for any grant funding.
- Annual cost difference between unleaded fuel and 100LL, accounting for any grant funding.

These outputs can then be used to assess the overall financial impact of the transition to each unleaded aviation gasoline under consideration.

Step 6. Decide on the Transition to Unleaded Fuel and Select the Fuel Type

In Step 6, the airport is expected to make two key decisions. The first is when to transition to unleaded aviation gasoline in addition to 100LL. The second, required if multiple fuels were considered, is determining which unleaded aviation gasoline will be supplied. These decisions are expected to follow the airport's normal decision-making process in conformance with airport's PMCDs, which may involve public meetings, requirements related to publication of notices, and other procedural requirements. The results of the financial analysis along with other factors, such as those listed as "opportunities" in the Primer, will be key elements in the decision-making process. These opportunities include the following and should be considered alongside the understanding that a transition to unleaded aviation gasoline will ultimately have to occur:

- Reducing lead emissions at and around airport facilities, thereby improving the health of both airport users and those who live, work, or go to school in the vicinity of the airport.
- Demonstrating leadership in addressing environmental challenges, such as lead emissions, to both the aviation community and the general public.
- Educating the local aviation community and the public about unleaded aviation gasoline.
- Providing aircraft operators with direct experience in using unleaded aviation gasoline before the current target end date for 100LL of December 31, 2030.

If the airport's decision-making process determines that a transition to supplying unleaded aviation gasoline along with 100LL will not proceed, the transition process can be paused until future developments warrant reassessment. This would require updating the work previously completed in Steps 1 through 5 and conducting another round of airport decision-making. If the decision is to proceed, the airport should move on to Steps 7 through 10, discussed later.

Step 7. Implement Transition Plans to Unleaded Fuel

Step 7 marks the transition from the information gathering, analysis, and decision-making activities of Steps 1 through 6 to the implementation of the airport's transition to unleaded aviation gasoline alongside 100LL. This step requires the airport to take several key actions considered in the earlier steps of the transition, including:

- Completing the process to secure grant funding for infrastructure and incentive programs.
- Securing an adequate supply and delivery of the selected unleaded gasoline(s) through contracts and other agreements with fuel suppliers and FBOs, as appropriate.
- Moving forward to begin and complete infrastructure construction or conversion projects, including the acquisition of fuel trucks and portable fuel storage, as appropriate.

- Addressing any necessary insurance and/or administrative requirements, including the addition of appropriate signage for unleaded fuel.

Any other issues directly related to the airport's facilities or general operations should also be addressed.

Step 8. Develop Safety Procedures

The purpose of Step 8 is for the airport and/or FBOs to develop safety procedures that prevent misfueling caused by supplying an unleaded fuel that is not authorized for an aircraft or by adding an unleaded fuel that is incompatible with another unleaded fuel already present in the aircraft.

This objective can be met through the development of standard operating procedures (SOPs) based on existing misfueling safety practices. Valuable resources on misfueling prevention are available through the NATA Misfueling Prevention program and should be reviewed as part of the development of unleaded aviation gasoline safety practices and SOPs (NATA n.d.).

A key difference between existing misfueling prevention practices and those for unleaded fuel pertains to instances where unleaded fuel approval is based on STCs rather than Fleet Authorization. In such cases, it is essential to confirm that the aircraft requesting unleaded aviation gasoline displays an STC indicating approval for use with the specific fuel. An example SOP developed by Naples Airport is included in Appendix B as an illustration of an unleaded-specific misfueling SOP.

Additionally, although unlikely at present and in the future due to the fact that Swift and GAMI unleaded fuels are not recognized as compatible with each other, the SOP should specify that any aircraft displaying multiple STCs for unleaded fuels must not be refueled until it has been confirmed what type of fuel was last present in the aircraft and the safety of refueling it with the unleaded fuel available from the airport. This procedure would become irrelevant if the compatibility of Swift and GAMI products is confirmed.

Once the development is complete, the new safety procedures for refueling with unleaded aviation gasoline should be incorporated into the airport's existing safety protocols and appropriately communicated with all relevant airport stakeholders.

Step 9. Conduct Training, Outreach, and Education

Step 9 of the transition process focuses on conducting training, outreach, and education activities.

Training activities should begin once airport SOPs related to the receipt and supply of unleaded aviation gasoline have been drafted. Training should also include opportunities to solicit feedback from personnel involved in these activities, and the SOPs should be refined as necessary based on that feedback.

Outreach activities should target stakeholders, including flight schools, pilots, airframe and powerplant mechanics, and other directly interested parties, informing them about the details of the airport's transition to supplying unleaded aviation gasoline along with the continued supply of 100LL. Making stakeholders aware of any available fuel price and/or STC subsidies would also be a key element of the outreach effort.

Educational activities should target local government agencies, local communities, and other parties with a general interest in considering lead emissions from aircraft operations around the airport. These efforts should address concerns about aircraft lead emissions, broader EPA and

FAA initiatives to mitigate them, and the airport's specific local efforts to reduce lead impacts at and around the airport. These efforts may also include additional mitigation measures, such as those outlined in the Primer as well as by the FAA (FAA 2024c).

Step 10. Monitor the Transition, Identify Issues, and Make Adjustments

The final step, Step 10, involves monitoring the implementation of the transition, identifying any issues that arise, and making appropriate adjustments to address them. While these issues will likely be airport-specific, potential challenges may include:

- Unexpectedly high or low demand for unleaded aviation gasoline.
- The need to switch to a different unleaded fuel than originally selected due to future regulations, changes in FAA Fleet Authorizations, or commercial factors.
- The need for additional outreach efforts to stakeholders to overcome unexpected resistance to unleaded fuel use or to address reports of aircraft or engine performance issues with the unleaded aviation gasoline(s) offered at the airport.
- The need for further educational outreach if additional concerns arise from local governments or the community related to lead emissions.
- The need to revise SOPs to enhance safety based on operational feedback.

Additionally, transitioned airports are strongly encouraged to monitor the EAGLE and FAA websites for updates and new requirements related to unleaded aviation gasolines as the process to eliminate the use of 100LL continues. They are also encouraged to share lessons learned with the EAGLE initiative and their FAA Airports District Office or Regional Office to support continuous improvement and assist other airports preparing for transition.

Tools to Assist with Transition Activities

As noted previously, five tools have been prepared to assist airports with transition-related activities. These tools are available with the guide and can be found by searching the National Academies Press website (nationalacademies.org/publications) for *ACRP Research Report 284: Transitioning to Unleaded Aviation Gasoline: A Guide and Tools*.

The first tool is the Transition Process Checklist Tool, an Excel spreadsheet that identifies the general actions suggested for nine of the 10 steps outlined in the guide (omitting the decision to transition, which is Step 6). It allows users to track whether the performance of each action is applicable to their airport, record the date of completion for applicable actions, and insert notes regarding each action. It is intended to assist airport staff in managing the details of the transition.

The second tool is the Individual Aircraft Unleaded Fuel Survey Tool, a fillable PDF form. This form is used to collect data from owners and operators of individual aircraft. This information supports the unleaded fuel compatibility survey required to characterize the airport fleet, as described in Step 2 of the guide. It is designed to allow survey information to be collected for up to four different types of unleaded avgas. This form can be provided electronically or printed and distributed in hard copy. It also includes links to FAA registration data and unleaded fuel STC sites. This data is intended to be entered into the third tool described as follows.

The third tool is the Multiple Aircraft Unleaded Fuel Survey Tool, an Excel spreadsheet. This file is used to collect data for the unleaded fuel compatibility survey from owners and operators of multiple aircraft, such as flight schools. This information is used to characterize the airport fleet as described in Step 2 of the guide. Similar to the Individual Aircraft Unleaded Fuel Survey Tool, it allows users to collect information for up to four different types of unleaded avgas in case more than one type of fuel is under consideration by the airport. It also includes links to FAA registration data and unleaded fuel STC sites.

