



# UPDRAFT

Newsletter of EAA106  
Greater Boston Chapter

We Build  
Airplane

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The meeting will be

**SATURDAY 7<sup>th</sup> with rain date of  
Sunday 8<sup>th</sup>**

**At the HANGER !!**

**The Grill opens at 4:00PM !!**

**The program will begin at 5:00PM  
to beat the dark of night.**

The subject will be **AIRCRAFT PAINTING**  
by **Paul DiNoto**

(If you have a part you want painted, let Joel Ventura know and it  
may be part of Paul's presentation)

**Bring chairs, Eats and INSECT REPELLANT**

**Please arrange to pick up the coffee pot if you're not planing to be there.**

**The October 5<sup>th</sup> meeting is tentatively set to be at the Hanger and  
feature Joe Delello on his turbocharger derived Turbojet engine.**

(Hopefully, we will see an engine run at our Hanger)

**Site of the Month**  
[www.cafefoundation.org](http://www.cafefoundation.org)

Information about combustion processes: from Joel Ventura.

Lean of Peak EGT operation of aircraft engines has been a very popular subject lately. There were articles on this subject in a recent AOPA magazine, and in the July issue of Flying Magazine. Everyone agrees that lean operation above 70% power will damage or destroy the engine. Where the disagreement comes in is over lean of peak operation at below 70% power cruise. Some engine manufactures also recommend against lean of peak (LOP) operation. I will get to the site of the month eventually, but first some basics on lean engine operation.

The stoichiometric mixture is defined as that mixture where there is just the right number of air molecules available to combine with the fuel molecules. The fuel/air mass ratio of that mixture is .066. But the mixture will burn at ratios from about .053 to more than .110 (the full rich setting in your airplane). In theory, the stoichiometric mixture should leave no fuel or oxygen left after ignition, but in practice not all the fuel and oxygen molecules get to find each other among all those combustion products, so both fuel and oxygen are present in the exhaust. You can richen the mixture to about .080 and use up all the oxygen. That will result in the maximum power out, and occurs at an EGT about 50 degrees rich of peak (and is also the mixture most likely to detonate!). Or, since oxygen is free, and fuel costs us money, you can lean the mixture to about .053 and burn a greater % of the fuel in the cylinder. This will produce the most economical engine operation.

There are two problems on the lean side. First the lean mixtures are much harder to ignite. Secondly, the flame front travels much slower for the lean mixture. The stoichiometric mixture will burn about 75 cm/sec, while the lean mixture about 52 cm/sec. Magnetos have fixed timing at about 25 degrees BTDC.

Electronic ignition is variable from 15 to 42 degrees BTDC, and therefore can take advantage of the economy available from the leaner mixtures.

On the ignition side, it turns out it is the duration and spatial length of the spark that are important to get the fire going, not the spark intensity. The spark plug gaps in magneto systems are usually set around .018". This is done to limit the voltage to about 12,000V. Magnetos will put out much larger voltages if you open up the plug gaps, but this often greatly shortens the life of the magneto coil, and at around 30,000 volts, you will get cross firing in the distributor. Since aircraft electronic ignition systems don't use distributors, they can operate at 60,000 volts. With the large plug gaps used with electronic ignition, it now matters how the plug electrodes are oriented in the combustion chamber. If the plug gap is set perpendicular to the flow of the fuel/air mixture, then the flow will blow the spark into a U-shaped arc which is longer, and therefore more likely to ignite a lean mixture, so the engine can operate at leaner mixtures.

In an aircraft engine with dual ignition and uniform mixture to all its cylinders, as the mixture is leaned, the EGT will at first increase, and then begin to decrease with further leaning. At some point the EGT will suddenly increase again. That second increase occurs because one of the plugs is no longer igniting the mixture on its side of the cylinder. You now have single ignition, and the mixture will still be burning when the exhaust valve opens.

As a side note, capacitive discharge electronic ignition systems are falling out of favor because, though they produce a very strong spark, it is very brief, and duration is more important. However, Klaus Savior produces a

very popular capacitive discharge system that gets around the duration problem by producing several short sparks at each firing instead of one longer spark.

