Oil Cooler, Cooler Plenum and Baffles

The oil cooler for the F1 Rocket needs to be pretty large. Regrettably, the space to install it is pretty small. The cooling area "face" of the Positech 20006C cooler that I'm using for my IO-540 is about 6x6 inches. The left side of the ship has enough room to mount the cooler easily, but the baffling doesn't give you enough surface area without resorting to a split duct and a couple of linked 3 or 4 inch scat tubes. Do-able, but others have reported poor cooling results with paired ducts.

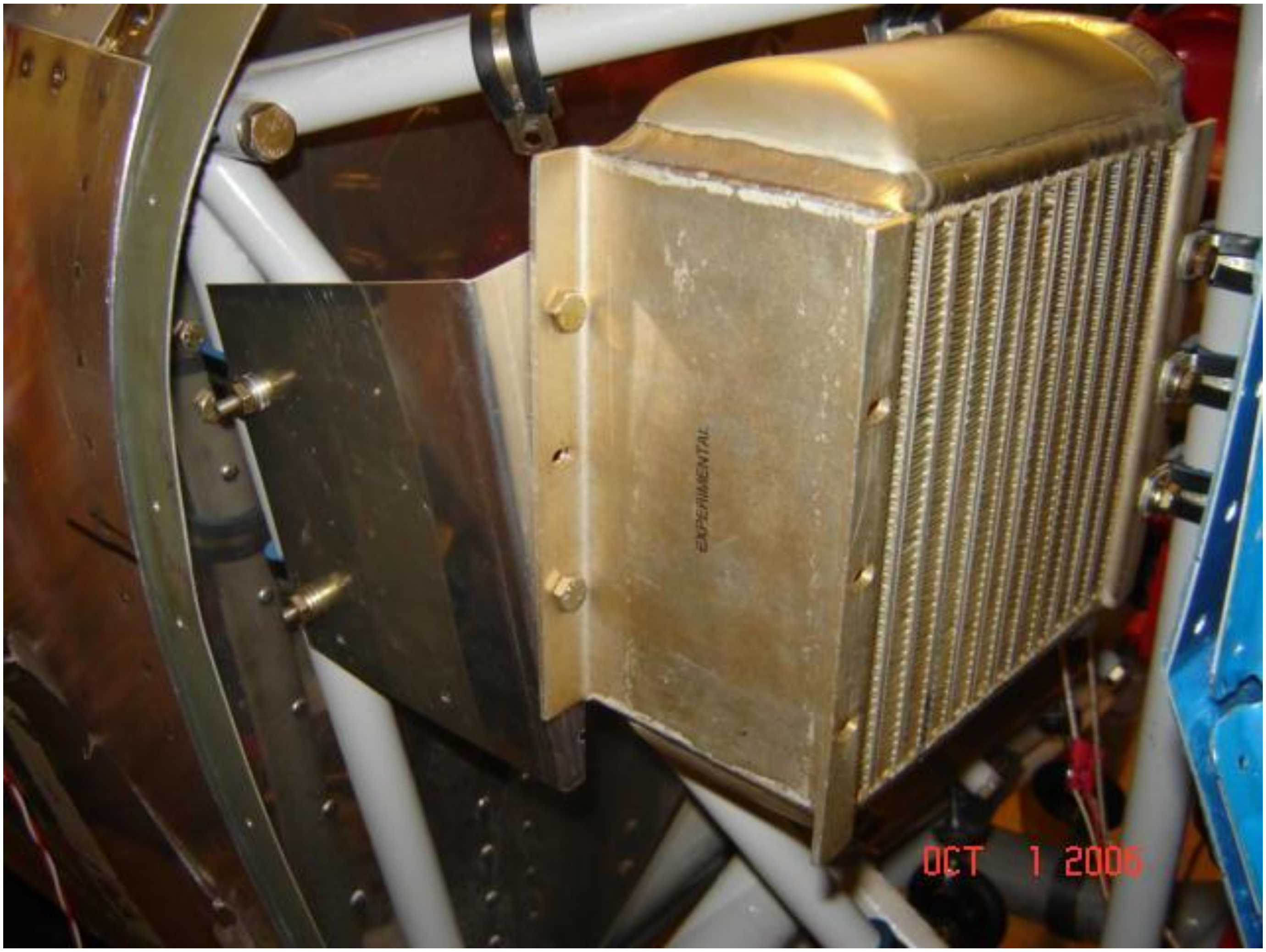
I chose to put the oil cooler on the right side. You can firewall mount the cooler, but I chose to hang this behemoth cooler on the engine mount with Adel cushion wedge clamps and a single simple bracket. I'm hanging it vertically, I.E. parallel with the rear baffles along the engine mount down tube. That means the air has to take a bit of a jog to get in there. Some builders tip the cooler somewhere approaching 45 degrees so that the flow goes more in line with the flow over the engine then out the bottom. I am just keeping my setup simple and easy. The cooler hangs directly on #14 Adel clamps on the inboard side, so I only have to make one bracket to hang the outboard side.

Oil cooling on these ships does not seem to be a big issue with these humongous coolers. However, if you don't get the air to the cooler and through the cooler, the thing isn't going to work. I think my install with allow marginal but adequate airflow to the face of the cooler. Time will tell.

My install started with buying about 10 #14 Adel clamps. The Rocket engine mount has 7/8 tubing for the main structure and 3/4 for the support structure. It turns out that my main oil cooler hangars are on the main engine mount members, so I needed lots of #14 wedge type cushion clamps. The first thing I clamped was the most forward inboard side of the cooler. I used Adel clamps direct to the cooler brackets from the 7/8 upright on the mount.

