

<p>1</p>	<p>1. G100UL Fuel Status</p> <p>a. Is the fuel you are currently testing your final recipe, or can further changes be expected?</p> <p>b. With whom are you testing the fuel; which engines/aircraft?</p> <p>c. How will your fuel perform in lower performance engines? Have you tested such engines?</p> <p>d. What is the status {and/or are the results of the FAA Technical Center's testing} of GAMI's reportedly non-standard CHT probes and probe placement, and the validity of GAMI's detonation test data as a result of differences in equipment and placement in the test engine?</p>	<p>a. This is important. It is probably a bad idea to think of this in terms of some "recipe".</p> <p>There is a specification. The fuel can be made many different ways - - just like current 100LL. Example: One refinery may make 100LL with essentially zero Toluene in the fuel. Another may make 100LL with as much as 20% Toluene, or more.</p> <p>We have tested the fuel at all of the reasonable corners of the "envelope". We have found no surprises. The different combinations behave in a manner that is consistent with what a person experienced in this field would predict.</p> <p>b. Lycoming IO-390. TCM O-200. TCM IO 550N (with turbo). (All of these have been in flight, in addition to the test stand running we have conducted.</p> <p>c. It will likely run better than 100LL just because it has no lead. Yes. The O-200. Neither I nor any of the three pilots who have flown the O-200 can tell the difference between the two fuels operationally in flight. Hot weather or cold.</p> <p>d. Assuming the question relates to the combustion pressure transducers (and not CHT probes - - which are standard) :</p> <p>There is no "standard" for combustion pressure transducers. We have run ours in direct comparison with the probes used by the tech center. They compare rather directly and produce fully equivalent results.</p> <p>In February I spent a day at the FAA tech center. They ran two of our spark plug based combustion pressure probes in one cylinder along with three of their own piezo-electric based water cooled pressure sensors - - ALL in the same cylinder. The poor cylinder had three holes drilled into the cylinder head for the piezo pressure transducers !!! They all worked just fine. No detailed report has been generated, but we watched the combustion pressure data in real time and the traces appeared to be the same for all of the five sensors.</p> <p>This is - - and has always been an invalid concern.</p>

<p>e. What problems have been discovered during testing that remain unresolved?</p>	<p>Why? Because if you do “back to back” comparison testing of a test fuel against a pair of known reference fuels that bracket the performance of the test fuel - - then the overall accuracy of the method of detonation testing becomes relatively unimportant.</p> <p>e. None that we know of. We may still be surprised.</p>
<p>f. Have you tested for cold temperature extremes, both starting and operating? How cold? Same question for hot extremes. What problems arose in these environments, and what is the solution?</p>	<p>Keep in mind, that if you put 100LL and Swift fuel at opposite ends of a scale from zero to 100 - - and then ask the question, how “close” is G100UL to either fuel ?</p> <p>The answer is, that if 100LL is at the left side of the scale at the zero mark, then G100UL is at about 10 to 15 on the scale from zero to 100 as far as being “similar” to 100LL is concerned.</p>
<p>g. Have you discovered any materials compatibility issues? Do you believe you are familiar with any such issues that might arise, and are there any for which you have not yet tested Such as fiberglass fuel tanks used in the Monarch {STC} tanks?"</p>	<p>f. Yes. We are still exploring the cold weather issues with carbureted engines. We have pretty thoroughly tested the fuel injected engines.</p> <p>But there are no issues we have found, yet. We have started the carbureted engine with no preheat of any kind in weather as cold as 35d F. The aircraft we are using is very hard to start even on 100LL if the temperature is much below 35d F. In hot weather, the vapor lock issues may be slightly improved over typical 100LL.</p>
<p>h. What are the observed consumption rates for comparable HP output {for the fuel being tested} – eg, 250 HP?</p>	<p>g. None that we consider significant. So far we have not observed any noticeable degradation of any components. We have done a lot of that testing using some accelerated testing methods with elevated temperatures in fuel confined to a pressure cooker. At this point, it is rather unlikely that we are going to be surprised. The wing of the Cirrus is fiberglass. We have tested a number of samples of the Cirrus wing provided to us by Cirrus. So far, all of this has been benign. But there is some further testing still to be done.</p>
<p>i. What is the weight/gallon for your fuel?</p>	<p>h. The consumption rate per gallon is about 3.5 to 4% less than with 100LL. That is because the energy content is about 3.5 to 4% higher - - per gallon.</p> <p>i. Depending on how the G100UL is made, it will run from about 6.2 lb/gal up to about 6.3 lb/gal</p>

