IAC 38 NEWSLETTER

July 2011

Howard enjoying the breeze in his face once again.

photo by Graham Bird

Prez Post

The biggest story this month, unsurprisingly, is the successful conclusion of another Paso Robles contest (this year affectionately known as the "Northern California Cloud Dancer Hoedown"). Attendance was down on prior years, as it has been at other contests so far, but we still had a good crowd of 44 competitors including lots of old friends from all over the West coast and some new faces, too.

(continued next page)

Martin Price
President, Ch 38

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As it turned out the lower turnout actually helped us somewhat since we lost the first couple of hours each morning to the Central Coast fog - the first time in my short run at Paso that I've seen that happen. Other than that things ran smoothly at the contest site and I believe everybody had a great time, wrapped up with the awards banquet at the Estrella Warbird Museum.

A lot of people put a ton of work into this contest. Special thanks go to Darren Pleasance, who saved us from a last-minute waiver issue; to Jim Ward, who traveled down from Seattle to be our Chief Judge; to Tom Myers, the Energizer Bunny who just never stops moving; and, in particular to the Price and Watson families. My Mom (now known to the contest world simply as "Mom"), Bobbi Jo and Dave and Lori Watson put in an extraordinary amount of work in the back office to keep things going - it's hard to understand until you've seen the process.

On that note we're now actively seeking volunteers from Chapter 38 (and your friends and family) to take on this workload for the 2012 Paso contest. Dave and Lori, in particular, have been doing this for 7 years straight. As Tom noted a couple of years ago, the chapter gets weaker when only a small number of people do the core work, so if you'd like to step up and help us out either with Paso or with any other chapter work please don't hesitate to let me know.

Post-Paso we're now starting to think about possible summer events and the meeting schedule. Again, please let me know if you have any suggestions and, now it appears to have finally stopped raining, I wish you all some fantastic flying!

-Martin

WESTERN 2011 CONTEST SCHEDULE

March 18-19	Redlands Minifest
April 14-16	Borrego (5 category contest)
May 5-7	Apple Valley
June 9-11	Paso (of course)
June 23-25	Ephrata, WA
July 22-23	Cut Bank, MT
Aug 11-13	Pendleton,OR
Aug 25-27	Ephrata, WA (Nor-Am Team Championship)
Sept 2-4	Delano
Oct 13-15	Borrego
Nov 3-5	Marana, AZ

WHAT AVGAS IS IN OUR FUTURE?

Submitted by Tom Myers, from a talk given to the EAA at Livermore by Paul Milner. He has flown a Cessna Cardinal for 36 years. He works for a major petroleum company with expertise on aviation fuel as manager of business development. This is not a precise transcript of Paul's talk, but it is intended to include his comments to help educate the EAA reader on the issues.

WHAT IS AVGAS?

Let's start with petroleum. At the refinery crude oil is distilled into 8-10 fractions based upon the temperature at which they boil off. Then each of those is further refined in 2-3 steps to modify the molecules to make the products people want to buy. So we crack them, we hydrotreat them, we alkylate them, we reform them. Each of those steps is intended to improve the product, for example, improving environmental factors by taking the sulfur and nitrogen out, modifying the aromatics and olefins that make more smog when they burn, modifying the vapor pressure, improving fuel performance to affect the octane, improve stability, or add heat content. This latter is because people don't want a fuel that gets less mileage. A typical refinery produces 10-15 gasoline components from this array of processes. We have about 70 plants at the refinery that are needed to perform the various steps necessary. In the '40s and '50s we actually ran the gas that came directly from the catalytic cracker and it wasn't such good stuff, so today we run it through 1-2 more steps to improve it. Of all those 10-15 components, only 4 are suitable for avgas, and even those need additional processing before they become Avgas. So it's hard to make, needs careful handling and control and all that is reflected in the price.