The baffling part (HAH!) about this setup was the bracket I needed to fashion to attach the outboard side of the cooler to the engine mount. I made a couple templates and really was having a hard time. Then I decided to make a few individual brackets, one for each of the cooler bracket holes. Well, after two hours of wasted time, I decided to move on to other projects and sleep on this one. Bright and early the next morning, while half asleep and the coffee still hot, I decided to make a very simple bracket and still use Adel clamps to hold the cooler.

The problem here is that the engine mount sits at a very awkward angle in regard to the cooler. The mount actually crosses between the bracket holes on the cooler flange, making it nearly impossible to go direct to the mount. So I thought. I was over thinking the problem. I was thinking I had to keep the bracket square and straight with the mounting flange of the cooler. All you really have to do is keep the thing flat for mounting the AN3 bolts. I had a nice piece of scrap sitting there, with a wide flange bent at a 90 degree angle. I started fitting it up. What I did was to keep the bracket parallel to the engine mount down-tube and then made the bolt holes in the bracket offset on the wide flange. I drilled the holes for the oil cooler and bolted the template up. Then I marked and drilled the locations for the Adel clamps on the engine mount. Turned out to be VERY simple, easy and effective.

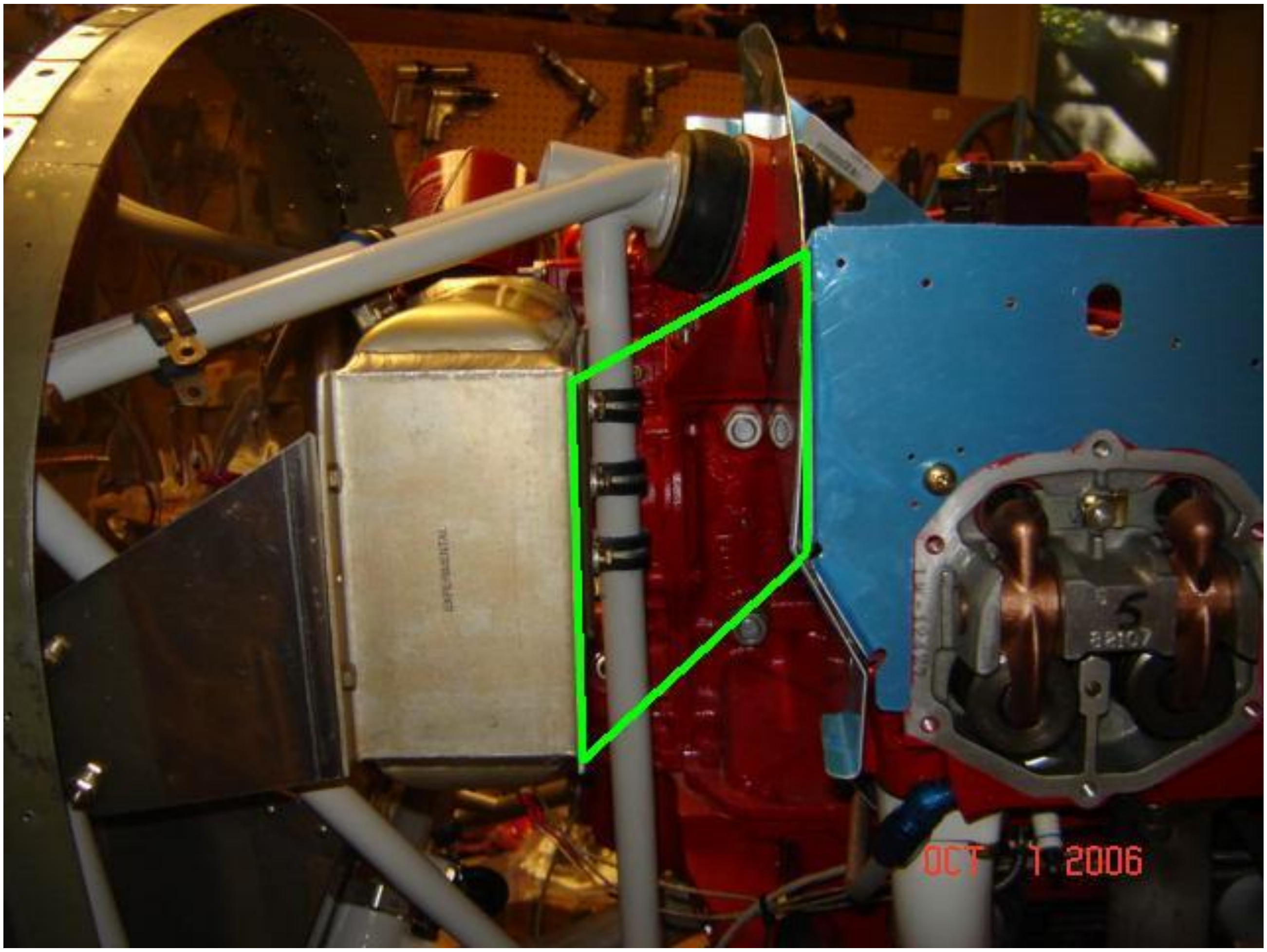


Note that in the test fit in the pic , the inboard Adel clamps are reversed from where then ended up. I turned them around and mounted them so that the oil cooler was closer to the baffling.

The template bracket still needs trimmed at the bottom, but I left it long for measurement purposes just to make it easy when I make the real bracket. Man, this setup is rigid, even with .032 material. The plan is to use .063 to make the outboard bracket.

Now for the duct work. Well, turns out I'm out of .020 and .025, so I made another order from Wicks. In the mean time, I did have a piece of .025 laying around that was large enough to make a faceplate for the air inlet side of the cooler. This faceplate covers the bolt hole flanges on the cooler AND it closes the small gap at the top and bottom of the face. The faceplate is about 7.25 inches square, with the center 6.25 inches cut out. Actually, I left a lip inside the faceplate of about 3/16 and bent it toward the fins and flanges of the cooler to help form an airtight seal around the face of the cooler. I think it will still need some RTV, but it'll be a pretty good seal all around once the cooler is bolted down to place (through the faceplate).

