Oregon Avgas—Where are we and where do we go from here?

Richard Scott, EAA Chapter 902, Mulino, OR
Dennis Douglas, EAA Chapter 1345, Bend, OR
Randy Hansen, EAA, Oshkosh, WI
Earl Lawrence, EAA, Oshkosh, WI

Background. In early 2007, the Oregon Legislature approved House Bill 2210 (HB-2210) that changed several Oregon laws and required all gasoline sold in Oregon to contain 10% ethanol. The ethanol requirement was to be implemented within 90 days after the Oregon Department of Agriculture (ODAg) determined that Oregon's capacity to produce ethanol had reached 40 million gallons[1]. This change to the law went un-noticed by Oregon's Department of Aviation (ODAv) and Oregon's pilot community until the fall of 2007 when ODAg began preparing an Implementation Rule for the orderly introduction of ethanol in Oregon's gasoline.

Upon hearing about the planned introduction of ethanol into all gasoline in Oregon, the EAA sent out an e-Notice alert to EAA members throughout Oregon[2]. On November 9, 2007, Oregon EAA members Bob Brown and Dave Martin attended an ODAg meeting in Salem and alerted them to the problems and hazards associated with ethanol in aviation fuel. (For a description of these problems and hazards, see references 3 and 4.) While Oregon's HB-2210 did not specifically exempt aviation fuels, officials from ODAg and Oregon's Department of Justice (ODoJ) have concluded that that HB-2210 doesn't cover fuels used in aircraft, and therefore they do not require an "exemption". But no provision was made for Oregon pilots to actually be able to obtain the needed ethanol-free fuel.

Besides Oregon, several states are considering or have passed legislation requiring ethanol in autogas. Missouri and Montana have exempted premium, while other states have come up with variations of their own. This paper describes the status of aviation fuel in Oregon as of December 2007, and measures that individual pilots and pilot organizations might take to mitigate the ethanol problem.

History. Ethanol is one of several "oxygenates" approved by the US Environmental Protection Agency (USEPA) that can be added to motor fuel to reduce carbon monoxide in exhaust fumes and to improve the octane rating of fuels. Other oxygenates include methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), and tertiary amyl methyl ether (TAME). Because of the environmental hazards associated with the ethers, and because ethanol represents significant revenue potential for farm businesses in the US, ethanol has become the oxygenate-of-choice for reformulated fuels.

---

[1] See Section 17(2) of http://www.leg.state.or.us/07reg/measures/hb2200.dir/hb2210.en.html.
[2] "EAA e-Notice to Oregon Chapter Leaders, Web Editors, and Newsletter Editors", November 8, 2007.
[3] FAA Special Airworthiness Information Bulletin (SAIB) No. CE-07-06. October 27, 2006 (http://www.aviationfuel.org/saibs/10_27_06%20-%20CE-07-06.pdf.)
[4] "Ethanol-blended Fuels", EAA document, May 24, 2007 (www.aviationfuels.org/faqs/ethanol_blends,pdf)

The use of ethanol in aviation fuels, however, poses significant problems, as described in References 3 and 4. These problems include the potential for vapor lock due to the change in volatility caused by the ethanol addition, deterioration of rubber seals and tubing caused by the ethanol, corrosion of fuel system components, phase separation that can allow the water into the engine, the reduction in available power and reduced range caused by the ethanol, and other problems. Because of the potential for these problems, pilots must be acutely aware of the fuel taken aboard their aircraft to ensure no ethanol is present or, for those aircraft whose manufacturers have approved some level of ethanol, that the level does not exceed the manufacturer's approved value.

100LL. Most pilots flying aircraft using spark ignition engines in Oregon use 100LL. 100LL will be exempt from the ethanol requirement and will continue to be available at virtually all airports that sell avgas. 100LL is exempt from the Oregon ethanol requirement because HB-2210 applies to fuels refined in accordance with ASTM D-4814 while 100LL is refined in accordance with ASTM D-910.

There is little chance that ethanol could be inadvertently added to 100LL. This is because retailers of aviation fuel (100LL) are generally contractually prohibited from selling auto fuel. Also there is a completely separate distribution system for 100LL than for other gasolines. This provides a physical separation between the two fuel products and lessens the likelihood of adulteration of 100LL.

The future of 100LL is uncertain. There are several threats that can impact the future availability of avgas. These threats include the environmental concerns of the lead, production and transportation issues, and the small quantities of 100LL refined world wide.

