PART 1

AVGAS VS. MOGAS IN LIGHT-SPORT AIRCRAFT

Upsides and downsides

BY CAROL AND BRIAN CARPENTER

ONE OF THE MOST requested topics for us to weigh in on is avgas (aviation fuel) versus mogas (automotive fuel) in light-sport aircraft. This is also one of the more controversial subjects that makes it very difficult to write an article that is definitive on the subject.

We often get questions like, "What type of fuel should I be using in my light-sport aircraft?" This is akin to the question, "Do these pants make me look fat?" Your first instinct should be to change the subject as quickly as possible. God forbid you do elect to engage, you need to recognize that the conversation is going to morph into many other unrelated topics, and nothing you say is going to be an acceptable answer.

Several years ago, we did a two-hour presentation on the subject for the RV-12 fly-in in Bend, Oregon. The first hour of the presentation was all the reasons that you shouldn't use avgas in your Rotax engine, and the second hour of the presentation was all the reasons that you shouldn't use mogas in your Rotax engine. Well, that wasn't very helpful, was it? But that was the point. If there wasn't a downside to a particular fuel, it would be a no-brainer for everyone just to select that particular type of fuel. It would also be easy for the manufacturer of each engine and each airframe to recommend only one type of fuel. So, in reality, it is a matter of choosing the fuel for a particular mission profile that provides the least number of downsides. Or, if you like, the fuel that is best suited for your mission profile.

It is important to identify the downsides of each type of fuel in order to make a judgment about how it will impact your airframe and engine under these operating conditions.

DOWNSIDES OF AVGAS AND MOGAS

AVGAS DOWNSIDES

- Tetraethyl Lead
- Expensive

MOGAS DOWNSIDES

- Alcohol and Methanol
- Effect on Composite Materials
- Short Useful Life
- Vapor Lock
- Different Formulas
- Accessibility

When we use the term "mission profile" we are talking about a particular set of operating circumstances. Your mission profile may change throughout the year. As a result, the type of fuel you may want to use will also change. It is important to identify the downsides of each type of fuel in order to make a judgment about how it will impact your airframe and engine under these operating conditions. Because each fuel has its own downsides, it is important to understand what additional maintenance or operating conditions need to be performed to mitigate or eliminate any potential problems that may arise from each of the two very different types of fuel.

In an effort to emulate our two-hour presentation on avgas versus mogas, let's start off with the downsides of avgas. On our list of downsides, we have simplified the list into two primary reasons for not using avgas: tetraethyl lead and cost.

Tetraethyl lead is the primary concern when using aviation fuel. Tetraethyl lead is the additive added to aviation fuel that provides the anti-detonation properties (octane). This stuff forms deposits that can cause problems over time in different ways. It tends to foul spark plugs, build up deposits on the pistons and rings, and sludge up the oil system. Even as late as 2004, Rotax was still fighting the battle of operators using the wrong type of oil in conjunction with avgas.

In its ongoing attempt to provide more guidance on the proper type of oil to use for each mission profile, Rotax issued service instruction SI-18-1997 R5 (now superseded). In the body of that text for the service instruction, it provided a simple summary of the problem.

"The lead content of currently available leaded avgas fuels is very high," the service instruction states. "The 100 LL avgas commonly available in North America contains up to 0.58 ml/liter of tetraethyl lead, more than four times the lead found in the leaded 80/87 avgas previously available.

Due to this extremely high lead content, residue formation leading to operating difficulties with valve and piston ring sticking and cylinder wall glazing occurs more frequently when engines are primarily operated with leaded avgas fuels. Lead deposits could cause glazing of the cylinder walls."

It wasn't so much a problem exclusively with the avgas, but rather the multitude of different oils that operators were experimenting with in conjunction with the avgas. Well, even this updated service instruction didn't put the issue to rest. As a result, we are currently working under service instruction 912-016R10. This latest endeavor to improve reliability and safety involved partnering with AeroShell to develop an oil (AeroShell Sport Plus 4) that is specifically designed for the Rotax 9 series engines.

According to AeroShell, the oil is designed to cope with the high shear stresses associated with integrated gearboxes and overload clutches. It also has detergents that help to keep critical areas, such as pistons and cylinders, clean.