The fourth tool is the Airport Unleaded Fuel Aircraft Inventory Tool, an Excel spreadsheet used to develop a complete characterization of the airport aircraft fleet. Data for each unleaded fuel under consideration, again, up to four fuels, should be entered into this tool, using information collected from either the Individual Aircraft Unleaded Fuel Survey Tool or the Multiple Aircraft Unleaded Fuel Survey Tool. Once the data is entered, the tool generates a complete database along with summary statistics and estimated volume demand for each potential unleaded fuel. It also includes links to FAA registration data and unleaded fuel STC sites.

The fifth and final tool is the Unleaded Fuel Cost Evaluation Tool, an Excel spreadsheet intended for use in performing the financial analysis of unleaded aviation gasoline alternatives, as discussed in Step 5 of the guide. This tool allows for the quantification of fixed costs associated with adding an unleaded fuel, as well as the evaluation of differences in variable costs between each potential unleaded fuel. It enables the evaluation of up to four different potential unleaded fuels.

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APPENDIX A

Airport Summaries

This appendix provides summaries of case studies of seven airports that had already begun or were in the process of being able to supply unleaded gasoline along with 100LL gasoline during the spring and summer of 2024 when interviews were conducted. The summaries are available for the following airports, along with the results of interviews related to the transition at Alaskan airports:

- Centennial Airport in Englewood, CO
- Long Beach Airport in Long Beach, CA
- Naples Airport in Naples, FL
- Rocky Mountain Metropolitan Airport in Broomfield, CO
- South St. Paul Airport in South St. Paul, MN
- Waco Regional Airport in Waco, TX
- Watsonville Municipal Airport in Watsonville, CA

Centennial Airport

Location & Date: Centennial Airport (APA), Englewood, CO (April 10, 2024)

Contact: Michael Fronapfel, Executive Director

Airport Overview

The Centennial Airport (APA) is owned and operated by the Arapahoe County Public Airport Authority. It is a general aviation reliever airport located southeast of Denver, Colorado. It is one of the nation's busiest general aviation airports, accommodating 362,704 operations (takeoffs and landings) in 2023. APA consists of approximately 1,360 acres of property, more than 125 businesses, and approximately 840 based aircraft. Centennial Airport prides itself on being a leader in sustainability and social responsibility. It was the first airport in Colorado to offer unleaded fuels and is the largest user of UL94 in the country.

Fuel Service at the Airport

There are three fixed-base operators (FBOs) at the airport: jetCenters of Colorado, Signature Aviation, and Modern Aviation. There is one additional smaller FBO that focuses on helicopter refueling. All aircraft refueling is delivered by fuel trucks serviced by fuel farms owned by the FBOs.

The airport dispenses approximately 16 million gallons of fuel per year, including jet fuel. jetCenters of Colorado is the largest FBO and serves about 60% of avgas sales. At the time of the interview, this was the only FBO participating in the sale of Swift UL94. There is an effort to also work with Signature to provide UL94, but this has not happened yet.

Both 100LL and UL94 are offered to customers. The airport does not have a requirement that fuels comply with ASTM standards. This is handled by the FBOs as a requirement. However, the FBOs at Centennial were not reported to be interested in GAMI G100UL because there is no applicable ASTM standard.

Infrastructure

The fueling infrastructure at the airport includes the following tanks:

- jetCenters of Colorado – has three fuel farms with approximately 210,000-gallon capacity. The FBO converted a 30,000-gallon tank for UL94 and has also converted one fuel truck to deliver UL94.
- Signature Aviation – has two fuel farms with approximately 69,000-gallon capacity.
- Modern Aviation – has one fuel farm with approximately 40,000-gallon capacity.

Process Leading to Offering Unleaded Gasoline

The Airport Board was supportive of the unleaded fuel initiative as there was community interest in addressing the use of leaded fuels. There were ongoing discussions with Board members regarding the transition initiative and also between staff and the FBOs in advance of proposing a resolution. The Airport Board passed a resolution in March 2023 in support of the initiative, and the airport began offering UL94 through jetCenters of Colorado on May 3, 2023. From November 2023 through October 2024, 582,903 gallons of 100LL and 159,536 gallons of UL94 were dispensed. UL94 accounted for 21.49% of avgas dispensed. During that same period, 13,983,871 gallons of jet fuel were sold, with 100LL and UL94 accounting for 5.04% of overall fuel sales.

The airport has an internal goal of UL94 reaching 25% of the avgas market but would like to see that increase to 50%. If the airport can transition to all unleaded fuel before the EAGLE initiative's 2030 goal, they will attempt to do so. If an appropriate unleaded replacement fuel becomes available, the airport anticipates implementing it within 2–3 years but may still need to offer 100LL for certain aircraft or to meet any FAA grant assurance requirements to provide 100LL.

Several factors influenced the decision and the Board's eventual adoption of a supportive resolution. A key consideration was ensuring there was a market for UL94, with a focus on the airport's flight schools.

Flight Schools & Flying Club

There are three flight schools under the jetCenters of Colorado leasehold on the airport. The largest flight school, Aspen Flying Club, chose to use UL94. They operate 28 aircraft with the required STC and are currently one of the largest users of UL94. Aspen reports aircraft maintenance cost benefits.

Also under the jetCenters leasehold is ATP Flight Training, with 24 aircraft with the UL94 STC, but they are not yet using UL94 fuel. Independence Aviation flight training is not participating because their aircraft cannot use UL94.

Flights Inc., another flight school with 16 aircraft with the UL94 STC, operates under the Signature Aviation leasehold. They do not utilize UL94 because Signature does not dispense UL94 yet.

Centennial Flyers, a flying club at the airport, is also a large user of UL94. Aspen Flying Club and Centennial Flyers are the largest users of UL94 at the airport.

Secondly, the airport wanted to ensure deliveries and costs were addressed. jetCenters of Colorado, the first FBO to offer UL94, wanted the ability to support full loads of UL94 deliveries. The cost of utilizing smaller-volume totes would have significantly increased the cost and end-user pricing. jetCenters of Colorado had the tank capacity to accommodate unleaded fuel by converting an existing tank while maintaining adequate capacity for 100LL.

Thirdly, the airport desired to initiate an incentive program. Initially, they offered to financially assist the FBO with a tank installation but did not need to, as a tank was already available on site. They will likely assist Signature Aviation if they agree to provide unleaded fuel. The airport has budgeted \$300,000, which could be applied to tank purchases, installation, fuel truck purchases, or retrofits.

Fourthly, the airport covers the full cost of any tenant aircraft STC. To date, approximately 103 aircraft have received STCs, costing about \$10,000. There is a sunset on paying for the STCs, and this program only applies to the Swift UL94 fuel, as GAMI G100UL might have a different STC cost.

Finally, the airport subsidizes the cost of UL94 to aircraft operators. To do this, the FBO conducts a weekly analysis of the price differential between UL94 and 100LL, which has ranged from \$1.13 to \$1.88 per gallon. The airport then pays this difference, with the stipulation that the FBO charge program tenants the same price for both 100LL and UL94. The FBO provides the airport with a monthly price analysis.

Additionally, the airport mentioned an EPA study completed in 2015 that measured lead levels in the air near the airport's most common aircraft run-up area. It was stated that the study found that the lead levels were at 0.02 micrograms per cubic meter, lower than the 0.15 microgram per cubic meter EPA National Ambient Air Quality Standard.

Fuel Supplier Coordination

jetCenters of Colorado is "Avfuel branded." Avfuel provides both 100LL and UL94 products. The airport elected not to utilize tote delivery (i.e., delivery of relatively small volumes of fuel in small transportable containers) and started with full tanker delivery, as the available tank would accommodate this, thereby lowering UL94 costs. To date, there have been no known delivery issues.

Training

The FBO provides the fuel and refueling services and is therefore responsible for the required training.

Communication with Tenants

The airport reached out to the FBOs and the flight schools initially to understand the issues and eventual demand for unleaded fuels. There were public meetings held. Additionally, there were a number of one-on-one telephone calls and meetings with tenants. The airport also advertised the program on their website and social media platforms.