Now the big question is... will I get adequate airflow through the cooler with the jog down from the engine baffling? I asked the F1 builders group about my setup. I was told to make the flow very smooth, and uninterrupted as much as possible, and that if I was going to hang the cooler vertically, I should get it as close to the engine baffles as possible. It was recommended that I make a truss out of 3/8 steel brake line tubing, and put the cooler to within 1 inch or so of the baffling. I was also told that I didn't need to expose the entire cooler face to airflow.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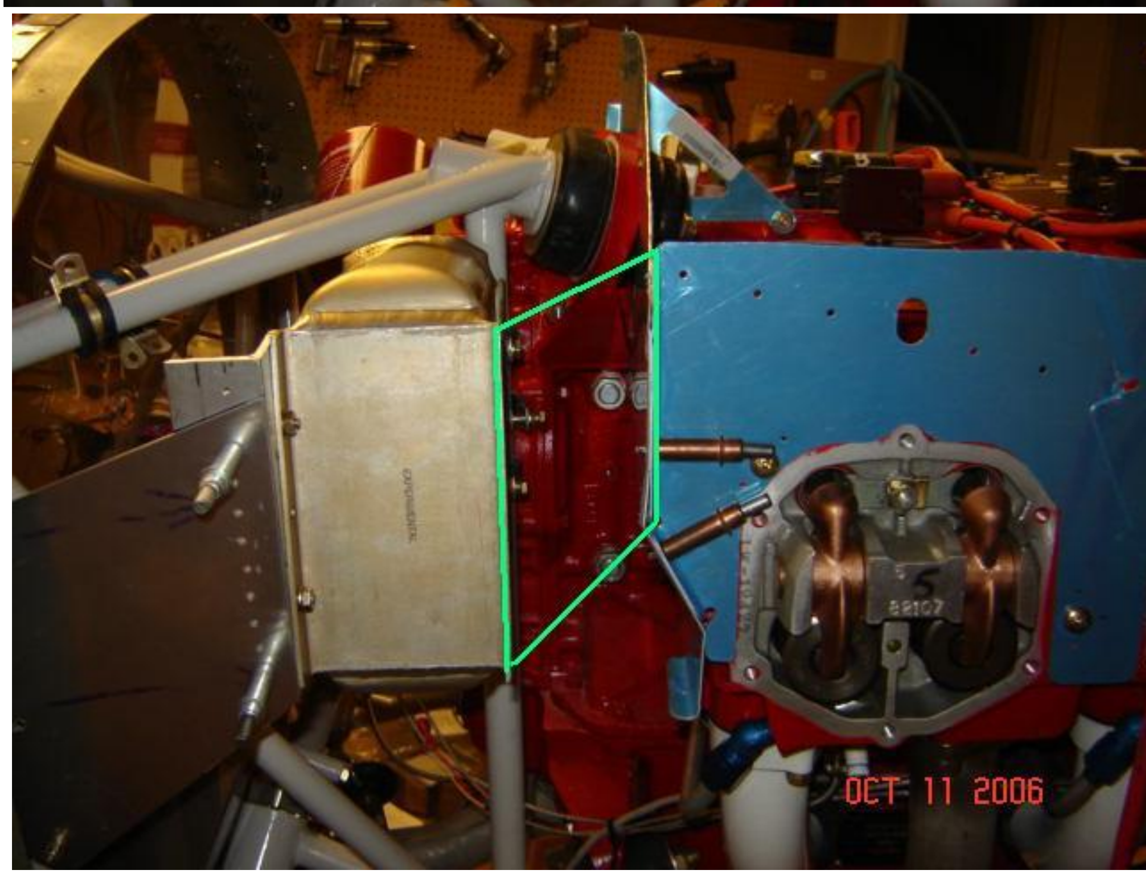
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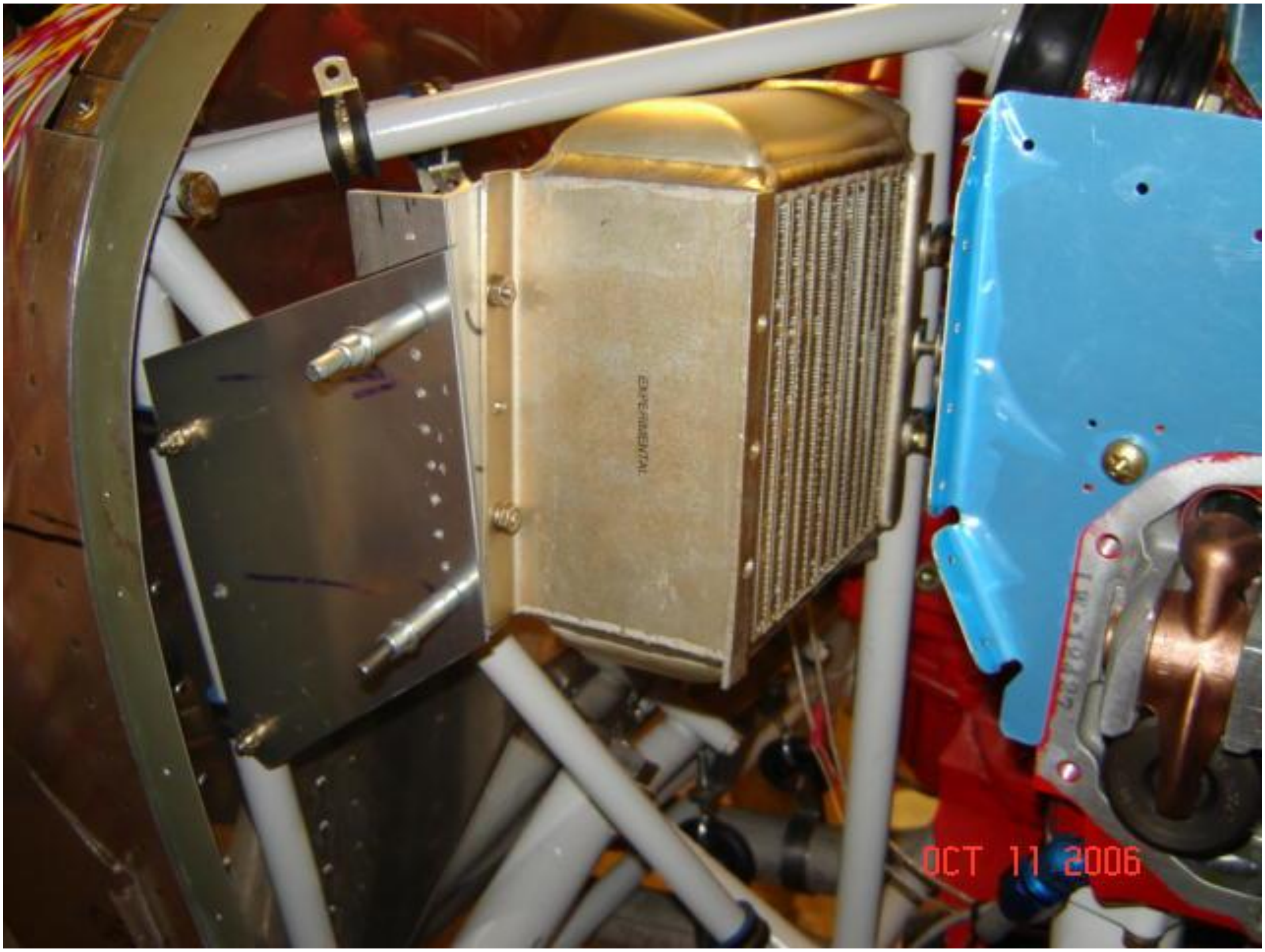
What I decided to do for now was to hang the cooler in the vertical manner as I had originally planned. The pic above shows the cooler with the Adel clamps facing aft. I reversed them and faced them forward. This made about 1 inch difference in how close the cooler was to the baffling. Now the cooler is just about 3 inches from the aft baffle. It also allowed me to bring the cooler up slightly. In service, there will barely be daylight between the cross member above and the cooler.