OCTANE

There's lot of jumbled info about octane ratings on the Internet. A specific isooctane molecule is as it sounds, 8 carbon atoms hooked together with hydrogen. If you like drawing molecules it's 2, 2, 4-trimethylpentane. This has been the 100 octane benchmark since '20s and '30s. But not always. An isooctane molecule that is used in a water cooled, fast-turning engine may test poorly in a slow-turning, hot, air-cooled engine. The same isooctane molecule in a car may test at 103 octane, but in an airplane engine it could test at 98 octane. The common nomenclature, named after a guy whose name starts with "F," there is F1, F2, F3, F4 octanes. What will you see is Research and Motor octane, where F1 is Research and F2 is Motor. At the gas station pump for your 92 or 87 octane fuel you'll see (R+M)/2. Which means the octane is the average of Research and Motor octane. In aviation we have a different test engine and that measures F3 and F4 octanes. The F2 and F3 are almost the same number, and generally it is computed from the F2 engine, we don't run an F3 engine. The F4 test engine is a super rich, turbo-charged engine, temperatures are really high and that's where the old 130 octane rating came about for our 100/130 avgas. Aviation is 80/87, 91/96 or 100/130, 115/145. Read that as Lean/Rich performance. Alert! This will clear up common confusion about

octane! Aviation octane is roughly the motor octane +5. It's equal to about (R +M)/2. Our 100 octane avgas is about 105 octane mogas. Contrarily, 91UL mogas is only bout 86 octane avgas. This means those O-360s that run fine on 91 octane avgas will not run fine on 91UL mogas because it's only 86 octane rating as avgas. You have to do things to prevent detonation that will very quickly destroy the engine under load. These are special reference engines made in Waukesha Wisconsin. They are big, heavy, 3,000 pound engines designed as octane test beds with adjustable compression ratio heads that screw in and out. Reference testing begins with a reference fuel made from a mixture of trimethylpentane at 100 octane, plus heptane, which is rated zero octane. These are mixed in proportion and run in the engine at the target fuel octane. A 98 octane test fuel would be 98 parts trimethylpentane and 2 parts heptane. When this is calibrated the target fuel is run and compared to the reference fuel. The engineers run the engine, then the automatic controls adjust the heads until they get a certain intensity of knock. The engines have to be rebuilt every week to clean out carbon deposits that would throw off calibration. In the US we had lots of development of avgas by just about every oil company before and during WWII, but today there are only 2 aviation engine test facilities: the FAA Atlantic City, NJ and GAMI in Ada, Oklahoma. The Waukesha engine is water cooled and they are limited in ability to model high temperatures of air cooled engine. It was fine 70 years ago preparing fuels for WWII, but today we can measure more precisely. GAMI has discovered the old specs and conversion models don't correlate as closely as we can measure today.

BACK TO THE '60s

Back in 1960 about 5-10% of the total gasoline consumption was avgas, we had 4 grades, 80/87, 91/98, (now 90/96) 100/130, 115/145. They varied from 0.5 to 8 grams of lead per gallon. Mogas at the time as 2-4 grams of lead per gallon. In 1960 there were about 1,000 refineries and about 80% of them made avgas because there was big demand. All gas was leaded.

JUMP TO 2011

Post 2008 we have had the biggest drop in mogas demand since the Great Depression, and avgas use has dropped even more. (Remember this fact when people talk about oil demand in US.) Avgas is now less than 0.1 of gas consumption in US. Only 1 grade of avgas, 100 LL. Less than 2 grams lead per gallon. Of 167 refineries, only 10 make avgas. Avgas is the only leaded fuel made which creates big problems. It's illegal to blend it. Due to lead content it has to be treated as hazardous waste. Avgas handling is very sensitive. Tanks aren't steel like mogas, they're steel with porcelain lining, and that's expensive. We have to clean them every few years to prevent contamination and dirt, yet the fuel can sit there for years waiting to be used. There's only 1 refinery on west coast that makes avgas – that's in Richmond, California. They supply gas to Alaska, for example, which has to be hauled in barges during the summer and sits there for an entire year, or more, until it's used and replacement fuel arrives. You don't want sludge in the storage tank. Avgas is stable, but the light ends such as butane are about 4-5% for the high vapor pressure. These eventually weather off, making it a hard-starting material in the cold. The octane of the

light ends is designed to be less than the rest.

LEAD ISSUES

There is a big lead smelter in El Paso, Texas that ships their lead to become our avgas. There's only one manufacturer of tetraethyl lead and that's Octel near Liverpool, England. If that plant has a problem, avgas has a big problem. Lead is not particularly toxic in avgas. EPA lead phase out of mogas was driven by the simple economic math. There was a motivation to mix cheaper leaded fuel with more expensive unleaded fuel, and the unintended consequences were costly for car owners. Two tankfuls of leaded fuel would destroy your very expensive catalytic converter. Those converters were the best solution to smog prevention. So lead fuel handling is costly because we can't use the same tanks, pipes and equipment used for unleaded. Phillips has a little pipeline in Texas, but that's the only one.