Challenges and Costs

Overall, Centennial believes the UL94 program has been a success.

Currently, the airport is using airport funds for the program. The airport budget for the STC/unleaded fuel subsidy program was \$250,000 for 2024, and the program was expected to continue

through the end of 2025. Centennial received a \$300,000 grant from the Colorado Division of Aeronautics, paying 90% of the cost to subsidize unleaded aviation gasoline prices. Provided future grants can be obtained, Centennial plans to continue the fuel price subsidy program until a 100-octane unleaded fuel becomes available. At the time of the interview, Centennial was the only airport in Colorado dispensing unleaded avgas, so it is likely the airport may continue to receive state grants going forward. There was proposed state legislation regarding the issue (House Bill 24-1235, which was later enacted). State Aeronautics is proactive and may be providing grants ahead of the legislation.

For federal funding assistance, the airport works with a lobbyist that assists airports across the country with the transition to unleaded fuel. Areas of discussion include possibilities such as rolling back taxes on unleaded fuels and/or taxing fuel to offer FAA Airport Improvement Program funds for infrastructure and fuel subsidies.

There was mention of individual tenants who have concerns or hesitations about using UL94 due to the University of North Dakota aircraft engine situation (Lycoming Engines 2024).

Advice for Other Airports

Centennial hopes to see legislative action for federal funding to assist other airports with the transition to unleaded avgas.

Additional Information

The EPA study and the FBO contact information were provided.

Liability Risk Management

The airport did not have any liability concerns because Swift UL94 had both FAA authorization and an applicable ASTM standard, and it had been used at other airports and by flight schools for years without any issues—in fact, some users reported benefits. Neither Centennial Airport nor the FBOs would support the dispensing of any unleaded fuel that does not have both FAA authorization and an applicable ASTM standard.

Long Beach Airport

Location & Date: Long Beach Airport (LGB), Long Beach, CA (April 23, 2024)

Contact: Juan Lopez-Rios, Deputy Airport Director

Airport Overview

The Long Beach Airport (LGB or Airport) is owned and operated by the City of Long Beach, California, located in the southernmost part of Los Angeles County, adjacent to Orange County, California. It is a small-hub airport providing services for general aviation, military, cargo, and commercial passengers. The Airport supports approximately 400,000 operations (takeoffs and landings), has approximately 400 based aircraft, and services more than 2 million enplaned passengers annually. LGB consists of approximately 1,166 acres of property.

Fuel Service at the Airport

LGB is served by two FBOs, Aeroplex Aerolease Group (AAG) and Atlantic Aviation. As a subtenant, Signature Aviation provides fueling service for AAG general aviation customers.

Infrastructure

- Fuel Farm #1
 - 2 – 15,000-gallon tanks, Jet A
 - 1 – 12,000-gallon tank, 100LL
 - 1 – 2,000-gallon tank, diesel
- Fuel Farm #2
 - 1 – 15,000-gallon tank, Jet A
 - 1 – 12,000-gallon tank, UL94

Signature Aviation at Van Nuys Airport provides a 1,000-gallon fueling truck for transporting UL94 to LGB, which minimized the need for an additional capital investment in a dedicated fuel tank at LGB. The fuel truck facilitated UL94's quick availability at LGB.

Process Leading to Offering Unleaded Gasoline

Based on data reported in EPA's 2017 National Emissions Inventory, LGB was identified as emitting the second highest amount of lead in the country (EPA 2017). The leaded fuel issue became a concern for the community and therefore for the Mayor and the City Council. In December of 2022, the City Council directed the Airport to develop a strategy to transition to unleaded avgas.

The Airport began an effort to educate the City Council and community on how airports operate and what is within an airport's purview to change. There was some community misperception regarding airport obligations under FAA grant assurances, believing the airport was obligated to provide certain fuel based on accepting federal funding assistance for airport projects. During December 2022 to August 2023, the Airport worked with the City Council, the FBO, and Swift Fuels to review options to introduce unleaded fuel at LGB. The Airport also provided educational information on airport operations to the Council and community.

In December 2022, Long Beach City Council authorized the Airport to institute a waiver of fuel flowage fees for unleaded fuel for the years 2023–2025. This was put in place as an incentive program for fuel providers at LGB to support the move towards offering unleaded fuel.

In August 2023, FBO AAG began offering UL94 and the Mayor performed the first ceremonial fueling at the FBO's press event. Avgas only accounts for approximately 10% of total fuel volume dispensed at LGB.

In October 2023, the EPA determination was released regarding potential health risks caused by lead aviation fuel emissions, creating greater concern.

Two additional incentive programs were subsequently developed with initial budgets of \$60,000 and \$200,000, respectively. In November 2023, the Airport offered a program for tenant reimbursement for the purchase of a Supplemental Type Certificate (STC), which is required to confirm that an aircraft and engine qualify for the unleaded fuel available. It was estimated that 60%-70% of aircraft based at LGB would be compatible with this STC. At the time of the interview, approximately 20 aircraft were in the application process. The Airport expected that the program would take time as pilots would need to become comfortable with converting to UL94. The Airport continued its promotional efforts. The first person to obtain an STC was featured in the Airport newsletter.

Based on the Long Beach Airport's experience at the time of the interview, high fuel transport costs resulted in the price of unleaded fuel ranging from \$2.00 to \$4.00 per gallon higher than 100LL. In January 2024, the Airport offered a third incentive program approved by the City Council, known as the Subsidized Aviation Fuel for the Environment (SAFE) program. SAFE

subsidizes the cost of UL94 so the consumer can buy UL94 at the same price as 100LL. The Airport works directly with Signature Aviation in the implementation of SAFE. The SAFE program for UL94 is available for all qualified aircraft, both LGB-based and itinerant. The negotiation and execution of the subsidy program was completed in May 2024.

On December 12, 2023, the Airport presented a comprehensive report, General Aviation Operations at Long Beach Airport, to the City Council and the community (City of Long Beach 2023a). This provided a public forum to further educate the community about airport operations in order to address misperceptions, including those related to the provision of unleaded aviation gasoline and to receive public comment on the matter (City of Long Beach 2023b).

Fuel Supplier Coordination

Signature Aviation branded but Swift provides the UL94 support.

Training

Since the FBO provides the refueling service, they are responsible for training.

Communication with Community & Tenants

There are two general aviation groups that meet to discuss concerns:

- (1) The Long Beach Airport Association is a community-based organization representing general aviation tenants and stakeholders at Long Beach Airport. This group helped develop voluntary fly-friendly procedures by analyzing traffic pattern data. These procedures are subject to use of standard traffic pattern procedures and air traffic control tower's directions.
- (2) The General Aviation Noise Advisory Committee is a tenant group established by the Noise Ordinance that meets as needed.

The community is concerned about the health risks associated with the continued use of lead fuel for general aviation operations. The flight schools conduct a large volume of touch-and-go operations. The flight schools, user groups, and tenants are becoming aware of the various issues and the available incentive programs. The flight schools are engaged in discussions regarding the community's concerns. Transition to unleaded fuel by the flight schools would help to address the health concerns of the community.

LGB coordinated with the FAA on a Community Webinar for the Long Beach community which was held in June 2024 after the case study interview (FAA 2024). The FAA had previously provided a similar webinar for the Newport Beach community adjacent to John Wayne airport (SNA) (FAA 2022). The Long Beach webinar was designed to cover many issues including fuel concerns.

Challenges and Costs

The unleaded fuel truck utilized by Signature Aviation at LGB is not approved for public roadways. The truck is physically hauled to Van Nuys Airport, loaded with UL94 and then hauled back for use at LGB. These transport costs and other factors increased the expenses for offering unleaded fuel.

At the time of the interview, there were no complaints from the pilot community regarding the programs, but there was hesitancy in converting based on safety uncertainties in the various unleaded fuels, and as a result, limited use of UL94.

At the time of the case study interview, California Senate Bill SB 1193 was under consideration and written to ban the sale of lead fuel in California. This bill was ultimately enacted with modifications. It bans the sale of leaded aviation gasoline in California on and after January 1, 2031.