I had to remake the outboard cooler bracket. Based on my template, I needed at least 1.25 wide angle, but I didn't have any. So I used 1.5x1.5x.125 and cut it down. The angle sits on the face of the aft side cooler flange. It just isn't oriented parallel to the flange. It's actually sitting parallel to the engine mount down tube.

The pic to the left shows the large .063 plate which is drilled for 3 evenly spaced #14 Adel clamps. They are spaced wider than the AN3 bolt pattern on the cooler flange.

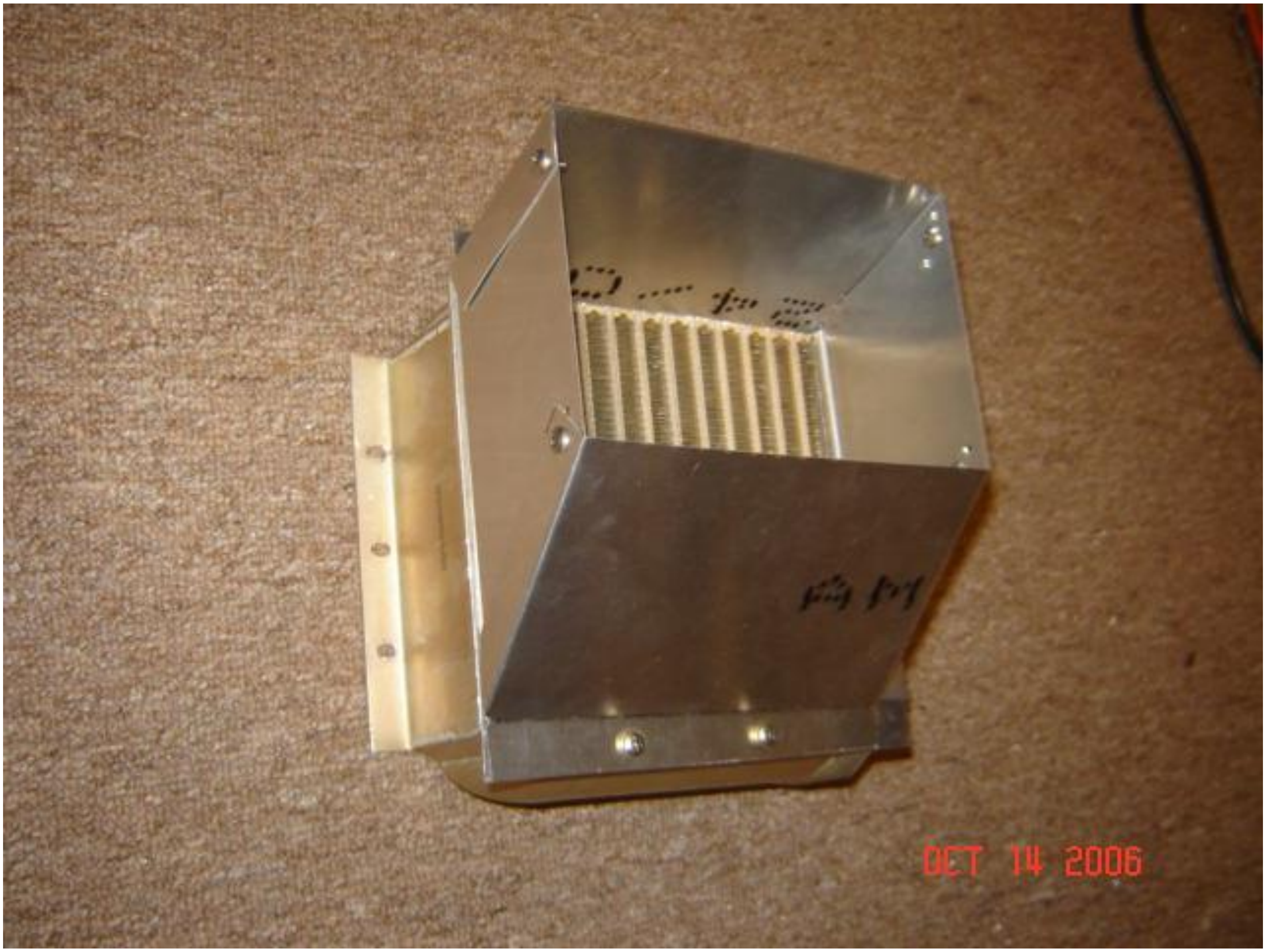
After I cut down the angle and dressed up the parts, I drilled the plate and angle to #30 and riveted them together with hard rivets at 1/2 inch spacing.