AeroShell Sport Plus 4

All the other oils that operators had been using for years are now absent from the list of approved oils. The AeroShell Sport Plus 4 oil is now the only oil recommended by Rotax for both avgas and mogas. It appears that Rotax is banking on standardization to prevent many of the ill-fated experiments that were ongoing in the past.

Not only that, it allows Rotax to work directly with AeroShell to make any "tweaks" that are necessary to improve performance and reliability as time goes on — and we have seen that happen already. The newest formulation of Sport Plus 4 oil is now packaged in a distinctive red bottle to differentiate it from the earlier version supplied in the black bottles. Rotax still allows the use of the original oil in the black bottles, but only until they have reached their expiration date.

One of the obvious advantages of the Sport Plus 4 oil is its ability to hold the tetraethyl lead in solution so that it can be extracted from the engine at oil change. In the early days, we used to take an airplane in for annual. If the owner was using some obscure oil, we would take an oil sample in a quart jar and watch the tetraethyl lead fall out of solution and settle on the bottom of the jar literally within hours of taking the oil sample. Not good. Conducting the same test using the AeroShell oil shows no separation even after many months of sitting. One of the other methods that Rotax employs to mitigate the effects of tetraethyl lead is to change the oil on a more frequent basis. The Rotax maintenance manual gives good guidance on the oil change interval depending on the percentage of avgas used. The premise is that changing the oil more frequently will reduce the amount of tetraethyl lead that the engine is exposed to.

Everyone agrees that the tetraethyl lead is a downside of avgas. Even in the conclusion of the most recent Rotax service instruction, it states, “If possible, operate the listed engine types using unleaded or low-lead fuel. (AVGAS 100 LL is not considered low leaded in this context.)” This statement makes it pretty clear that Rotax favors the use of automotive fuel over 100LL.

It is a matter of choosing the fuel for a particular mission profile that provides the least number of downsides.

The second item on our list of downsides for avgas is cost. Not just the cost of fuel, but the cost of doubling up on your oil changes and the increased maintenance costs associated with operating 100LL. Even if you are of the mindset that cost should not play a role in the decision of which fuel to use, we must bring the total cost of operation variable into the equation. For many people, the cost of operation can be the tipping point between flying and not flying. The $100 hamburger used to be considered a joke. Nowadays, it is more like an aspirational goal that is often dreamt about but seldom achieved. The cost of fuel is a significant portion of the operating costs for any airplane.

The good news is that the vast majority of light-sport aircraft use engines that are literally sipping fuel compared to our big Lycoming and Continental brethren. Using automotive fuel in lieu of aviation fuel can improve the bottom line of the operating cost. But only when it makes sense. So far, in this article, all we have talked about are the downsides of avgas. If you’ve come to the conclusion that avgas should not be used on a Rotax 912 engine, hold your horses. If you think we painted a bleak picture here, wait until we talk about the use of automotive fuel in light-sport aircraft and engines.

In Part 2, we will do just that. We will talk about all the downsides to using automotive fuel and show you some of the reasons why you may think that automotive fuel should not be used on a Rotax 912 engine. The good news is, it’s not the end of the world. Never fear. We will help to sort out when it would be a better idea to use one type of fuel over the other, and what to do to mitigate the negative effects of each type of fuel. When approached appropriately, there isn’t any reason why your engine can’t reach TBO using either of these two types of fuel. *EAA*

Carol and Brian Carpenter, EAA 678959 and 299858, owners of Rainbow Aviation Services, have co-authored two aviation books and team teach the Light Sport Repairman Workshops. Brian is a CFII, DAR, A&P/IA, and the 2017 Aviation Technician of the year. Carol is an SPI, PP, LSRM, and FAAST representative.

PART 2

AVGAS VS. MOGAS IN LIGHT-SPORT AIRCRAFT

Downsides and upsides

BY CAROL AND BRIAN CARPENTER

LAST MONTH IN PART 1 of this article, we looked primarily at the downsides of using 100LL fuel. In this article, we will look a bit more in-depth about the use of auto fuel or mogas as it is often referred to.

We identified in the previous article that Rotax allows the use of avgas as well as mogas. However, it was clear that in all the service bulletin and maintenance manual information available from Rotax, there were significant concerns and operating recommendations to mitigate the negative side effects when using highly leaded aviation fuels such as 100LL. Working with the premise that Rotax favors the use of mogas over avgas begs the question: Why would we not always use mogas in our Rotax engines? Well, that's exactly what we're going to address in this article.