A petition filed with the EPA by Friends of the Earth in November 2007 requested that the EPA find that aerial lead emissions from general aviation aircraft cause or contribute to air pollution and that the EPA propose emission standards for general aviation aircraft. If insufficient data were available to make that finding, the Friends of the Earth requested that the EPA study the situation. .

EAA's Earl Lawrence recently met with EPA officials to discuss this petition. EPA says that only two locations in the country, one having a lead smelter, exceeds the current EPA's standards for aerial lead pollution and that it would be years before sufficient data could be collected and analyzed to propose elimination of lead from avgas, should that be indicated by the data. Consequently, the Friends of the Earth petition is not expected to lead to the elimination of 100LL in the foreseeable future.

The biggest threat to 100LL probably derives from production, transportation and strategic issues. Since it is necessary to keep 100LL and unleaded products physically separated during the refining and transportation phases, it is becoming increasingly expensive to transport and store 100LL; thus, the price of this fuel is likely to increase disproportionally to the cost of auto gas. The lead additive, tetra ethyl lead (TEL) is another factor. It is manufactured in only one factory in the world and only two tanker

ships carry the material. Both ships are about 30 years old. Given the age of the ships and the small market for TEL if one is involved in a serious accident or is scrapped, they will not be replaced. Future shipments will be in individual tanks that can be loaded on a conventional transport ship, which will increase the cost of transportation.

Worldwide production of 100LL amounts to only about 1,600,000 tons per year[5]. In terms of volume, this amounts to less than 0.5% of all auto fuels produced annually. While the small volume of 100LL produced does not contribute greatly to aerial pollution, it does contribute to the diminishing cost-effectiveness of that production and increasing prices for the fuel. Those increasing prices will likely result in declining usage, leading to further reductions in capacity, leading to yet-higher prices (the classical "supply and demand curve"). The result may be that, eventually, oil companies no longer view avgas as a viable product[6].

Mogas. It is estimated that more than 1/3 of the aircraft using spark ignition engines registered in Oregon are eligible to use mogas. While 100LL is refined and produced at the refinery with carefully controlled ingredients and in accordance with strict quality measures, auto gas (mogas) is created over a series of steps by various companies with varying chemical additives and quality control. The basic process creating mogas entails refinement of the crude oil in different grades to obtain base stocks of gasoline, shipment to a “terminal” where company proprietary additives are introduced, and where additional state- or region-mandated additives are blended, shipment to a distributor, and then delivery to your local retailer.

Ethanol is added to automotive gas at the terminal. There are three terminals in the Oregon area: one each in Portland and Eugene, and another in Boise, Idaho. The Portland and Eugene terminals receive fuel base blending stocks via the “Olympic Pipeline” that originates in Seattle; the Boise terminal receives its base stock from Salt Lake City. At the terminal and depending on the type of base stock being processed, some additives are blended into the base stock to increase the octane to the required levels and others blended that provide proprietary advantages (e.g., Shell’s “V-Power” and Chevron’s “Techron”).

Three gasoline base stocks are currently provided in the Olympic Pipeline: “91 clear”, 87 clear” and “sub-octane 84”. The 91- and 87 clear stocks are sent from Seattle with the specified octane values. The “sub-octane 84” requires the addition of ethanol to achieve the desired octane rating. Because of HB-2210, in early 2008 the Olympic Pipeline will begin to deliver only the “sub-octane 84” base stock. This means that in 2008, pilots in Oregon whose fuel comes through the Olympic Pipeline will find it difficult or impossible to purchase ethanol-free mogas.

As noted above, some states have exempted premium fuel from the ethanol requirement. Gas stations generally have only two tanks for gasoline, one for premium

[5] Lennert Persson, “Future Fuels of Aviation”, presented at the IAOPA Toronto Meeting, June 2006; (www.iaopa.org/info/assembly23/ppts/persson.pdf)
[6] “Status of High Octane Leaded Gas”, EPI, Inc. (http://www.epi-eng.com/ET-EndOf100LL.htm)

and one for regular. When you order mid-grade gas, the two grades are mixed by the pump. In states that require 10% ethanol in regular but exempt premium, mid grade has only 5% ethanol. In September 2007, premium-grade gasoline represented only 8.7% of the auto gas sold in the United States, which would seem fairly insignificant. Mid-grade added another 8.6% and combined the two grades represented 17.3 % of auto gas sales[7]. Politicians who might accept 8.5% of the gasoline being free of ethanol may resist when the exemption is boosted to 17%. In addition, some consumers in states with ethanol-free premium, unhappy with the reduced mileage associated with ethanol-blended regular-grade gas may opt for higher grades, boosting the sales of ethanol-free gas and undermining the objectives of the ethanol requirement. For some politicians, this may not be acceptable. Thus, exempting premium from ethanol requirements may not be a feasible answer politically in the short term and changes in refinery practices make it an uncertain answer for the long term.