BTW, the pic shows a test fit. In service you absolutely have to have long AN3 bolts through *both sides* of the cooler flanges. Matter of fact, you should also sleeve the bolts between the flanges to give them extra support so that they are less likely to crack.

With this install, my hose fittings on the cooler and on the engine need to have 45 degree angles. I bought 4 of them from Summit Racing. The fittings need to be 3/8 NPT to -8 AN. The hose is going to be Aeroquip -8 AN "Socketless" hose and fittings. Aeroquip assures me that the grip of the socketless hose at the fitting is superior to the burst pressure of the hose.

I'm using Permatex Form-a-gasket #2 to assemble the NPT fittings. It's a good practice to keep the first thread clean so that no sealant material is introduced into the flow of the lines.

The oil cooler plenum was troublesome for me. On the order of many of the canopy procedures. After working with the whole concept and mounting the cooler canted a bit, I decided to square up the cooler in relation to the engine mount and aft engine baffles, then make a plenum out of .020 T6. I already had a faceplate made for the forward face of the cooler. Originally, I was going to make the plenum riveted to that faceplate. Since then, I'd decided I need to make this thing able to be completely disassembled, but it turns out that it is NOT necessary. I'll also decided to make the aft engine soft baffles for the cooler able to be disassembled.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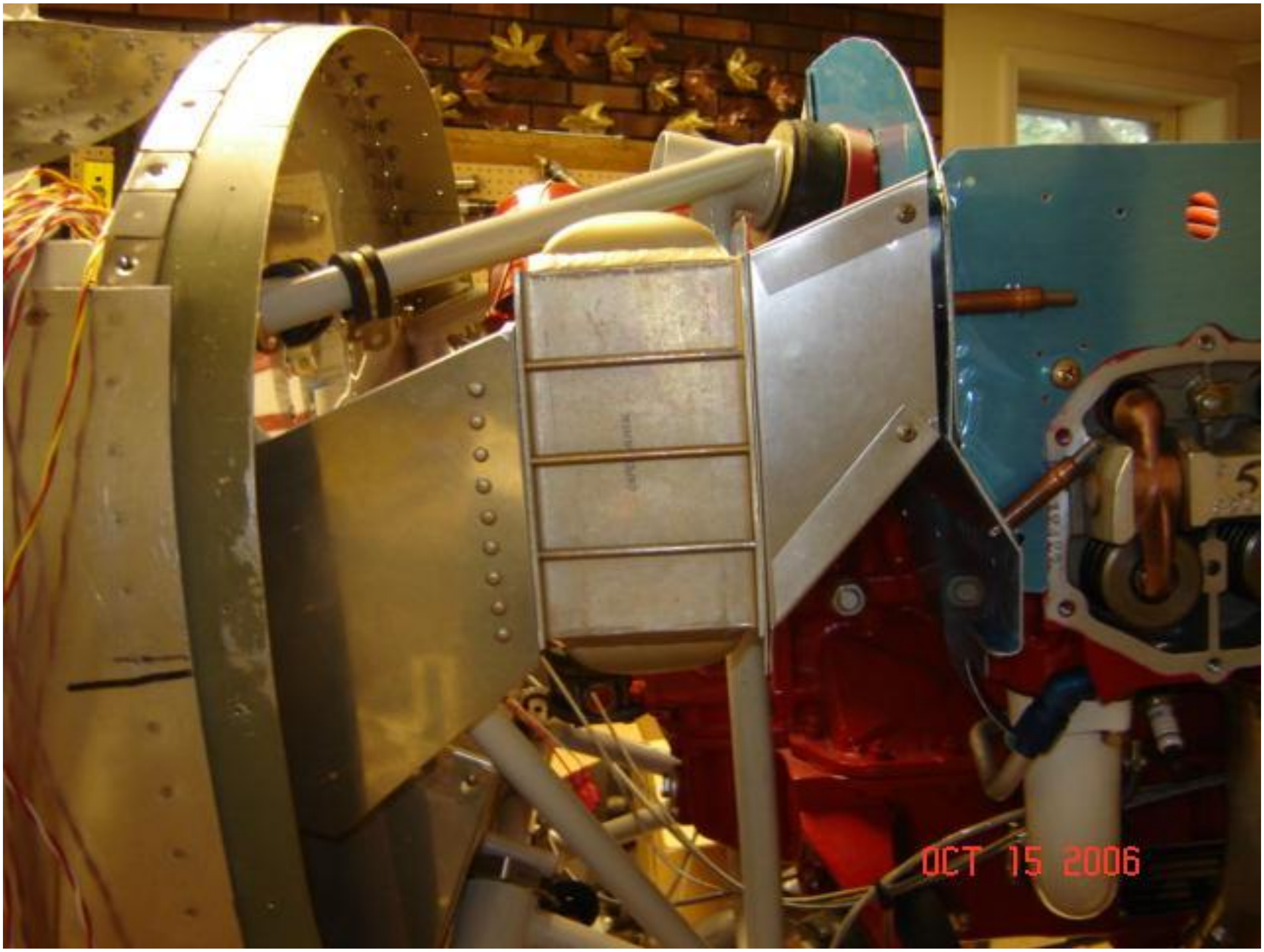