Advice for Other Airports

It takes time to develop contracts and arrangements, and one must be aware of local public sentiment and politics. Communities can be galvanized on sensitive issues, but cordial communication is essential to ensure that input from citizens and organizations is heard. Long Beach Airport found that holding public discussions in conjunction with elected officials and airport representatives was helpful in discussing the transition to unleaded fuel.

Naples Airport

Airport: Naples Airport (APF), Naples, FL (March 12, 2024)

Location & Date: Byron Gray, Director of FBO Services

Airport Overview

The Naples Airport (APF) is owned and operated by the Naples Airport Authority (NAA). In addition to the airport, the Authority also owns and operates the FBO. It is a general aviation reliever airport located in southwest Florida. During 2021–2022, the airport experienced just over 113,000 operations (takeoffs and landings) and annually services more than 200,000 visitors. APF consists of approximately 732 acres of property, two terminals, and approximately 360 based aircraft.

Fuel Service at the Airport

The NAA owns and operates the sole FBO. They offer Jet A, 100LL, and UL94. The FBO experiences approximately 36,000 fueling operations per year, dispensing approximately 350,000 gallons of 100LL and approximately 57,000 gallons of UL94 annually, or 16% of avgas sales. The fuel is delivered by mobile trucks; however, there is a self-serve option for 100LL fuel (100LL is provided by a 50/50 mix of self-serve and full service). The fuels are ASTM certified, and at this time, Naples probably will not switch to another unleaded or non-ASTM fuel.

Infrastructure

The fueling infrastructure at the airport includes the following tanks:

- Tank #1 – 30,000 gallons Jet A
- Tank #2 – 20,000 gallons Jet A
- Tank #3 – 20,000 gallons Jet A
- Tank #4 – 20,000 gallons UL94
- Tank #5 – 40,000 gallons Jet A
- Tank #6 – 40,000 gallons Jet A
- Tank #7 – 40,000 gallons Jet A
- Tank #8 – 10,000 gallons Diesel
- Tank #9 – 2,000 gallons Unleaded Gasoline
- Car rental – 12,000 gallons Unleaded Gasoline
- North Self-Serve – 12,000 gallons 100LL
- South Self-Serve – 10,000 gallons 100LL

There are two 100LL refueler trucks and one additional truck that has been dedicated to UL94.

Process Leading to Offering Unleaded Gasoline

There was growing concern from the community regarding the use of 100LL and lead emissions. The NAA considered offering UL94 and approved the transition, including subsidizing additional costs for the based tenants. Upon approval, staff proactively implemented the operation in just over two months.

NAA performed a survey of other airports* supporting and offering UL94 to the flying community. They determined if other airports were subsidizing the program and learned the details. Next, they performed a tenant survey to gauge interest in UL94. They reached out to Swift Fuels and provided them with a list of all NAA-based tenants who use 100LL to determine which aircraft qualified to use the product. NAA presented these findings and then determined how they would subsidize the program. The Board granted approval for FY23 and FY24 at a sum of \$182,500. They started in June 2023, and as of November 2024, they have used \$142,865 and the sales have been consistent. They plan to request that the Board renew the subsidy before it is spent.

UL94 is subsidized at about \$1.30 to \$1.50 per gallon in an attempt to match the 100LL rate for based aircraft; non-tenants pay the full retail price. An additional subsidy, limited to \$250 per based user, is offered for the purchase and installation of the required STC for applicable based aircraft.

NAA started by using a refueler truck provided by Avfuel to store and distribute UL94. After a two-month period, they converted an existing 20,000-gallon 100LL fuel tank into a UL94 tank. They drained and cleaned out the tank and replaced the filters in the system. They leased a 1,200-gallon aviation gasoline refueler dedicated to the UL94 product. All products are ordered through Avfuel at 8,000-gallon loads compared to the initial 900-gallon orders. This reduced freight costs considerably and lowered the subsidy cost.

During this process, NAA completed some soil testing for lead levels at the airport, around the runway environment, and in residential areas near the airport (homes, tabletops, etc.). All tested levels came back well below residential limits.

Fuel Supplier Coordination

NAA's FBO is Avfuel branded. Avfuel provides both 100LL and UL94 products. Delivery by tote cost was estimated to be between \$11.00 and \$13.00 per gallon. This cost could be reduced to around \$7.00 or \$8.00 per gallon with full-load deliveries, allowing for reduced freight costs coming from West Lafayette, IN.

Training

NAA utilized their internal training department to develop an SOP**, then trained all line technicians and customer service representatives regarding the new procedures. X1 software developed a new product code to help prevent misfueling. In addition, they developed a tenant authorization form to record the aircraft transition to UL94. They do not offer UL94 as a self-serve product and only offer it through the mobile refueler.

NAA states, "with 37-line personnel, there is always opportunity for mishap." NAA prioritizes training, following written SOPs, and supervisor support. The use of aircraft placards, colors (industry recently dyed UL94 purple), and color stickers on nozzles all assist with proper refueling. It was stated that NATA does offer a training program; however, it is very brief and buried in the "misfueling" section.

Communication with Tenants

NAA's communications department sent out emails surveying the tenants and their interest in using the product. There are 360 based aircraft and approximately 120 qualified to use UL94. Currently, there are 36 aircraft enrolled, 17 of which are flight schools that consume 96% of the monthly UL94 purchases. In addition, they contacted each qualified tenant asking if they wanted to participate, and 12 additional customers were enrolled. They continued to send out random communications inviting others to participate. A recent survey had a light response of 40 out of 360, indicating low interest.

Challenges and Costs

The addition of UL94 has been well received with positive Board support. However, there is low demand and a concern that it would not be sustainable without the subsidy. There are negative responses regarding trust in the product, and several tenants will not transition at this time. There is a concern about shelf life if the product is not sold in a timely manner. The shelf life is 6 months before recertification, or a new load of fuel equal to the current inventory may reset the clock.

Having the existing tank and ability to convert presented low implementation costs for NAA. There is a concern about compatibility with other unleaded products.

Advice for Other Airports

Based on this example, other airports could consider liability. Avfuel helps cover quality control. NAA made their insurance company aware of the additional product for sale. A primary concern is misfueling, which NAA seeks to address through training. No aircraft can be fueled if not placarded. No self-serve of UL94 is permitted.

There is a real concern regarding the compatibility of all the unleaded products coming online (GAMI G100UL, Swift UL94, and LyondellBasell & VP Racing Fuels UL100E product). Some are going the STC route while others are pursuing the ASTM route, but uncertainty exists on compatibility between products when they come online.

Naples will likely not switch from UL94 in favor of another unleaded option.

The airport owns and operates the fueling. It may be difficult to convince an FBO to implement unleaded fuel depending on equipment and support through subsidy, etc.

NAA offered an industry perspective. They would have preferred waiting for the ultimate drop-in product rather than offering an additional unleaded option (UL94). There are ongoing developments and questions on implementation.

***SEBRING, FL:** Airport operates FBO and is offering the product at a price that does not cover the cost of the product.

STATON, MN: Airport is offering a \$0.50 per gallon subsidy.

DENVER, CO: Airport subsidizing \$2.00 per gallon through at least 2024.

OXNARD, CA: FBO is subsidizing \$3.00 per gallon and \$.06 flow fee waived.

VAN NUYS, CA: Removed \$0.11 flow fee July 7 until April 2024 (it is unclear if this subsidy continued past this date).

SANTA MONICA, CA: Airport provides a \$1.50 subsidy and pays for STC (\$100), and covers the cost for an airframe and powerplant mechanic to complete STC (\$200/aircraft).