For a Comparison of typical automobile gasoline Anti Knock Indicators (AKI),
the number on the pump, with motor octane numbers (MON)
the first number is used in identifying aviation gasolines e.g. the 80 in 80/87.
Regular car gas 87 AKI is equivalent to 82.5 MON
Premium 91 AKI car gas is equivalent to 87.5 MON
Note: Typical 100LL is 104 to 106 MON

Options. For most pilots in Oregon, the ethanol-blended auto fuels pose no problems and the solution is simple: If your airplane can tolerate 100LL, you may continue to fly it for the foreseeable future. Should 100LL eventually go away or become excessively expensive, it will likely be replaced by something like the 91/96 U/L fuel which most aircraft can use. A specification for this fuel already exists, but the fuel is available only in Europe at this time. High compression engines, however, can not use 91/96 U/L so a new specification will have to be developed.

Two classes of aircraft that are generally at the opposite ends of the financial spectrum are most affected by the changing fuel availability: low compression engines in certificated aircraft that can not tolerate 100LL and high horsepower, high compression engines. Operators of low compression engines can use 100LL until it is replaced by an unleaded alternative but will have an increase in maintenance activities. Operators of high compression engines may have difficulty finding a suitable replacement if the supply of 100LL is disrupted and may have to modify their engines to run on lower octane fuel. This may entail replacing pistons and rings to reduce the compression ratios, resulting in a horsepower reduction and perhaps reduced range as those engines will be running at a lower level of efficiency. STCs for these modifications may be required and entail long lead times to develop and approve those STCs.

For pilots who regularly fly with mogas, the ethanol-blended mogas presents a challenge. For many of these engines, 100LL contains *too much* lead for the older, low-compression engines. Based on the current status of fuels in Oregon, the best solution

[7] Energy Information Administration
(http://tonto.eia.doe.gov/dnav/pet/pet_cons_refmg_d_SOR_VTR_mgalpd_m.htm)

may be to use 100LL together with a lead-scavenger additive such as Alcor TCP. TCP (Tri-Cresyl-Phosphate) is used to reduce or eliminate spark plug fouling problems and does so effectively. The future availability of TCP is uncertain, however, because of recent shipping issues and production decisions.

Another lead scavenging product is Decalin RunUp™. It has the same active ingredient as TCP, but has a different carrier and does not have the shipping restrictions as the Alcor product. The manufacturer says it is safe to carry in aircraft, unlike TCP. However, Decalin is not approved for use in certificated aircraft.

Thus, if your engine has problems using 100LL and ethanol-free mogas is not available, you can use 100LL and TCP, as long as you can find it. If your aircraft is an experimental, you can use Decalin RunUp. If TCP is unavailable and you fly a certificated aircraft, you will have no option but to clean your spark plugs frequently until 100LL is replaced by an unleaded formulation.

Rotax engines will need more frequent spark plug cleaning with 100LL. Rotax allows 5% ethanol fuels, but the airframe manufacturers may not. Check with your airframe manufacturer before flying with ethanol-blended gas. And rather than flying on straight 100LL, you might consider a 50/50 blend of 100LL and Oregon's mogas in order to get 5% ethanol and reduced lead.

EAA's Earl Lawrence suggests that any engine that requires premium when run on autogas is safe to run on 100LL as these engines were designed to use 100LL. If 100LL is replaced it will be able to use 91/96 U/L. Carefully consider your options if you are thinking about a high compression engine. Low compression engines may have problems for a few years, but will be fine with an eventual changeover to 91/96 U/L or any other unleaded replacement for 100LL.