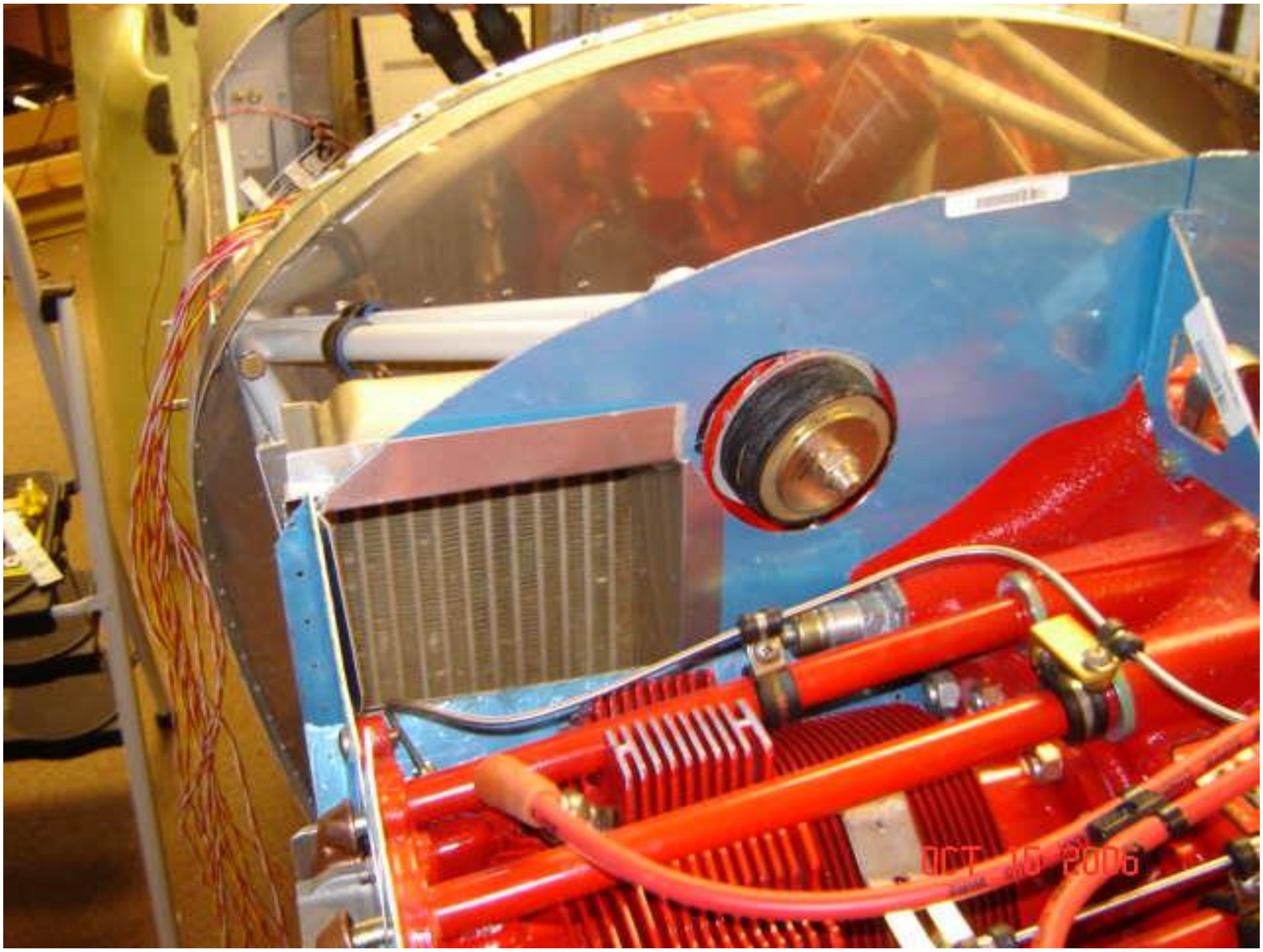
The opening to the plenum is about 4x6.25. I was shooting for more, but the top cowling and aft engine baffle limits how tall you can make the plenum, particularly at the outboard edge. And if you taper the inboard side up the "crown" of the aft baffle, well, the angle of the air going into the cooler plenum gets quite steep, perhaps enough to actually deter the airflow. Ideally, I wanted to make the top of the plenum completely up against the upper cowling. Indeed, I thought about not using soft baffles at the top of the aft baffle, and cutting it completely away.

I made the cooler plenum as wide as I could for the mounting location I chose. It is open completely from the side engine baffle to the engine mount ears on the engine. I have the maximum width you can get. The angle down to the lowest part of the cooling fins is VERY steep and may work against me, but the cooler is mounted as high on the engine mount as possible.... completely against the cross member. So I went ahead and used the lowest "flat" spot on the aft engine baffle as the lowest part for the soft baffles and angled the plenum from there to completely open the face at the bottom of the cooler (I've been told you don't have to have the entire cooling surface exposed to the airflow for it to do it's job. I'm using all the flat face of the aft baffle from the highest point along the outboard side down to where the baffle turns under the cylinder. In fact, when I construct the soft baffles, I may actually have to make a hard baffle to keep some of the air from getting to the cooler and keep it in the #5 cylinder. So the height and width is maxed out given the way I'm hanging the oil cooler.