**SOP: Training line staff on how to handle UL94 and identify aircraft and its markings.

- Training is supported by a written SOP explaining clear procedures, pictorial examples of aircraft markings (Appendix B) and a designated (purple) customer fuel order slip.
- N-number aircraft require an STC for UL94.
- Transient aircraft must have appropriate markings and complete a signed fuel order release. They pay full retail. The difference in profit between based and transient works out to be \$.08 per gallon. NAA sells UL94 at cost for retail, pricing \$7.00 per gallon. UL94 tenant pricing is \$5.64 per gallon, which is a \$1.36 per gallon subsidy for tenants.
- UL94 is now purple in color, which assists personnel in identifying fuels.
- Fuel is no longer referred to as “avgas”; must use specific identifier (100LL, UL94).
- There are some challenges with based aircraft and user pushback, and some older aircraft do not have the required fuel placards near fueling ports.
- Avoiding misfueling and procedures to address these concerns are prioritized.

Disclaimer: *The information provided in this document is based on regulations and guidance available at the time of writing and is intended for general informational purposes only (and, as such, should not be construed as advice on any subject matter). The City of Naples Airport Authority (NAA) assumes no responsibility, and hereby expressly disclaims all liability, for any actions taken or not taken based on the information in this document. The content of this entire document is provided “as is,” and no express or implied representations or warranties of any kind are made, including, without limitation, any warranty that the content hereof is error-free. Note: “This entire document” refers to the Naples Airport case study of Appendix A (pages 24–27), not the full guide.*

Rocky Mountain Metropolitan Airport

Location & Date: Rocky Mountain Metropolitan Airport (BJC), Broomfield, Jefferson County, CO (April 17, 2024)

Contacts:

Ben Miller, Airport Planning & Development Administrator, Project Lead Unleaded Transition
 Christopher Nicholas, Airport Operations Manager
 Kevin McKay, Airport Operations Specialist - Environment

Airport Overview

Rocky Mountain Metropolitan Airport (RMMA) is a county-owned general aviation reliever airport located northwest of Denver, Colorado. RMMA consists of approximately 1,700 acres of property, including nearly 50 businesses and over 400 based aircraft. RMMA is a self-supporting enterprise fund of Jefferson County. Its operations and maintenance are funded through revenues from airport ground leases and other user fees. In 2022, RMMA was the third busiest airport in Colorado in terms of operations (takeoffs and landings), with a landing or takeoff occurring every three minutes on average.

Fuel Service at the Airport

There are two FBOs at the airport that own and operate fueling systems. Signature Aviation offers self-service fueling (a 1,000-gallon tank of 100LL) and fuel trucks for both 100LL and Jet A. Sheltair utilizes fuel trucks. In addition, there are a number of privately owned fuel systems/tanks at the airport primarily for corporate jet aircraft operators. The airport is trying to phase these out as leases expire.

The airport currently does not offer unleaded fuel. However, it recently acquired a surplus 100LL truck with a 1,000-gallon capacity with the intention of adding tank/service capacity to offer unleaded fuel. This would potentially be operated by one of the FBOs under one of the airport's possible models to offer unleaded fuel. The airport's goal is to partner with one or both existing FBOs to provide unleaded fuel service rather than managing the supply and delivery themselves.

The fuel volume dispensed in 2023 was 6.3 million gallons of combined 100LL and Jet A. Fuel volume dispensed in 2022 was:

- Avgas: 541,993 gallons
- Jet A: 5,236,761 gallons

Infrastructure

The fueling infrastructure at the airport includes the following tanks:

- (1) 1,000-gallon tank – 100LL (Self-serve)
- (1) 40,000-gallon tank – 100LL
- (1) 124,000-gallon tank – Jet A

There is one central fuel farm location that serves both FBOs. There was no mention of a requirement that dispensed fuels have an applicable ASTM standard.

At the time of the interview, RMMA anticipated installing an FAA grant-funded unleaded fuel tank in 2025.

Process Leading to Offering Unleaded Gasoline

Airport operations have increased by 50% in the last 5 years to approximately 288,000 operations per year. The increase in operations initially led to community concerns about noise impacts and a Community Noise Roundtable (CNR) was formed to address concerns. The initiative to begin providing unleaded avgas began in early 2023. Airport stakeholders, including the CNR, community members, local politicians, and County Commissioners, expressed concerns about the use of leaded aviation fuel. This led to the airport purchasing the previously mentioned surplus fuel truck with the goal of offering unleaded fuel by the end of 2024.

The Jefferson County Board of Commissioners is supportive of providing unleaded fuel.

There are four approaches being considered for the unleaded transition process:

1. The airport is looking at FAA grant options to install a large tank at the fuel farm location. This may involve an application for federal BIL funding. This tank would be used for unleaded fuel such as UL94 and would also require a fuel truck to be used by an FBO.
2. RMMA purchased a 1,000-gallon fuel truck/tank for use with unleaded avgas to be positioned at one FBO leasehold. The airport would look into donating this truck/tank if the FBO would agree to operate and dispense the unleaded fuel. The FBO believes the costs to transition this truck to unleaded are minimal. There are concerns that this capacity might not be adequate for fuel product deliveries, requiring the delivery of Swift UL94 totes rather than full loads, which would drive up UL94 costs.
3. Purchase an existing large 12,000-gallon tank located at the airport from a private party that is not being used. The tank would then have to be converted from jet fuel to unleaded fuel.
4. Purchase a large capacity tank to install at either FBO.

There is also a concern regarding demand for UL94. Flight training makes up the majority of operations at the airport. There are over one hundred total aircraft used by flight schools. They

have discussed transitioning to UL94 with the flight schools, and one of the flight schools has an interest, but also has concerns about using UL94 due to the University of North Dakota aircraft engine situation (Lycoming Engines 2024).

Currently, all the flight schools refuel aircraft by truck, so this may be a factor in choosing between a stationary fuel tank/system or a mobile refueler. Besides efficiency and convenience, they indicated the operation would have to be cost-effective as well. The pilot community appears to be supportive of unleaded fuel, but there is a question regarding cost impacts. The airport is interested in doing a more formal survey with more tenants.

There has been discussion regarding possible rent credits or tie-down credits for tenants who would use UL94 to subsidize the cost of acquiring STCs. They are gathering data on estimated cost differences between 100LL and UL94 to better understand the financial implications. The airport noted it does not have the budget to subsidize the unleaded fuel costs that Centennial Airport does under its program.

Fuel Supplier Coordination

Both FBOs use branded fuel suppliers; Signature – Shell, and Sheltair – Avfuel. As of the date of the interview, the FBOs had only been engaged in fact-finding discussions regarding costs and pricing.

Training

The airport would continue to rely on the FBOs to provide the fuel and, therefore, the required training.

Communication with Tenants

The Jefferson County Board held a press conference in October 2023 announcing their intention to transition to unleaded fuels. They continue to have ongoing discussions and updates at Airport Board meetings, CNR meetings, and County Board of Commissioners meetings. The messaging has shifted from “why we can’t offer unleaded fuels” to “how can we implement a transition to unleaded fuels?” The Board wants more community engagement, increased transparency, and more frequent outreach.

Challenges and Costs

There is concern about the costs and the airport’s ability to secure funding. In addition to BIL funding, a State of Colorado House Bill (HB 24-1235) was being considered at the time of the case study interview to assist aircraft owners and airports in transitioning to unleaded fuels. RMMA is seeking a \$300,000 annual grant from the Colorado Division of Aeronautics to subsidize unleaded fuel costs. They are also considering details of offering credits towards STCs for tenant-based aircraft.

They are evaluating examples from other airports where unleaded fuels are sold to assess demand to determine the financial feasibility of offering unleaded fuels.

Preliminary communications with FBOs have occurred, but potential issues may arise—such as multiple FBOs being interested in providing unleaded fuel—which could require a formal request for proposals process to allocate access to airport-provided unleaded tank infrastructure.

Flight schools, particularly Spartan College, have indicated concerns about engine wear with UL94. They will closely monitor this issue.

Advice for Other Airports

RMMA noted that a checklist or guidance document, such as the one being developed under ACRP 03-73, would be helpful for supporting their transition efforts.

Liability Risk Management

The FBOs have expressed concerns about serving both unleaded and leaded customers across a ramp with over 100 aircraft. The airport will continue conversations with the FBO and tenants to develop a plan that minimizes the risk of misfueling.