Methanol and ethanol are the two most common alcohols used in automotive fuel today. And like the bigger topic of avgas versus mogas, there are upsides and downsides to their use. First the upsides. Both of these alcohols have a relatively high octane rating, approximately 109 RON (research octane number) and 90 MON (motor octane number), which equates to approximately 99 AKI (anti-knock index). And due to their lower carbon-to-hydrogen ratios, these fuels have lower toxic emissions and improved engine efficiency.

Now for the downsides. Both fuels contain what are called halide ions. Halide ions are primarily responsible for the increased corrosivity of the fuels. Both from a direct chemical attack as well as increasing the conductivity of the fuels, which promotes increased galvanic and direct electrochemical attack. To make matters worse, ethanol is hygroscopic and readily attracts water from its surrounding environment. Whether you attribute the resulting corrosion primarily to the ethanol or the water is kind of a moot point when considering the final result.

Both fuels [methanol and ethanol] contain what are called halide ions. Halide ions are primarily responsible for the increased corrosivity of the fuels.

Figure 1 shows an example of corrosion within a Bing carburetor float bowl mounted on a Rotax 582. This condition is the result of only a few months of exposure to ethanol-based fuel. The oxidation of the brass caused the formation of deposits on most of the jet, but more significantly on the inside diameter of the main jet. This reduced the flow of fuel through the main jet. You can think of it as a partially clogged drainpipe reducing the flow of water in your sink drain. However, in this case, the reduced flow through the main jet caused a lean fuel-air mixture and subsequent seizure of the cylinder associated with this carburetor. (Figure 2) Regardless, it's safe to say that corrosion within your fuel system — whether it is in the fuel tank, fuel pump, fuel lines, or carburetor — is a high-risk bullet point that we would like to avoid. If you happen to have access to fuel without ethanol, consider

Figure 1

***Figure 2:** Restricted jet on left, normal jet on right.*

yourself fortunate. Many operators of light-sport aircraft (LSA) are not so lucky. If you're having trouble finding non-ethanol fuel, check out *www.Pure-Gas.org*. Out of the 14,000 stations listed, only 20 show up for the entire state of California. Our little town of Corning is one of the lucky ones. When E10 first became the new normal, the Rotax engines were only authorized to use a maximum of 5 percent ethanol. It took Rotax many years to accept the new 10 percent ethanol standard, which it now authorizes in its maintenance manual. We only bring this up because, in recent months, we have seen the EPA fast-tracking modifications to legislation that would allow the use of E15 fuel to be sold year-round without any additional modifications to the Reid vapor pressure (RVP) requirements. It will be interesting to see how Rotax addresses the E15 fuel.

Figure 3: *A one-off airplane called the Ranger, designed and built by Brian Carpenter circa 1995.*

Both ethanol and the aromatic hydrocarbons that are in gasoline (such as benzene, toluene, and xylene) have shown to be incompatible with some polymers. Many of these aromatic hydrocarbons have been shown to react with a variety of polymers, causing swelling and in many cases breaking down the carbon-carbon bonds in the polymer that reduces its tensile strength. When we say polymers, we are talking about a wide variety of materials. However, for our purposes, it's primarily parts that are rubber and plastic within our fuel system as well the resins and epoxies used in composite structures. We had a great example of how these compounds affected rubber when we switched from 100LL to auto fuel in the Ranger aircraft. (Figure 3) The aircraft sat for nearly a month after the first introduction to auto fuel. When we were preparing to fly the aircraft again after this period of inactivity, we found that rubber on the fuel caps had swollen up so much that it was nearly impossible to remove them. After switching back to 100LL, the rubber returned to its natural state, and was there ever after, functioning as designed. In the early days of the auto fuel STCs, many aircraft we worked on experienced the same type of problems, but on a much more intense level. We often used to joke that the added maintenance costs would typically exceed the fuel savings for at least the first year. However, once all the hoses, gaskets, O-rings, and general fuel system components had been converted to components that were compatible with auto fuel, the vast majority of problems began to dissipate. And ironically, the bulk of these problems were directly related to owners using ethanol-based fuels, which were never approved fuels per the STC.