<p>j. What is your opinion about the lubricity of G100UL, as compared with 100LL? Have you conducted any lubricity testing {G100UL vs 100LL} on older, high-powered engines – e.g., high power radials manufactured prior to 1950?</p>	<p>j. There is no “lubricity” requirement for ASTM D910 100LL. There has been high aromatic content in many 100LL fuels for about the last 20 years. It has shown no issue. The 150 hour block test on Swift fuel (85% heavy aromatic) showed absolutely no evidence of any accelerated wear characteristics. As noted during the conference, the valve seats on all of the big high powered radials are hardened materials just like newer engines.</p> <p>This concept of “lubricity” due to lead continues to generate a lot of comment on various pilot forums and mail lists.</p> <p>The lead in the tetra-ethyl lead molecule is almost completely converted into other molecules by the time the piston gets to top dead center during the combustion stroke. That then leaves lead in the combustion chamber is in the form of lead oxy bromide. There is not much about that chemical molecule that would cause someone to recommend it as a lubricant.</p> <p>In fact, we go to great lengths to get rid of the lead in the combustion chamber - - by using special “additives” in the “lead package” that are designed to “scavenge” the lead at relatively low exhaust gas temperatures. Without the scavenger agents, the spark plugs and the cylinders would load up with lead in 20 to 30 hours of run time.</p> <p>I have tried to track down the ultimate source of the concept of combustion products as a “lubricant”. That is very elusive. If someone knows of a genuinely authoritative source for that concept, <u>that includes good data</u>, I would like to see it.</p> <p>Keep in mind, when we got rid of lead in car engines - - the durability of those engines improved dramatically.</p> <p>That is likely one of the best reasons for getting rid of the lead in Avgas.</p>
--	---

	<p>k. Have you analyzed for toxicity? Are there any known carcinogenic effects for any G100UL components? This especially relates to aromatics such as toluene and benzene.</p>	<p>Keep in mind, that there are few things around the environment that are as toxic as the tetra-ethyl lead in Avgas. Compared to that? There is nothing even close to TEL in G100UL. All of the components are all already common in existing 100LL fuel, or else they have previously been evaluated extensively and tested by standard industry screening tests and found to be negative.</p> <p>One should not confuse aromatics like toluene, xylene, & tri-methyl benzene with “benzene”.</p> <p>These are, mono-methyl benzene (toluene) bi-methyl benzene (xylene) tri-methyl benzene (mesitylene)</p> <p>That is they have either one, two, or three “methyl” groups around a benzene ring. A methyl group is a single carbon atom with three hydrogen atoms.</p> <p>These aromatics are different chemicals than benzene even though they are built around a benzene ring.</p> <p>Of these, toluene may be the “most aggressive” solvent in lay terms. At high concentrations, it will dissolve Teflon® pipe tape in seconds and cause a threaded pipe joint sealed with Teflon tape to begin leaking.</p> <p>Xylene and TMB appear to be much less aggressive on airframe and engine wetted parts, and based on our experience in routinely handling those aromatic hydrocarbons.</p> <p>Keep in mind that common California car gas has about 20% toluene in that fuel and it has been that way for 20 years or more. Same for a lot of 100LL that has been sold for the last 20 years. We have seen local FBO 100LL with as much as 29% toluene in that fuel !</p>
<p>2</p>	<p>2. Approval and Qualification Process</p> <p>a. Where are you along your ASTM pathway? What bottlenecks are you currently encountering as you try to move toward approval?</p>	<p>a. On March 31st, 2010 the FAA asked us to revise the spec to include detailed compositional percentage requirements in addition to the existing “performance” requirements that were in the spec.</p> <p>“Performance” requirements would be things like vapor</p>