South St. Paul Airport

Location & Date: South St. Paul Airport (SGS), South St. Paul, MN (March 29, 2024)

Contact: Andrew Wall, Airport Manager – City of South St. Paul

Airport Overview

South St. Paul Airport (Fleming Field) is a municipally owned general aviation reliever airport located in the Minneapolis-St. Paul metropolitan area in Minnesota. There are approximately 200 based aircraft at the airport and a number of aviation-based businesses on the field. The airport is a non-primary general aviation regional classified airport falling within the FAA Great Lakes region.

Fuel Service at the Airport

The City of South St. Paul owns and operates the airport, including fuel service to airport users. The airport offers 100LL, Swift UL94, and Jet A, which are self-serve only from underground fuel storage tanks. There are no mobile fueling trucks utilized at the airport.

Unleaded Fuel

The airport has been offering Swift UL94 for approximately the last five years and was the first airport in the state of Minnesota to offer UL94. The volume of UL94 dispensed at the airport averages approximately 5,606 gallons annually, representing about 4.6% of the total volume sold between UL94 and 100LL (Fuel data: 2021–2023). In comparison, the approximate annual volume of 100LL is 116,921 gallons, or about 95.4% of the total volume sold between the two products.

The sales of UL94 are slow compared to 100LL. The retail price of UL94 ranges from \$1.00 to \$1.50 higher per gallon than that of 100LL. The airport does attempt to keep the cost of UL94 down for consumers by lowering the markup relative to 100LL. The City of South St. Paul, which owns and operates the airport, does not subsidize the cost of any STCs for unleaded fuel. There are no other cost discounts or incentives offered by the airport to use UL94. The primary users of the product are two RV12 aircraft used for flight training, with usage by these customers recently decreased.

Infrastructure

The fueling infrastructure at the airport includes the following tanks:

- (1) 10,000-gallon tank – 100LL
- (1) 6,000-gallon tank – UL94 (This tank was previously used for UL91)
- (1) 10,000-gallon tank – Jet A

All tanks are underground. Each system has its own tank, cabinet, pumps, hoses, etc. The 100LL and UL94 share a fueling pedestal for customers to enter payment cards and select either Pump A (100LL) or Pump B (UL94). The airport does not require that fuels offered have an applicable ASTM standard, but all fuels presently offered do have applicable ASTM standards.

Process Leading to Offering Unleaded Gasoline

The initiative to begin the service of Swift UL94 was initially researched by several airport Board members who then contacted Swift Fuels. Swift Fuels provided a presentation to the Board as a whole. The decision was driven more by finances than by tenant demand or environmental issues. It was decided that an existing 6,000-gallon tank used for UL91 fuel could be converted to UL94. Airport Management was not opposed to this in light of the low sales volume of this fuel. No other significant internal or external factors influenced this decision.

Fuel Supplier Coordination

Swift Fuels worked closely with the airport to prepare for UL94 service. Notably, Swift coordinated with the airport to empty and clean the airport's existing 91-octane tank to transition the system from 91-octane to UL94. Swift paid \$0.50 per gallon for the old fuel and made accommodations to dispose of it. They then had the remaining fuel and any sludge pumped out of the bottom of the tank. They do not recall any extensive tank cleaning process. All decals and labeling for UL94 at the fuel farm were provided by Swift. Swift also assisted with the rollout of the product and provided the airport with a press release.

The airport cannot currently accommodate full loads of UL94 since the 6,000-gallon tank cannot accommodate a full delivery load. The airport often seeks split loads of UL94 with other airports in the area offering UL94. Swift is proactive and often contacts the airport to see if additional product or split load opportunities arise. Swift Fuels utilizes dedicated transport carriers out of Indiana. The airport takes delivery of the product consistently with all fuel delivery orders, including quality control testing, white bucket tests (a visual inspection of fuel for contamination), and API gravity verification.

Training

The airport offers self-service fueling only, so there has not been extensive training outside of making people aware of the new product. If the airport utilized fuel trucks or full-service fueling, there would be greater concern for training to avoid misfueling, STC issues, etc. The systems and type of fuel are clearly placarded. At this time, the UL94 is clear in color and has a distinct smell that sets it apart from 100LL. Self-service customers are responsible for selecting the proper fuel and being aware of and complying with any STC requirements. The airport does not, however, police this.

Communication with Tenants

When UL94 was first offered, the airport informed tenants through a variety of channels, including email, social media, flyers in the terminal, and notices posted around the fuel system. These communications included information about the STC requirement. A press release was also provided by Swift Fuels. The airport lists UL94 alongside other available fuels on pilot websites.

There was no mention of open meetings on the topic beyond the Board's discussions during the decision process to begin offering UL94, which were not widely attended by tenants or users.

Challenges and Costs

There have not been complaints from airport users regarding UL94, but it is not widely used at the airport. Some UL94 users have reported that they have observed fewer deposits in the engine and cleaner spark plugs during 100-hour inspections.

Airport staff are aware of the EAGLE initiative 2030 timeline and are looking towards future infrastructure needs for the 100LL to unleaded gasoline transition. Cost may be a challenge given perceived limitations regarding availability of federal funding for tank infrastructure.

Advice for Other Airports

Talk to other airports that have transitioned to unleaded fuel—find out which fuel they offer, what incentives they provide, and how they manage the overall process.

Liability Risk Management

The fact that UL94 has an applicable ASTM standard did play a role in the airport's decision to offer the fuel, although it was not the driving factor. Shelf life and vapor lock issues in aircraft with UL91 unleaded were what really interested them in switching to UL94. If an unleaded fuel did not have an applicable ASTM standard, the airport may have had more conversations with the supplier, the League of MN Cities (insurance provider), and their legal staff.

Waco Regional Airport

Location & Date: Waco Regional Airport (ACT), Waco, TX (May 14, 2024)

Contact: Joel Martinez, Airport Director

Airport Overview

The Waco Regional Airport (ACT) is owned and operated by the city of Waco, Texas, and is located approximately 90 miles north of Austin, Texas. It is a regional non-hub airport providing services for both general aviation and scheduled commercial airline service. For the year ending June 30, 2022, the airport supported 66,191 operations (takeoffs and landings) and annually serves more than 54,000 enplaned passengers. ACT consists of approximately 1,369 acres of property, flight training facilities, and approximately 89 based aircraft.

Fuel Service at the Airport

The Waco Regional Airport is served by Texas Aero, the sole FBO. They offer Jet A, 100LL, and UL94. The FBO is a branded fuel distributor supported by Avfuel; however, Swift offered to support the FBO for the UL94 product. At the time of the interview, the FBO offered 100LL at \$6.65 per gallon and UL94 at \$6.99 per gallon.

Infrastructure

There are two fuel farm systems at the airport. All tanks are above ground, encased in concrete. The fueling infrastructure includes the following:

Fuel Farm #1

(2) – 15,000-gallon tanks, Jet A

(1) – 12,000-gallon tank, 100LL

(1) – 2,000-gallon tank, diesel

Fuel Farm #2

(1) – 15,000-gallon tank, Jet A

(1) – 12,000-gallon tank, UL94

Process Leading to Offering Unleaded Gasoline

In 2019, Universal Flight Concepts, a flight school also operating out of Scottsdale, Arizona, entered into an agreement with the Baylor University flight training program. A portion of their fleet consists of Tecnam aircraft. Universal Flight Concepts wanted to use UL94 for these aircraft and approached the FBO. Since the flight school initiated the request and was interested, the City had no objections and, in fact, had limited awareness of or involvement in the unleaded fuel issue. There was no other driving force behind the transition to unleaded fuels.

There were two FBOs at the airport, but in 2017, one went out of business, leaving Texas Aero as the sole operator. Texas Aero took over the former FBO's operations and fueling infrastructure. An existing tank was available and suitable for conversion to accommodate UL94. The city had no objections to the transition and did not allocate any funding for it.