PHOTOGRAPHY COURTESY OF **CAROL AND BRIAN CARPENTER**

Figure 4

The one area that continues to haunt the LSA community is the use of auto fuel in conjunction with composite fuel tanks. Many of the older types of epoxy worked well with auto fuel up until the formulations changed and began to incorporate the use of ethanol and increased percentage of aromatics, even on the non-methanol containing fuel (E0). Oftentimes, it isn't obvious that there is a problem until several years have passed, and we start to see the results of the fuel degrading the composite structures. Manufacturers of new aircraft have started to take this to heart and are employing many new techniques to mitigate the effects of the new fuel formulations, including new types of epoxies and the use of fuel tank sealing compounds that are compatible with the myriad of chemical compounds found in modern fuels. Although new aircraft occasionally have problems, the vast majority of auto-fuel-related fuel tank problems relate back to the older aircraft. For many years now we've had a standard recommendation that if you have a composite fuel tank or, more importantly, a composite aircraft with a "wet wing," you should avoid auto fuel unless the manufacturer specifically authorizes its use. Figure 4 shows the float bowl off of a Rotax 912 where the fuel tank epoxy is reverting from a solid to a liquid state, then coating, sticking, and gumming up the fuel filter, fuel pump, fuel valves, and the carburetor. Who knows what kind of damage could have been done to the engine itself if it were able to run with fuel contamination of this severity. Even after flushing the fuel tanks several times and reverting to 100LL, the carburetors continued to need disassembly and cleaning several different times over the course of a month because of what was obviously contamination from the original epoxy problem. The other area that is really hard to pin down is the myriad of magic potion additives that owners experiment with. We are often suspicious when we see one-off problems that are related to the fuel system, especially when we know the aircraft owner has been watching way too many late-night infomercials. When you decide to take on the role of a chemist, who knows what you might end up with when combining all those different chemicals together. Remember, if the engine and airframe manufacturer does not recommend your favorite additive, you are now part of the research and development team for this particular product on your particular aircraft and engine.

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As a final thought about automotive fuel, we need to talk about its relatively short shelf life. Unlike aviation fuel, auto fuel may have a shelf life anywhere from 90 days to a year from the date of its blending. A great deal of this variable is dependent upon how the fuel is stored. Because aircraft fuel tanks are vented, they are exposed to the atmosphere allowing many of the different compounds within the fuel to evaporate or degrade. As the gasoline ages, it will become less volatile, making it harder to start the engine. More importantly, it may lose octane, which is our protection against detonation within the engine. This is where the proponents of fuel stabilizers begin their sales pitch. Although we are not against the use of fuel stabilizers, this falls under the category of additives, so we will almost always defer to the engine and airframe manufacturers for suitability. The general rule that seems to have permeated the LSA industry is that auto fuel has a reliable shelf life of about 30 days. One of the reasons for this relatively conservative number is all of the unknown variables that come into play that you have no control over, especially what has happened to the fuel between the blending and the time that you pump it into your airplane. Therefore, we typically buy from gas stations that are right on the freeway with relatively high turnover in fuel sales. Buying fuel from a mom-and-pop operation that has not bought a fuel load in six months puts you at a distinct disadvantage to start with. Interestingly, the statistics on premium gas is that it is only about 5 percent of total gas sales. This means that the premium fuel will have been sitting in the ground for a considerably longer period than the fuel that comes out of the regular pump. Also, gasoline that has been stored for a considerable period turns into a varnish-like substance that coats the internal components of a carburetor. Out of the hundreds of carburetors that we have torn down for troubleshooting, repair, or rebuild, the one universal characteristic seems to be varnish buildup that needs to be addressed. If you are using auto gas and don't fly often, it's essential you have a simple, easy, reliable, and safe way to remove fuel from your aircraft and get it into your car. This being said, the best way to remove gas from your airplane is to fly on a regular basis. It is also one of the best things you can do for your aircraft as a preventive maintenance item. And yes, if you need a note for your spouse explaining the necessity for this frequent flying on the basis of safety, we would be happy to provide that.

In Part 1 of this article, we talked about some of the pros and cons of the use of avgas. In this article, Part 2, we have addressed the same regarding auto fuel. In the next article, Part 3, we will tie this all together to give you some recommendations on what type of fuel you should be using and how to mitigate any of the downsides associated with each type of fuel. *EAA*

Carol and Brian Carpenter, EAA 678959 and 299858, owners of Rainbow Aviation Services, have co-authored two aviation books and team teach the Light Sport Repairman Workshops. Brian is a CFII, DAR, A&P/IA, and the 2017 Aviation Technician of the year. Carol is an SPI, PP, LSRM, and FAAST representative.