At this year's AirVenture, Brian Seely of the Café Foundation gave a very interesting talk entitled CAFÉ Makes Sense of Ignition, EGT, and Lean Mixture Operation. In this talk he summarized years of research he and other members of the CAFÉ Foundation have done on electronic and magneto ignition systems, exhaust systems, intake systems, and lean of peak operation. Sport Aviation would not publish his article, because they wanted a maximum length of 4 pages (otherwise they would have to drop some of those AirVenture pictures). And there was no easy way to condense all his graphs and data into 4 pages. Fortunately all the information is available at the above CAFÉ web site. (I told you I would get to that site.) Just go to RESEARCH, then IGNITION DYNAMICS I, II, and III. But you better have a love of data and details, because he doesn't leave much out. It will take a few hours of study to get a handle on all he has to present but let me steal some of his fire with

his conclusions. LOP operation produces a cleaner engine, cleaner oil, reduced CHTs, and the most economical engine operation. (He is talking about 100 degrees LOP here.) All this, and there is no evidence of increased engine wear or damage. The big catch here is all these data have been collected on a highly modified engine. So it is not clear how much of the results are going to be useful to us.

First of all, if you have a carburetor, you will probably not be able to operate more than one cylinder LOP anyway, because of the great fuel mixture variability from cylinder to cylinder in a typical carbureted engine. The fuel mixture can be balanced, but it is much more difficult to do with a carburetor than with fuel injection. (His airplane uses an Ellison Throttle Body.) He spent many hours and many dollars balancing his intake system by reshaping the intake spider before he got it right. Secondly, you need an electronic ignition system to enable you to use the wide range of ignition advance settings required. But to show you the kind of performance that can be obtained, Brian claims his highly airframe and engine modified Mooney will cruise at 200 MPH on 7 gal/hr.

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There are also other papers on this site dedicated to Exhaust Systems and Local Flow (drag reduction and flow devices). These are also very good papers with data to back up his statements. Abbreviated versions of some of these articles have been published in Sport Aviation. It is a great place to visit on a rainy day. --Joel

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As an insight as to the use of richer than ideal mixtures by the engine manufacturers, our air-cooled engines are also fuel cooled. The excess fuel carries off some of the heat produced by the engine. Guess who pays for the extra fuel. However it does keep the clunker up front a bit cooler, which hopefully gives a longer life. ---yr fthfl edtr

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Angier kindly sent some pictures of his progress on his airplane which I've included two of here. I really like his shop. It looks like a very nice work space. More pictures will follow but I don't want to make the e-mail file too big, and besides I can use some articles.

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**New Panel (ready for the instruments)**



**A nice view of the Tail Feather Installation.**

## PASSED ON TO ME----the Real Story----Boeing StratoLiner crash

I received this from a friend who is a MIT Prof.

SEA02FA060NTSB Identification: SEA02FA060 Accident occurred Thursday, March 28, 2002 at Seattle, WA Aircraft:, registration: N19903

Injuries: 4 Uninjured.

This is preliminary information, subject to change, and may contain errors. Any errors in this report will be corrected when the final report has been completed.

On March 28, 2002, approximately 1305 Pacific standard time, a Boeing S-307 StratoLiner, N19903, registered to the National Air & Space Museum, operated by The Boeing Company, as a 14 CFR Part 91 maintenance and proficiency flight, ditched in the waters of Elliott Bay, Seattle, Washington, following a loss of engine power. Visual meteorological conditions prevailed at the time and no flight plan was filed. The aircraft was substantially damaged.

The two airline transport pilots and two flight engineers were not injured.

The flight departed from Everett, Washington, and was destined for Seattle, Washington. During an interview, the flight crew reported that the purpose of the flight was for maintenance/systems checks and crew proficiency.

The flight departed from Boeing Field (BFI), Seattle, approximately 1230 enroute to Everett, Paine Field (PAE). The Captain reported that he made a full stop landing at PAE without incident. The aircraft was taxied back to the runway and the takeoff was initiated.