The primary user continues to be the flight school, and there is limited demand for UL94 outside of that organization.

Fuel Supplier Coordination

The FBO is Avfuel branded, but Swift provides support for UL94.

Training

Since the FBO provides the refueling service, they are responsible for training. They utilize Avfuel's general quality assurance training, which is not specific to unleaded fuels.

Communication with Tenants

There was not a significant outreach effort. The tenants and aircraft owners are long-term and generally do not rotate ownership over the years. The airport believes there is a general awareness of the availability of unleaded fuel. There has been no discussion from the flight school regarding lead emissions or UL94-related performance or maintenance issues.

Challenges and Costs

There were no additional costs for the city. The FBO already had a suitable tank, making the transition easy and inexpensive.

Advice for Other Airports

In this case, the flight school initiated the request, and a solution was already in place. Being supportive and accommodating was all that was required.

Watsonville Municipal Airport

Location & Date: Watsonville Municipal Airport (WVI), Watsonville, CA (April 23, 2024)

Contact: Rayvon Williams – City of Watsonville

Sam Rosas, Airport Operations Manager – City of Watsonville

Airport Overview

The Watsonville Municipal Airport is owned and operated by the city of Watsonville and is classified as a general aviation regional airport within the FAA's Western Pacific region. The airport is located in Santa Cruz County, California, and is home to approximately 280 based aircraft and several aviation-based businesses. The airport is self-funded, with approximately \$5 million in annual revenues from sources including fuel sales, hangar rentals, and property use.

Fuel Service at the Airport

The airport owns and operates the fuel systems at the airport using fuel trucks for full-service customers. Fuel types offered include 100LL, Swift UL94, and Jet A. Airport staff provide fueling services daily, with six operations specialists working in two rotating crews.

Approximate total annual fuel volumes dispensed:

- July 2022 through July 2023:
 - UL94—24,096 gallons
 - 100LL—105,345 gallons
- July 2023 through July 2024:
 - UL94—26,975 gallons
 - 100LL—120,528 gallons
- July 2024 through November 2024:
 - UL94—8,018 gallons
 - 100LL—42,263 gallons
- UL94 Annual Percentage Rate: 18%
- 100LL Annual Percentage Rate: 82%

Unleaded Fuel

WVI began offering Swift UL94 on September 20, 2021. Specialized Aviation, a flight school also providing aerial tours, operates three to four helicopters and five to six fixed-wing aircraft and is by far the largest user of UL94.

The volume of UL94 dispensed decreased from approximately 40,000 gallons in 2022 to approximately 20,000 gallons in 2023, largely due to another flight school discontinuing use of UL94. Airport staff believe this may be due to the higher cost of UL94 not resulting in the expected operational savings.

The local Experimental Aircraft Association chapter, with 30 to 40 members, is also supportive, and several members use UL94.

Infrastructure

The airport has three 12,000-gallon underground fuel storage tanks. There are four dispensers with full service provided by staff utilizing mobile fuel trucks. There are self-service options for 100LL and UL94 out of dedicated dispensers. UL94 is self-service only.

The airport converted an existing 12,000-gallon 100LL tank for UL94 storage. This involved changing out the fuel filters and preparing the system for a new product. This also involved hiring a local company to clean out the underground storage tank, dry it, and change three filters in the system at an approximate cost of \$1,100.

WVI does not have a documented requirement for fuels to meet an applicable ASTM standard; however, all fuel products currently in use comply with one, and this is also a requirement imposed by the airport's fuel suppliers, World Fuels and Swift. WVI considers this adherence a best practice and anticipates that any decision to offer a fuel not covered by an ASTM standard would necessitate a formal risk management evaluation.

Process Leading to Offering Unleaded Gasoline

Airport management wanted to be proactive with environmental initiatives, including offering unleaded fuel. WVI were already working on LED lighting, accommodating electric vehicles, and solar power. Therefore, WVI was interested in offering unleaded fuel to get out in front of the issue and be proactive before it became a mandate from the City Council. The City Council was not involved with the initial transition process.

There were no internal or external pressures influencing the decision to move to offering unleaded fuel. The airport requested that the regional EPA office provide a letter to the City Council endorsing its recommendation to offer unleaded fuels, which the EPA office agreed to and submitted. Airport staff also checked with local regulators, including the Monterey Bay Air Resources District, the Santa Cruz Commission on the Environment, and the Certified Unified Program Agency.

The investigation and preparatory work for the transition took about nine months. The airport explored transitioning to unleaded fuels on three separate occasions:

- 2013: About four experimental category aircraft users expressed interest in unleaded fuels but offering unleaded fuel did not seem viable at the time.
- 2015: Rabbit Aviation Services in San Carlos provided input, as there was interest in using unleaded fuel with aircraft powered by the Rotax engine.
- 2020: The most recent investigation, which led to the adoption of Swift UL94.

In December of 2020, WVI began the vetting process for UL94. The airport evaluated customer demand, logistics, and potential profit margins of Swift UL94. This process involved conducting several surveys to assess demand. Once the decision was made to proceed, an existing 100LL fuel storage tank was converted for UL94 use, and the airport began offering Swift UL94 on September 20, 2021.

Fuel Supplier Coordination

Regarding supplier contracts, the airport has a five-year contract with World Fuels for 100LL and Jet A that includes minimum gallon requirements. If these minimums are not met, the contract must be extended by one year. The Swift Fuels UL94 contract is separate and can be terminated at any time. The UL94 agreement with Swift Fuels provides the same level of liability coverage as the airport has under the World Fuels agreement.

The contract received Council approval, but there was no competitive selection process because there was only one fuel under consideration.

World Fuels is the airport's fuel supplier, and both 100LL and Jet A fuel trucks and dispensers are branded under World Fuels. Swift UL94 is separately branded by Swift Fuels.

Swift Fuels provided labels and decals for the UL94 dispenser. Everything is labeled, including reels and hoses. They helped to ensure self-service dispensing equipment was clearly labeled to minimize the chance of misfueling. Purchasing notices, such as messages asking the customer

to confirm their selection of UL94 and reminders about the STC requirement are displayed at the dispenser. They also ensured that all fuel products are further identified by color-coding of platforms and pumps:

- Avgas (100LL)—Dark Blue
- Jet A—Black
- UL94—Purple

There were some transportation issues that needed to be resolved. Staff wanted UL94 delivery volumes to be the same as those used for World Fuels. World Fuels uses the same transport company and can be scheduled within two to three days. Initially, Swift wanted to deliver the smaller-volume totes, but they eventually began using standard delivery vehicles. To accomplish this, Swift looks for other airports to split loads with and arranges for UL94 to be delivered by rail to the area. WVI then contracts with their own carrier to transport the fuel to the airport at their expense.

Training

Staff undergoes fueling training every two years. Even though the airport is not an FAA Part 139 airport, it uses a 14 CFR Part 139 Supervisor Training program. This is not UL94-specific training. The program covers all aspects of fueling, including safety, quality control, inspection procedures, fuel truck operation, and fire extinguisher use. WVI requires all operations staff to complete supervisor training so that team members can train new hires. Training is provided by World Fuels.

Communication with Tenants

The airport made presentations regarding UL94 to user and tenant groups as part of information exchange meetings. The Watsonville Airport Advisory Committee meets monthly. Tenants were provided with information on the dos and don'ts of using UL94. Additionally, the airport website offers detailed information on UL94, including a dedicated link that directs viewers to all relevant content.

Airport staff considered offering incentives to encourage the use of UL94 but ultimately decided against it. They treat all grades of aviation fuel as products sold at defined margins, in line with the airport's mandate as a self-sustaining enterprise fund.

The airport also hosts a fuel promotion on the second Saturday of each month, offering discounted fuel. These events may lead to increased transient sales of UL94.