SOME MISPERCEPTIONS ABOUT LEAD IN AVGAS

First, it can damage your sensitive oxygen sensors in short order. There is an common misperception that lead is a engine lubricant – it's not. The early transition problems with unleaded fuels and cars that ran on them was that valves failed and people attributed it to lead. The reason wasn't lubrication, it was without lead we had lower octane and detonation or running rough. The premium spec was 93-94 leaded. We called that extra 1-2 octane "give away" over the spec. The higher expense of unleaded meant tighter spec and "give away" was a mere 0.1-0.2 octane over spec. Lead is not a lubricant in today's engines. The FAA ran a study of leaded / unleaded and with identical octane in a twin. O-360. 91/96 octane. After teardown from 500 hours they couldn't tell difference in engine wear. Lycoming and Continental transitioned to hardened valve seats about 1973. The 80/87 engines went to mogas. In fact, during the last decade of 80/87 avgas fuel it was made without any lead because it was easy to make. It has a 0.5 gram lead spec, but that was max, not minimum.

ENGINE ALTERNATIVES

Cessna tried diesels. The business case isn't closed. They're hard on props due to power pulse. Or add a reduction unit which adds weight and fails instead of the prop. They have to be water cooled and that means you need more cooling and more cooling drag to get from 400+ degree cylinder head to a 220 degree water jacket. What about turbines? They're expensive and have high specific fuel consumption. 0.38 lbs/gas/hp for typical Lycoming while a decent turbine is nearly double.

CONUNDRUM

70% of airplane fleet can use mogas. But 30% of airplanes that require high octane avgas use 70% of all avgas. They have higher utilization, bigger engines, higher horsepower, more fuel consumption. The cost to airports for two grades of fuel makes it uneconomical. FADEC and other tools don't reduce octane demand more than a 1-2 octane. Lycoming knows they can't reduce octane and make a reliable engine that will avoid detonation. EPA has been prodded by Friends of the Earth to deal with lead toxicity. From 300 picograms/cubic meter before to about 100 today. This uncertainty has a chilling effect on avgas innovation or mere investment in maintenance of old systems that eventually fail. CRC aviation fuel committee, what reports to ASTM, has spent 21 years working on

100UL solution. We've had reliable avgas spec from WWII, who would want to modify it?

FUEL ALTERNATIVES

BP favorite is triptane (2,2,3-trimethylbutane). It's a chemical feedstock for plastics. If you mix it with any other avgas it has negative octane 100T +100LL = 93 octane. Texaco, part of Chevron, is promoting nitrotoluene. 1-2% added to avgas makes good octane. But has problems. It's efficient but it stinks enough to make you throw up involuntarily. Some of the petro engineers aren't aware that pilots and ground crews come into physical contact with our avgas. It will burn your skin on contact! It's not stable. Chevron proposed to half the lead. This doesn't solve the Octel tetraethyl lead elimination problem. World inventory of lead is 1-2 years in process. If Octel goes out of business, avgas has a big problem. Exxon Mobile and Conoco Phillips proposed super alkylate, but it has problems. It's an isooctane. They have 5 cents a gallon for royalty in mogas, 50 cents a gallon for avgas. Before Lindberg flew to Europe, he did a lot of fuel testing. He would run an engine at night and see how red the cylinders would become. Following testing he chose fuel from Richmond refinery with lots of napthalene. Best we can do with existing unleaded avgas is 93-95. Continental wasn't successful with their tests on 6 cylinder Bonanza. A $10K FADEC ignition will help, but not enough to monitor the peak pressure in the cylinder which is the key problem to avoiding detonation. Lycoming TSIO-540 J2BD is the bad boy of engines used on Navajos. Certified back in 80s with a high spec avgas from Amoco. Engines would detonate to destruction very quickly if not adjusted perfectly. What class of engines would work with 95 UL without detonation danger? Believe it or not the less efficient engines do better. The IO-360-B&D are parallel valve engines and they aren't as efficient at breathing that keeps cylinders cooler. The -A and angle valve engines are more efficient breathing, get hotter and when pushed without octane, and will detonate quickly to destruction. Compression ratio isn't the only factor as the difference is 8.5 Vs 8.7. Angle valve breathes better, but heats up more. Your margin from detonation is much reduced. If we don't like that answer, let's move the goal posts. Heavy aromatic components can offer sufficient octane. Xylenes and trimethylbenzene is the Swift fuels solution, made from switchgrasss. Problems here are weight per gallon of avgas 6 lbs per gallon, and distillation constraints of having carbon form when rich. These are being testing on Waukesha engines, not aviation engines. Paul gave a lot of credit to EAA and AOPA to guide FAA to a solution for our needs. GAMI PRISM. the PRISM system continuously monitors and controls the cylinder combustion pressures, and the system does monitor peak pressure, but is not being pushed as support from Honeywell has ebbed. Swiftfuel has proposed bio sourcing trimethylbenzene (,2,4-Trimethylbenzene) from renewables. Switchgrass cost requires a new $100 million plant that has to be amortized across building costs, plus operating costs. Bottom line is perhaps $10 a gallon as biofuel. Indy cars used to run on this fuel, but 2 years ago Indy cars went to ethanol. It's a great scientific idea, but a tough business model to justify. Doesn't work as well during cold weather in carbureted engines. GAMI has tried several unleaded fuels on real aviation engines and learned the data didn't correlate to Waukesha engines. GAMI is raising money from private investors and venture capitalists. They