<p>b. What is the reason you are using an STC process to qualify your fuel? How will you proceed to fleet-level certification?</p>	<p>pressure, or motor octane testing, or distillation curve requirements.</p> <p>We did that. We added the component specification matrix as FAA insisted. It took a while and cost some money in re-testing etc. to get it done. Then, with the component percentage requirements added to the revised specification, that specification was presented to the ASTM. They formed a task force to work on the G100UL specification.</p> <p>Later, FAA which had previously required us to change the fuel specification and add “compositional limitations” changed its mind and rather unexpectedly announced that it had no objection to removing the component specifications from the fuel - - even though FAA was the one who demanded that they be included.</p> <p>Needless to say - - that totally unexpected course reversal (think of Lucy and Charlie Brown and the football) has been a source of delay and some serious frustration.</p> <p>b. See part a, above. The ASTM process often takes five to ten years. And it has its complications, as noted.</p> <p>For example, I happened to open up an old power point presentation the other day from seven years ago, in 2004. It was a presentation by the FAA at one of the twice yearly ASTM meetings. The subject matter was a task force that was charged with writing a specification for “how to write a fuel specification.”</p> <p>Yes. You did not misunderstand. That is a task force which is tasked with the task of writing a specification on how to write a specification.</p> <p>That “specification” for how to write a fuel specification is still being written - - seven years later.</p> <p>As I said, the ASTM process has its challenges.</p> <p>We have a fleet wide STC application filed. We will pursue it when we complete the initial STC, unless the ASTM process becomes much more obviously workable than it appears at the present time.</p> <p>I believe it is correct to note that Lycoming has approved non ASTM fuel without any STC or ASTM specification.</p>
--	--

<p>c. What is your understanding of the differences between the current qualification advisory circular {Ac20-24B} and the proposed replacement {C}? Which do you prefer; why?</p> <p>d. In the December 2010 issue of <i>ABS Magazine</i> GAMI wrote: "In early October, 2010, GAMI had a very productive two day meeting at our facility in Ada with a number of the key people working this matter from the FAA. We were able to resolve a number of the "how do we do this" type certification issues. It does now appear that the FAA will allow us to follow the existing AC 20-24B advisory material, with some additional testing which we agree is appropriate. The certification process is still painfully slow, for such a pressing and high priority issue. But it looks like we are finally making some headway." Is it still GAMI's viewpoint that it is making positive headway toward STC approval of G100UL in accordance with AC 20-24B? Why or why not?</p> <p>e. In your view, what is the purpose of ARC? What do you expect will be the final work product? How optimistic are you for this outcome? Are you sending a representative?</p>	<p>ASTM is not essential to this process. It would be <u>VERY</u> useful if it could be done on a timely basis and protect intellectual property rights as part of that process. We do intend to pursue that when it can be done in a timely basis.</p> <p>c. The AC 20-24B has worked reasonably well. It actually follows the regulations. The draft AC 20-24C is wildly outside the regulations and contains whole sections that are not in any way traceable to the regulations. The FOIA (freedom of information act) request submitted by the Clean 100 Octane Coalition revealed in a supplemental document production that the FAA's internal quality assurance group has advised the author of the draft AC20-24C at the FAA Engine Propeller Directorate that many of the provisions of the draft AC20-24C were not consistent with the regulations. That earlier internal FAA review of the draft AC20-24C appears to have been ignored in the version the AC20-24C that was released for comments.</p> <p>d. That October meeting was productive. Unfortunately, the head of the EPD retired in December. Since then, almost nothing positive has happened, and we have gone backwards in several areas. This is rather complex and beyond my ability to further elaborate in the space available. I am hopeful that the STC process can again be put back on track. But that remains unresolved as of the time this Q & A is being last revised (March 13, 2011).</p> <p>e. Tim and I are concerned that the ARC will end up being an extension of the problem that Michael Kraft described last summer at Oshkosh: "We have to quit loving the problem - - - and just fix it." Keep in mind, when Tim sits down at the ARC meeting next week in Washington D.C., he will be the only one in the room that is routinely flying around in a high performance turbocharged general aviation piston</p>
---	---