Challenges/Costs

There are some complaints from tenants having to pay for the STC and concerns that the price of UL94 is too high. Current fuel prices are:

- 100LL—\$6.80 per gallon (self-service)
- 100LL—\$7.30 per gallon (full service)
- UL94—\$7.45 per gallon (self-service)

The airport reports that a small number of aircraft owners do not believe unleaded fuel is good for engines. However, the airport staff believe the primary barrier to broader use is the higher cost of UL94. While some pilots have shared that UL94 may offer long-term benefits, the lower price of 100LL tends to drive short-term decision-making.

The airport has also evaluated GAMI G100UL unleaded avgas as a potential replacement for UL94 and identified some potential challenges. One concern is distribution; airport staff would prefer that World Fuels be able to distribute the product. This would allow the airport to meet its minimum gallon requirements under the World Fuels contract.

WVI staff explained that there is a conundrum: They would like to be the first to offer GAMI fuel, but although the GAMI fuel is FAA-authorized, the city would likely object from a risk management perspective since the fuel is not subject to an ASTM standard. Additionally, there are concerns that GAMI's price point would likely exceed that of UL94.

Advice for Other Airports

It would be beneficial to mobilize the industry's support to fund and develop distribution pathways for unleaded fuels. WVI also indicated interest in seeing FAA funding made available to help airports acquire unleaded fuel tanks and related infrastructure.

Liability Risk Management

WVI considers fuel provisioning a key element of its service commitment and a critical component of their continued self-sustaining model. As such, the airport spent nine months vetting UL94, interviewing other airports and flight schools, and researching all available information prior to bringing the fuel on the field. As a result of this effort, they had no concerns but hedged their commitment by signing a purchase-on-demand agreement with no volume obligation.

The fact that UL94 is subject to an ASTM standard was a consideration, but not a requirement. The airport is currently considering fuels that do not have applicable ASTM standards. If such fuels are introduced at the airport, the manufacturer or distributor will be required to contractually agree to provide liability and risk management protection equivalent to that offered by the Jet A and 100LL providers.

No concerns were raised by the specialized aviation service organizations (SASOs) on the airfield regarding UL94, aside from its cost. Of the three SASOs operating at WVI, two initially converted to using UL94, however, one of the SASOs later reverted to 100LL due to pricing concerns. Specialized Aviation is currently the only SASO on the airfield using UL94.

Summary of Alaskan Issues

At this time, no airports in Alaska have transitioned to higher octane unleaded aviation gasoline, although a number of airports do offer and continue to provide non-oxygenated mogas. As a result, no Alaskan airports were included as case studies. However, two individuals, Adam White, representing the Alaska Airman's Association, and Jake Matter, representing Alaska Fairbanks International Airport, were interviewed through a process analogous to the case study surveys. They reported that Alaska has approximately 240 airports, many of which are small and located in remote areas.

The primary issue raised during the interviews regarding a potential transition to unleaded fuel in Alaska was the logistical challenge of distributing more than one type of aviation gasoline, given the state's airport population. Aviation gasoline in Alaska is supplied by a single fuel supplier, Crowley Fuels Alaska, which typically sources 100LL from California and delivers it via marine transport to a central terminal. From there, deliveries are made by barge, truck, or air to outlying airports, which generally lack spare tankage or infrastructure to accommodate a second

type of aviation gasoline. Non-oxygenated mogas is typically available from companies that supply gasoline for motor vehicles.

Given these constraints, the general feeling was that Alaska can realistically support only one type of aviation gasoline that must be suitable for all gasoline-fueled aircraft. A transition would likely require a lead time of several years. However, this timeline could be shortened if there was an unleaded aviation gasoline suitable for use in all aircraft that was also compatible with being commingled with 100LL. Both representatives also noted that aircraft owners and operators would likely have concerns about the cost of unleaded aviation gasoline and any issues it might raise with respect to aircraft performance and maintenance.

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A P P E N D I X B

Naples Airport UL94 Unleaded Fuel SOP

2.25 UL94 Unleaded Fuel



A. General

UL94 is a 94+ Motor Octane aviation gasoline without tetraethyl lead that meets the ASTM D7547 Unleaded Avgas specification. With two types of avgas fuel products available, it is essential for all personnel to be properly trained and to understand the specific procedures and safety measures put in place to help avoid a potential misfuelling incident.

B. Supplemental Type Certificate (STC)

A supplemental type certificate is an FAA-approved major modification or repair to an existing type certified aircraft, engine or propeller. In order for an aircraft to become eligible to use UL94, compatibility must be determined by an FAA-certified A&P mechanic and the STC purchased from *Swift Fuels*, the fuel supplier. Fuel placards are supplied and must be installed at the filler ports of the aircraft. Aircraft without the correct placards will not be fueled with UL94.

Tenants who obtain the STC and sign the UL94 Authorization Form will be added to an approved list, which will be used to verify the aircrafts eligibility to use the UL94. FBO Management will verify STCs and manage the approved list.

Rotax Engine driven aircraft are approved for UL94 fuel. **Experimental Aircraft** do not require an STC for UL94 fuel.

C. Procedures for CSRs and Dispatchers

When receiving a fuel order for UL94, in person or over the phone, there are a few steps that must be taken to assure the correct grade of fuel is provided to the customer. A supervisor or manager signature will be required on a Service Request form for each fuel order.

Tenant Aircraft:

1. Tenants' aircraft must be on the approved list. Verify that the customer's tail number matches the one on the list. If the aircraft is not on the approved list, proof of an STC must be brought to FBO management for verification before the aircraft can be fueled with UL94.
2. If the tail number matches one on the list, then enter the fuel order in X1.

Transient Aircraft:

1. Transient aircraft operators must fill out a UL94 Service Request form. A printed name and signature is required.
2. Enter the fuel order in X1, or create a new profile.
3. Double check the order in X1 to ensure the correct type and grade of fuel has been ordered.
4. A supervisor or manager will review the order before it is dispatched. The Service Request form will be filled out and signed by a supervisor or manager and filed.

Important: The term "Avgas" is no longer sufficient when ordering fuel. The customer must specify "100LL" or "UL94". ALWAYS VERIFY THE TYPE AND GRADE OF FUEL.

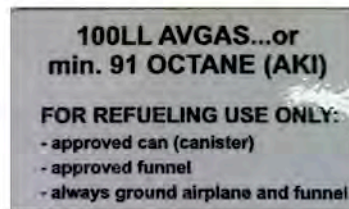
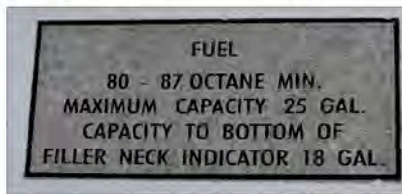
Important: For visual identification all UL94 fuel will be colored **PURPLE**

D. Procedures for Line Technicians

When a UL94 fueling is dispatched, there are several steps that must be taken to assure the correct grade of fuel is provided to the customer.

1. Obtain the key for the UL94 Truck from Dispatch.
2. Follow the standard operating procedures for accepting a fuel order and operating a mobile refueler.
3. Verify that placards are in place near the filler ports. Aircraft without the correct placards will not be fueled with UL94.
4. Follow the standard operating procedures for avgas mobile refueling.
5. Park the UL94 Truck in the designated parking space and return the key to Dispatch.

If placards are not in place or there is any doubt that the fuel request was made in error, DO NOT FUEL the aircraft and call your supervisor immediately.



Placards must indicate the "minimum octane".

These placards are acceptable for use with UL94.

Sample UL94 Service Request →

E. Procedures for Supervisors

For transient aircraft, verify that the UL94 Service request form has been filled out completely and has a printed name and signature of the aircraft operator.

All UL94 Service Request forms will be filled out completely, with the supervisors printed name and signature to confirm that all steps have been completed correctly. The color of the service request form is to signify the fuel color purple.

F. Reference Additional Fueling SOP's

- 2.05 Mobile Refueler Operations
- 2.06 Avgas Mobile Refueling
- 2.09 X1 Accepting a Fuel Order
- 2.10 Meter Refueling Procedure



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Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FAST	Fixing America's Surface Transportation Act (2015)
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
GHSA	Governors Highway Safety Association
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S. DOT	United States Department of Transportation

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