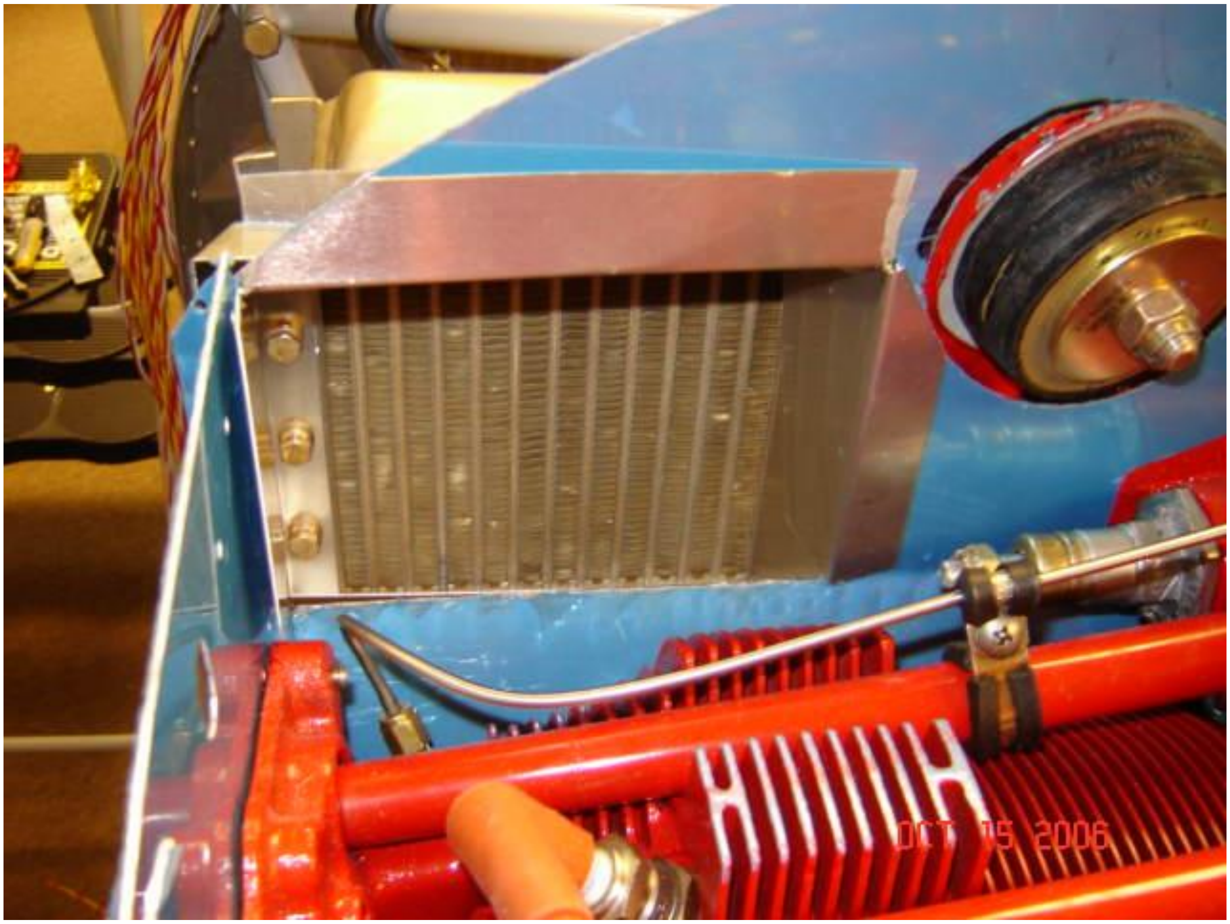
I chose to make the plenum square (actually rectangular) instead of my original idea which was to use the entire crown, or arch, of the aft baffle. I built the plenum so I can still do that if I need more airflow than I'm getting with my configuration. If I make that change, there won't be any soft baffles along the top of the engine baffle, and the top cap of the oil cooler plenum will be up against the top engine cowl. I don't think making that change will be necessary, and in fact might be a waste of time. I'll know aft my first couple flights.