PART 3

AVGAS VS. MOGAS IN LIGHT-SPORT AIRCRAFT

Decision time

BY BRIAN AND CAROL CARPENTER

LIFE IS A SERIES OF CHOICES. Most of us are pretty good at choosing between different scenarios. That is right up until the consequences become significant, and all of the choices are less than ideal. One of those choices that still give pilots a lot of angst is this decision between avgas and mogas. In this article, Part 3 of this series, we will help you decide how to approach the dilemma with your aircraft. And when we say dilemma, we are talking about choosing which fuel will be the least detrimental to your particular type of operation. In Part 1 we discussed the downsides of avgas. In Part 2 we shared the downsides of mogas. If you did not get the opportunity, we recommend reading the previous two articles on this subject as a foundation for this article.

The simple decisions first: If the manufacturer of your engine and aircraft recommends not using auto fuel, then the decision is quite simple. The most common reason for this prohibition revolves around the degradation of composite fuel tanks. Over the years, we have seen enough problems in this area that we have become gun-shy to the use of auto fuels in composite fuel tanks. On some aircraft, we have seen degradation of the fuel tank that didn't show up until years later, even with fuel tanks that have special sealants applied to the interior of the tank. All of this, simply because a small crack in the sealant allowed the auto fuel to pass the sealant membrane and propagate into the composite structure.

If the airplane is going to fly, we like to use auto fuel. If the airplane is going to sit, we like to use 100LL.

Figure 1: *Hovey Delta Hawk built by Brian Carpenter.*

In the late '80s, one of our first aircraft builds was a highly modified Hovey Delta Hawk. One of the modifications was a composite fuel tank that we manufactured to also act as a gap seal between the top two wings (Figure 1). Nearly two years after the aircraft's first flight, the auto fuel had degraded the epoxy in the lower aft right corner of the fuel tank. The fuel tank sprung a leak on a flight from Oroville, California, to Chico, California, and the aircraft ran out of gas only 1 mile short of Runway 31R, resulting in an off-field landing. The choice to use auto fuel in this aircraft was primarily based on the two-stroke engine that was installed. Which leads us to another simple decision when dealing with two-stroke engines.

We have a vast history showing the downsides of using 100LL in two-stroke engines. In our maintenance classes, we have many examples showing the long-term detriment of using 100LL (Figure 2). The primary reason for avoiding 100LL is based on the operating principle of the Dykes ring on the two-stroke pistons. This could easily be an article within itself, but to simplify, the buildup of

PHOTOGRAPHY COURTESY OF BRIAN AND CAROL CARPENTER tetraethyl lead within the ring grooves can lead to a rapid decline in ring performance and subsequent failure of the engine. On top of that, the tetraethyl lead is notorious for fouling spark plugs. We can get away with 100LL for short periods on the dual ignition two-stroke engines. The fouling of a single spark plug will typically burn clean after a few minutes of normal engine operation on the other spark plug. However, on the single ignition engines (even two-cylinder engines), fouling of a single spark plug will lead to engine stoppage. For this reason, the use of 100LL is considered unacceptable. On the dual ignition two-stroke engines that have used 100LL for a short period, switching back to auto fuel can, over a period of time, clean out the remnants of the tetraethyl lead, but only if the engine is set up and operating correctly.

Speaking of "set up and operating correctly," all engines can significantly mitigate the effects of 100LL simply by having the engine operating at optimal settings. Having an engine that is running rich, or not burning all the fuel completely, will naturally lead to an increased buildup of tetraethyl lead on not only the combustion side of the engine, but also on all of the internal engine components. Complete combustion is one of those events that significantly helps scavenge the carbon and lead buildup from within the combustion chamber. Even with Continental and Lycoming engines, we see a significant increase in tetraethyl lead within the oil filters on engines used as training aircraft, primarily because of student pilots who are not trained on how to properly lean the mixture during a normal cross-country flight. These aircraft are also the airplanes that require spark plug cleaning on a much more frequent basis.