applied for an STC to try a fuel on 1,000 turbo-charged Bonanza and Cirrus, for example, for a couple years. They'll then tear down engines and check the
wear and performance data from which they can specify future fuel. G100 is their fuel name, which is flying in Cirrus, Cessna 150, and others. These are experimental aircraft. Senator Inhofe is running it in his RV. It's 6.2 pounds per gallon, which is outside of current fuel specification of 6 pounds per gallon and has raised other issues. G100 could move through pipelines, but batches are too small. It could simplify storage and tank trucks, though. The challenge is for FAA to grant this STC to
be tested. This testing is being supported by EAA and AOPA. We'll get enough data to make good decisions. We may need to iterate on the fuel, but it will be in response to data and it is a process that can be managed safely. The spec will go to ASTM panel, with required changes to existing fuel specification. These are not big changes for petroleum industry, but they are for FAA. Then industry will make economic decision.

ETHANOL SHRINKS GAS SUPPLY

The vapor pressure changes when we mix ethanol with gasoline. If you add 7 psi VP gas to 7 psi VP ethanol you get 8 psi VP mix. The EPA and CA want VP low to prevent volatizing to atmosphere. We have to shrink amount of gasoline in the mix by about 5% to reduce the amount of iso pentanes and pentanes that now produces less energy. This shrinks supply. It actually makes gasoline supply smaller. It gets more confusing as promotion of ethanol to reduce use of petroleum but we use more.

SOME RESPONSES TO Q&A:

Is there foreign influence? He sees this is as US aviation industry problem and solution, with minimal influence from outside countries. We are the dominant player and we have to find our own solution, which others will follow. *Is there a risk of detonation in our low compression engines?* Not for the 70%. You'll lose a bit of performance in a IO-360 parallel valve. But the angle valve won't be happy on 95 octane. Your CHT has to be under 400 degrees because it will detonate. Many Mooneys will need 430 degrees to get out of the pattern. *Should I overhaul?* If you want to overhaul and upgrade, you should do so. This will be solved in foreseeable future, perhaps 5-6 years.

Thanks to Paul for a most compelling and detailed description of the problems and possible solutions to avgas issue.

Complete results from Paso Robles

http://www.usnationalaerobatics.org/IAC/IAC_ContestResults.asp?ContestID=325

Here is a small sample of Graham Bird's album from Paso Robles. Please check out all 192 photos and a video slide show at his website. The first link is the gallery and the second is the slide show with music. Thank you Graham!

http://photos.brearleyphoto.com/Airplanes/Paso2011/17454710_tss9Jk#1338899499_5PR2Gs9

http://photos.brearleyphoto.com/Airplanes/Paso2011/17454710_tss9Jk#1338899499_5PR2Gs9-A-LB

photo by Graham Bird

The shades are working for you,Tom

photos by Graham Bird

All eyes went skyward every time Terry Middaugh turned upside down and the engine got real quiet.