	<p>f. Do you think the ARC work product will be helpful to GAMI and others seeking to develop a drop-in replacement fuel?</p>	<p>aircraft that has now been operating on unleaded avgas for more than a year.</p> <p>The one thought that will constantly be going through his mind is: "Why are we having a meeting to try to figure out a path towards a future unleaded Avgas - - when that path has already been well identified ?</p> <p>f. See the response to e., above .</p> <p>Maybe. At one level, they are trying to solve a problem for which there is, in our view, already a solution at hand. On the other hand, the ARC committee has some very experienced industry people as part of that group. They may be able bring some focus and clarity to the unleaded fuel issue that would not otherwise exist. I want to take a positive attitude and see how it works out.</p>
<p>3</p>	<p>3. Economic Factors</p> <p>a. What does your business model suggest the delivered-at-the-pump unit cost of production would be for your fuel assuming it is produced in current 100LL production volumes {including all factors – i.e., materials, manufacturing, distribution, fixed and variable costs}?</p> <p>What would this model suggest as a unit cost for production volumes at half the current 100LL production rate?</p>	<p>3 a. We may be wrong. But right now, we believe that It should not cost a premium over existing 100LL of more than about 50 cents.</p> <p>We base this on the fact that we can run pricing models using the known "out the door of the refinery" cost number for existing 100LL and then add and subtract appropriate amounts for the different components in the existing G100UL fuel.</p> <p>At least 55 to 60% of the G100UL fuel is nothing more than the good stuff that is already in 100LL (without the lead). We know what the other 40 to 45% will cost because, unlike other fuel candidates, the non-traditional components of the G100UL fuel are commercially refined and sold in huge quantities as feed stocks for other industries, inside the United States each year.</p> <p>I doubt that 50% production would impact the producers. It would impact the local airport economy and devastate that economy. A LOT of FBO's would simply go out of the avgas business.</p> <p>A better question to consider is this: What would an INCREASE in the volume of sale of a genuine unleaded 100MON / 150 Rich Rating fuel do ? Ask yourself if</p>

<p>b. What factors are principally responsible for governing cost at the pump; can they be managed to drive costs lower; what are you doing to manage them; are you optimistic that you will succeed? Why?</p> <p>c. What is your projected price at the pump at today's 100LL volumes? What would be the price today if nothing changed wrt current prices of manufacturing inputs?</p> <p>d. At what volumes are you currently producing?</p>	<p>the old 115/145 purple fuel were available in an unleaded version, would it be sold for the marine market? The off road sport / race car industry? The answer is clearly YES !</p> <p>So it may be possible that the total volume of a premium fuel would go up by 200%, not down by 50%. That would be very good for the pricing and delivery and infrastructure behind the future of an appropriate replacement for 100LL.</p> <p>b. Good question. Our thinking has been evolving. Several of the smaller refineries and even some of the chemical companies have started making inquiries.</p> <p>They do not presently make leaded fuel but they are interested in the premium they see in the Avgas market, if they do not have to invest in equipment to handle the toxic lead.</p> <p>This kind of widespread competition would be extremely helpful in moving the Avgas pricing back towards premium car gas pricing.</p> <p>As noted above, we also see a much expanded market for the high performance engine world. Nothing out there will perform as well as the G100UL. The marine market would be very attractive.</p> <p>See the response to a, above.</p> <p>d. We are currently only making fuel on an "on demand" basis, since there is only one aircraft flying that is based at our airport that is legal to use the fuel.</p> <p>Keep in mind, unlike other proposals, we have no intention of trying to get into the refining business !</p> <p>However, we have had the fuel priced in a 100K gallon volume range for delivery in five sequential 20,000 gallon lots over a year. It appears that pricing came back lower than the pricing others have received for smaller batched sizes of 94UL fuel.</p>
---	--