Back to auto fuel for a bit. The ethanol-based fuels are our biggest concern. If you have the option of buying non-ethanol-based fuel (pure gas), it is almost always a better option over the ethanol-based fuels. In Part 2, we discussed in depth the corrosion aspects associated with the ethanol-based fuels. The Rotax 9 series engines are approved for up to 10 percent ethanol and will operate reliably with this type of fuel. The trick here is simply to use up the fuel as soon as possible. On aircraft that operate frequently, there is little downside to using auto fuel. It is primarily the relationship between the potential problems created within the fuel system due to corrosion and fuel degradation that presents a hazard. Using fuel from a station that has high turnover, quality fuel in an airplane that operates at least 10 hours a week is probably the ideal operating condition. Letting the fuel sit for weeks on end is when we start to see the majority of problems. For aircraft that fly in the neighborhood of fewer than 10 hours per month, we start to favor the use of 100LL simply because of the trade-off in potential maintenance problems related to the older auto fuel. If the airplane is going to fly, we like to use auto fuel. If the airplane is going to sit, we like to use 100LL.

Figure 2: *Close-up of lead build up on a Rotax Piston.*

Figure 3: *Rans S-6S Coyote II right and left fuel tanks.*

This now brings up an alternative operating procedure. If it's summertime and you have plans to fly on a frequent basis, go ahead and use auto fuel. As it gets closer to winter or to a period when you know you're not going to be operating the aircraft, start switching over to 100LL. If you had anticipated flying and were loaded with auto fuel, and then ended up not flying, we recommend removing the fuel from your airplane and putting it in your other vehicles. If your airplane has sat for some time with an ethanol-based fuel, we would recommend an inspection before getting back into the air. At a minimum, pull the float bowl off the carburetors to see the internal condition. Degraded fuel or corrosion would be a red flag to dig in even further. Remember, the degradation caused by fuel affects not only the carburetor but all the rest of the fuel system — the fuel pump, fuel lines, fuel selector valves, and the fuel tanks. A degraded carburetor float bowl is only a symptom of a much larger problem. For those who are unsure of how much flying they might do in the near future, we would probably just recommend 100LL.

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That leads us to our latest experiment that we are doing at Rainbow Aviation. We have a RANS S-6 Coyote (Figure 3) that we have modified to allow the use of 100LL in one fuel tank and auto fuel in the other fuel tank. This allows us to operate primarily on auto fuel during the majority of a flight. Once we are 10 to 15 minutes from our destination, we can simply switch to the 100LL. This leaves the aircraft sitting in a condition as though it had always run on 100LL with none of the downsides of letting auto fuel sit inside of the fuel system. But, because we are operating for such a short period of time with the 100LL, it significantly reduces the negative effects of tetraethyl lead within the engine. Although not our primary thought process, it does allow us to mitigate the potential effects of auto fuel that starts to degrade with time. Old auto fuel under extreme conditions may not be up to the task. But by using 100LL for takeoff, climb, and landing, we essentially have the safety and reliability of the 100LL and eliminate the possible problems associated with old auto fuel. Once at altitude, where the manifold pressure is lower and the potential for detonation reduced, we can switch to the auto fuel. This can significantly reduce the operating cost. If at any point we suspect the auto fuel is compromised, we can always switch back to 100LL for safety. Having the reliability of 100LL for the takeoff and landing phase of flight, along with the long-term storage benefits struck us as a concept worth experimenting with. And let it be said that this is, in fact, an experiment. Often, we don't recognize the downsides until we have put enough time in to be confident of our hypotheses. We will continue to evaluate our concept and publish the results.

Last but not least, we need to address the issue of Swift Fuels UL94. It is nearly impossible for us to make any legitimate comments about Swift Fuels when we have literally no experience. Our research into what Swift Fuels is doing is very positive, and we would probably be using it if we had access. For you Midwesterners, a lot of options are available. However, for us on the West Coast, the San Carlos Airport is the only airport from Mexico to Canada that supplies the UL94 fuel. And only four other private operators west of Kansas use UL94.

Everyone's accessibility to different types of fuel is different. That, along with the different mission profiles, makes a one-size-fits-all approach inadequate. However, with the different concepts and underlying theories presented in these three articles, you should now be able to make a better-informed decision about how best to approach your particular operating circumstances depending on fuel availability and your unique mission profile. *EAA*

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