Please Note:
July Chapter meeting 4:00, July 10 at Attitude Aviation

One of my favorite videos featuring two of my favorite pilots, Peter Besenyei and Svetlana Kapanina
http://youtu.be/J3q8MDFltxI

photo by Dave Williams

And a good time was had by all

IAC Chapter 38 Membership Application/Renewal Form

Name: _____ **Spouse:** _____

Address: _____

_____

City: _____ **State:** _____ **Zip:** _____

Home Phone: _____ **Work Phone:** _____

E-mail 1: _____ **E-mail 2:** _____

IAC #: _____ **EAA #:** _____

Certificate #: _____ **EAA Expiration Date:** _____

Judge: ☐ Regional ☐ National

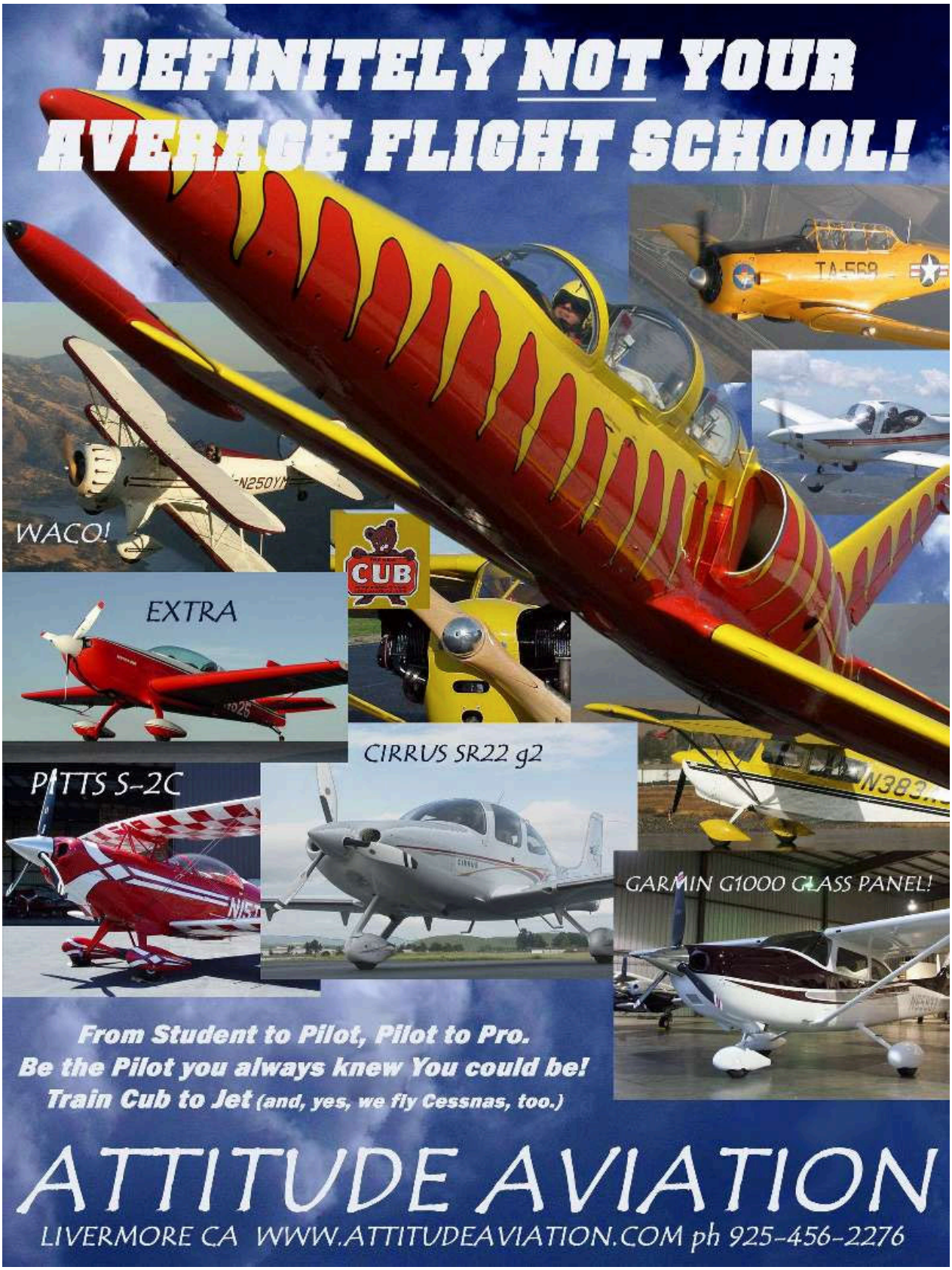
Competition: ☐ None ☐ Basic ☐ Sportsman ☐ Intermediate ☐ Advanced ☐ Unlimited

Aircraft: _____ **N #:** _____

Referred By: _____

Dues: ☐ Single Membership ($25/year) ☐ Family Membership ($30/year)

Send with check, made payable to "**International Aerobatic Club Chapter 38**", to:
Howard Kirker, IAC38 Treasurer - 2279 Ocaso Camino - Fremont, CA 94539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