Octane need vs. compression ratio can be **estimated** for **air cooled** aircraft engines as follows: Low compression (7:1 to 7.2:1) type certified to 80 Motor Octane Number (MON) Mid compression (8:1 to 8.5:1) type certified to 91 (MON) STCed to 87MON premium autogas High compression (8.7:1+) and Turbo Charged engines type certified to 100+ MON

Other solutions. Aviation groups, such as EAA chapters and pilot organizations such as the Oregon Pilot's Association might form co-ops to purchase and place tanks at selected airports and sell unleaded, ethanol-free mogas to their members. Tanks might also be leased. The markup in fuel price could lead to the financing of additional tanks so that eventually a network of outlets may be available. An additional benefit to these organizations is the increase in membership that may come from people joining so they can purchase the gas they want or need. Fleet tanks for this purpose start at about $3,000, but the larger the tank, the lower the delivery cost per gallon, so a larger, more expensive tank could be considered. Used fuel trucks may also be a possibility and there are often some listed on eBay and in *Trade-A-Plane*.

The Jerry Brown Company in Eugene is a potential resource for getting ethanol-free mogas to Oregon pilots. That company is a large distributor of automobile and specialty

fuels. A company representative said that they would be willing to bring in ethanol-free gasoline and sell it to Oregon co-ops and pilots, but that before they could commit to doing that, they would have to determine the economic viability of doing so. Since the Jerry Brown Company is a distributor, purchasing smaller quantities of fuel than from a terminal operator could be a workable solution. Carson Oil in Portland is also interested in providing ethanol-free mogas.

Peterson Aviation, located in Minden, Nebraska, is another potential solution. Peterson Aviation has sold many autogas STCs and is working to establish retail outlets to provide unleaded autogas at various airports. At this time, Peterson has 3 outlets selling autogas under his own brand name in New England. Petersen has the appropriate testing equipment to assure the gas is alcohol free and is the correct octane. Peterson also has the needed liability insurance. Should co-ops establish their own tanks, Petersen can do all the testing of the fuel, either in person or samples sent to the company.

An Action Plan for Oregon Pilots. World, national, regional and statewide forces are driving decisions on aviation fuel, whether intentionally or not. Aviation is seeing laws passed without regard for aviation either because general aviation interest groups have not been paying attention or because they are so small in the bigger scheme of things that they don't have sufficient clout, or their efforts are fragmented. General aviation interests need to work together and take the initiative to find and make acceptable proposals or they will be left wondering "what happened?" when they suddenly find appropriate fuel unavailable.

General aviation needs to:

- Pay attention to what is brewing in lawmaking bodies. In light of what happened in Oregon, it is clear that large general aviation organizations such as EAA and AOPA do not have the resources to monitor activities of all 50 state legislatures and make the case for aviation at each legislative body. Chapters need to make contact with lawmakers, find out which ones have a connection with aviation and ask to be notified of any legislation that might affect aviation.
- General Aviation pilots, owners, and businesses in Oregon need to write (contact) their state legislators to remind them of their mandate to represent the interests of all their constituents, not just specific lobby groups.
    - Specifically point out that this was not done when passing the ethanol-blending mandates in HR-2210. As a direct result, their constituents who fly general aviation aircraft, operate motorboats, operate two-stroke engine powered landscaping/garden tools, and who operate Rotax-engine powered recreational equipment have been harmed by their actions.
    - In the same contact letter/phone call, specifically ask the legislator to introduce legislation amending HR-2210 to exempt premium autofuel from the ethanol-blending requirement for 5 years. The 5 years should be sufficient time for the manufacturers of all affected equipment to work out a viable and safe solution to the engine/fuel system hazards created by

ethanol-blended fuel in open vented vehicle, vessel, aircraft, and other equipment fuel systems.

- EAA and AOPA need to work aggressively with the petroleum industry and engine manufacturers to develop a gasoline specification that will work in all spark ignition piston engines. The FAA needs to be involved so that they may act quickly to give approval for the new fuel to be used in all engines and aircraft previously approved for 80/87 and 100LL. One fuel for everybody.

Summary. Given Oregon's plan to blend ethanol with all autofuels, we have no perfect answers and can't predict the future. A ship could sink. The advisability of using ethanol to displace gasoline is not a settled issue and could become discredited due to consumer revolt or the effects on food prices, crop failures or new studies showing an energy or monetary loss in production and distribution. Be prepared for surprises and plan for options.

Questions? Contact Richard Scott or Dennis Douglas through their appropriate EAA Chapter web site.