	<p>e. Do you expect to manufacture in volume, or will another entity do this? If another identity, has it been identified?</p> <p>f. Has GAMI received any statement of intent from an existing fuels producer(s) and distributor(s) to deliver G100UL to the market in current 100LL volumes?</p> <p>g. What do you estimate the capital investment requirement to be to complete development and certification, manufacturing and distribution? Have you raised this capital? If not, when</p>	<p>e. As noted, we have absolutely NO desire to be in the manufacturing business for fuel.</p> <p>Several entities have expressed specific interest. We would not identify them. That would be their prerogative.</p> <p>f. A “statement of intent” is, in our view, not particularly helpful at this time. For one thing, there is nothing binding about it. Actions are much more important. But the entities that are actively engaged with us all desire not to be identified publicly. That should not really be a surprise to anyone.</p> <p>g. We could have had the fuel STC’d months ago except for specific efforts to side track the project by one individual in the FAA. Those delays have made the process much more painful and expensive. We have funded the whole effort from internal cash flow. There are a couple of significant entities that have contacted us about participating. Those discussions are ongoing.</p> <p>We do not intend to spend anything on manufacturing and distribution. As noted, we do not want to be in that business. So that capital cost is nil to us. The existing refining infra-structure is perfectly adequate to produce 300 M gallons /year of G100UL.</p>
<p>4</p>	<p>4. Other</p> <p>a. For the better part of a decade GAMI offered its PRISM electronic ignition system as an answer for running existing high compression engines on unleaded avgas.</p> <p>Over a typical period of aircraft ownership, the projected PRISM modification cost would appear to be significantly cheaper than a \$2/gallon increase in fuel expense {as might be an expected premium for a replacement fuel over 100LL.}</p> <p>Why is PRISM no longer your preferred solution?</p>	<p>a. PRISM would work fine for a 96 or 97 MON fuel.</p> <p>But for a 93 or 94 MON fuel it would compromise the ability to operate at very high power in cruise.</p> <p>We made PRISM run a Lycoming TIO-540J2BD at 350HP under hot day certification conditions on a 93 MON fuel. It can be done and can be certified. But the cruise power would be limited to probably 65% when operating with anything other than rather rich mixtures.</p> <p>We think the best use of PRISM is to allow the existing general aviation fleet to operate at overall higher power to weight ratios. With PRISM, it is not very hard to get a current turbocharged 300 Hp class engine to operate at 400 to 425 BHP and do so with rather benign internal stress on the components. That is a huge improvement in the power to weight ratio. Improved power to weight ratios have always been the foundation for all progress</p>

		<p>in aviation - - starting with the Wright Brothers.</p> <p>Like most of everybody else - - we bought airplanes to go fast. We have become addicted to operating Bonanzas at 85% of rated 300 Hp and Cirrus aircraft at 86% of rated 310 BHP. It is our goal to not have to give that up or go backwards in performance or efficiency in any way.</p>
<p>5</p>	<p>5. We are seeing interest for a non-ethanol mogas from the lower horsepower crowd {which consists of around 70% of the GA fleet}. The motivation is the expectation that a replacement for 100LL will be much too expensive for recreational flyers – current pump prices for 100LL are claimed to be \$2/gal too high. If this effort gains traction how will it affect G100UL?</p>	<p>We hear the concerns on that subject, also. But the survey results from AVconsumer do not suggest that there is a huge push.</p> <p>Regardless, if we can get some of the refiners who have traditionally NOT made 100LL to enter the market then we think the G100UL will remain competitive in pricing and the gap between full service airport 100LL and full service autogas will shrink.</p> <p>Ten days ago, it was \$4.79 at the aircraft pump locally. That is full service.</p> <p>At the same time, full service 91 R+M/2 premium car gas cost in our town something above \$3.60. So the difference in full service Avgas vs full service car gas is probably around \$1.10 at this snapshot in time in our geographical area.</p> <p>It is VERY important to make sure you get an “apples to apples” comparison. I do not think it is \$2.00.</p>
<p>6</p>	<p>6. How can The Clean 100 Coalition assist your effort?</p>	<p>That is a very important question. I think the answer is to keep asking this question at every opportunity and on every forum and at every meeting of every group of pilots :</p> <p>“Why not G100UL?”</p> <p>“Why has the FAA failed to follow the existing AC 20-24B advisory circular for the G100UL project - - just like it did for dozens of auto fuel and ethanol STCs?”</p> <p>Why do we need to continue to study or continue to “love the problem” ?</p> <p>It would help if some folks could get their Congressional members motivated sufficiently to start asking some pointed questions of the FAA about the slow pace of</p>

		<p>progress on this subject.</p> <p>For example, why is the G100UL project still waiting on an issue paper that should have been finished a year ago.</p> <p>Why has there been no “conspicuous progress” as was mandated by the deputy administrator in early July of 2010?</p>
7	Weathering over time?	<p>The “stuff” that is in car gas that causes it to have a very short shelf life is not found in Avgas and it is not found in G100UL. We really do not anticipate any of those types of issues. Testing so far has not revealed any. We do have some more of that testing to do.</p>