Shortly after liftoff, the number three engine experienced a momentary surge, then normalized. Due to this

anomaly, the flight crew decided to discontinue the flight activities and return to BFI. In preparation for landing at BFI, the landing gear was lowered, however, the left main gear did not fully extend. The approach was aborted to orbit the area to try and remedy the situation.

The Captain reported that the flight engineer at the radio station, left his station to try and manually hand-crank the left gear down. After a few minutes, the flight crew reported a green (fully extended) light for the left main. The flight then headed back to BFI when a low fuel pressure light was noted for the number three engine followed by a loss of power. The flight crew feathered the engine when low fuel pressure was noted to the remaining three engines which all subsequently began to lose power. The Captain reported that he did not believe that the aircraft could make it safely to BFI and opted to ditch the aircraft in Elliott Bay near the shoreline.

The aircraft impacted the water in a slightly right wing low, level attitude and remained upright. The aircraft remained afloat and all four flight crewmembers safely exited the aircraft and were rescued within minutes of the accident.

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And now for the rest of the story-----

The story is that these highly trained Boeing test pilots decided they'd take this airplane out for a flight, to do some circuits. They were paying for it themselves, out of their own pockets, so elected to only put \*300 gallons\* of gas in it when they were on the ground at Boeing Field. They were hoping to avoid Galvin Fling's extra \$0.04/gallon by putting more in when they got to Paine Field (where gas was cheaper) to do circuits.

Somewhere en route to Paine Field, the fuel situation was driven from their mind, probably because they were having so much fun flying.....so they did circuits at Paine until the #3 engine coughed, then died. They feathered the prop, and decided they should probably land to investigate.

They selected gear down, to find that the gear leg under the #3 engine wouldn't lower, because the hydraulic pump needed to do that was powered by the #3 engine (now feathered). So they lowered the gear leg manually, but decided (get this) to fly \*back to Boeing Field\* to park the plane, rather than land at Paine Field. Shortly after making that bright decision, the other engines started failing. No engines were running by the time it ditched, and three of the four props weren't feathered.

The kicker here: The Stratoliner's maintenance base is apparently \*at Paine Field\*. Any maintenance to be done would require that it be brought back to Paine Field anyway (or a bunch of equipment moved to Boeing Field). When asked why they wanted to bring it back to Boeing Field, the response was "Well, our cars were at Boeing Field". Someone should have asked where their \*boats\* were.

A detail that may be useful, if you're keeping track in your head: these engines, at 30" manifold and 2000 rpm, would burn about 50 gal/hr each in cruise, and would average more like 70-80 gal/hr each if you were doing circuits. Some things that weren't reported in the article below: When they peeled back the interior linings, they found that "it's all twisted at the bulkhead where the spar attaches to the fuselage". Both main gear legs were both ripped off by the ditching, and were found floating next to the aircraft... The official explanation to date is that the engines failed due to "air in the fuel lines". I guess that's one way of putting it. My take is that the dipsticks were in the cockpit, and not in the fuel tanks...

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**EAA 106 Hanger (978) 683-8751**

This **Newsletter** is for **communication** and **enlightenment**, but should **not** be relied upon as absolutely correct in content.

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**DIRECTIONS TO EAA Chapter 106 Hangar at Lawrence Airport, North Andover, MA**

Take Route 28 North from Route 128/95 and turn right onto Route 125 North. Follow this down a short section of Route 114 then right toward Haverhill. Route 125 blends into Route 133, Osgood Street, which you follow past the turnoff to the airport terminal area, then in about two miles after passing a nursery the road widens for a left turn lane toward a large incinerator plant chimney. Turn left there onto Holt Road and turn right when it tees onto Clark Street. Next left is our road, access to the North ramps, via a combination locked gate which will be left open. The EAA 106 hangar is straight ahead, first on the right. Park in front. **BRING CHAIRS**

Easy way: Fly into Lawrence Airport and ask the tower for taxi instructions to the EAA 106 Hanger. This route avoids traffic congestion on the roads.