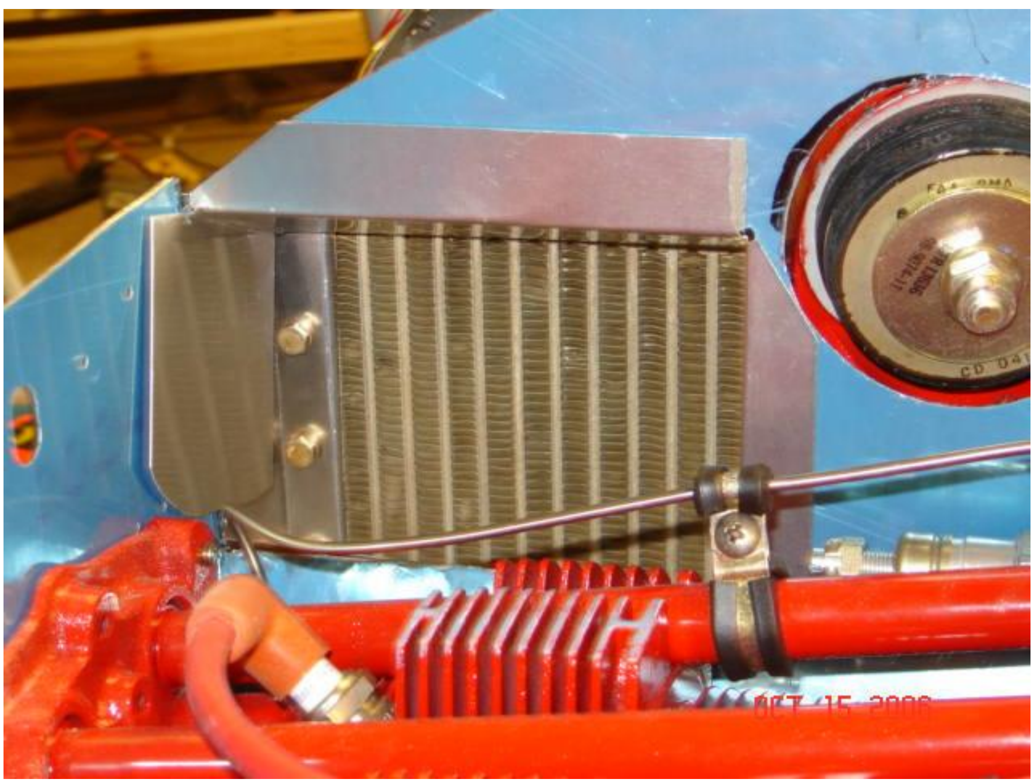
The soft baffles will sit deep inside the oil cooler plenum. They will be free to move with the engine inside the oil cooler plenum. I plan to keep the soft baffles tight inside the plenum, but I don't want any hard parts rubbing. Time to figure out how to insert the soft baffles...

Boy, this is getting about as bad as the canopy! I made two sets of 4 brackets to screw to the aft engine baffle and hold the soft baffle material inside the oil cooler plenum. Afterwards I decided to make a "bracket" to help tie the side baffle to the aft baffle around the engine. At the outboard (right) corner, the aft baffle curves down the side and gets very thin. So I thought maybe I could kill two birds with one stone by making a bracket that goes from the side, across the top and down the inboard side of the engine baffle. I started making it out of .032 and scrapped that really fast. Back to the new .020 material. EASY to work with. Strong enough to hold silicone baffle material as well as help hold the engine baffle intact.



In my setup, the outboard side cooler baffle is flat to the engine side baffle. It's a straight shot along the side into the plenum. That's why I put the outboard bolts inside the plenum, so I could come straight off the side and gain a little more airflow (hopefully). The top and inboard sides are angled just like you would imagine. And the whole thing sits in there at an angle due to the pitch down of the plenum to the face of the cooler. I ended up using a 10x4 piece of .020 and cutting and flanging it by hand. Took a lot of trimming to make it insertable into the aft baffle while in place on the engine. It will be screwed to place to aid in engine baffle and oil cooler removal.

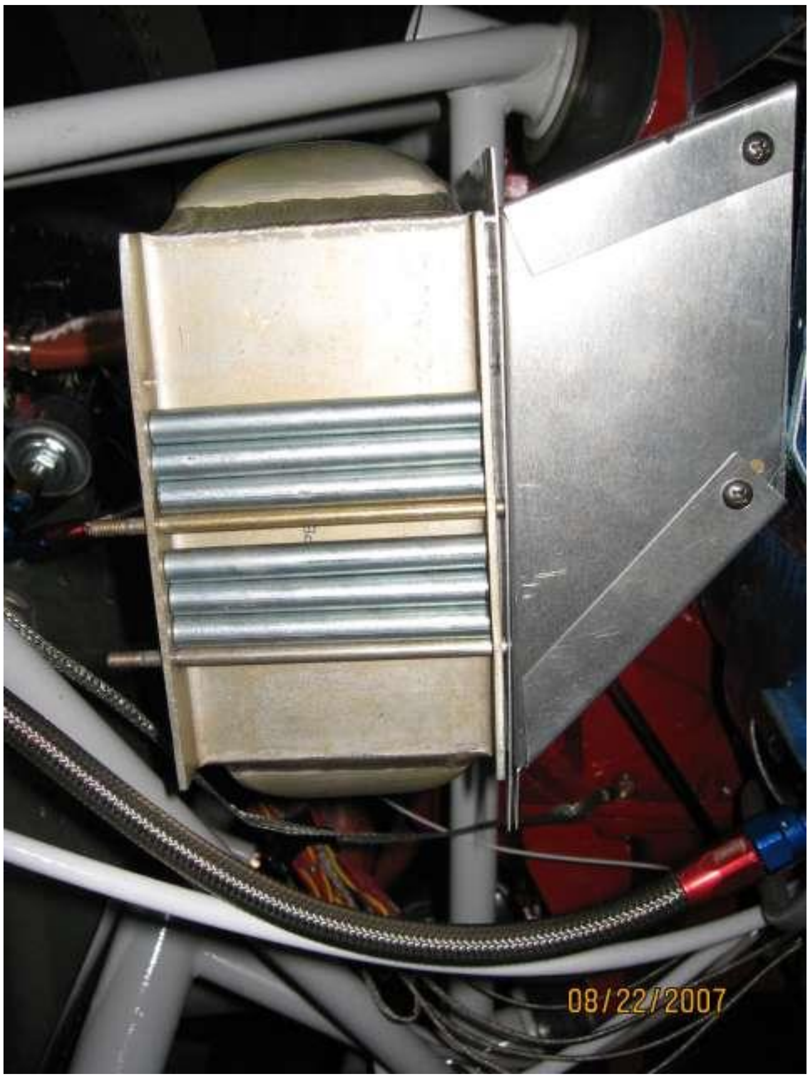




Now I have to attach the soft silicon baffle fabric to the bracket parts. Then drill them to place and install some screws. So far there is clearance between all the hard parts. Well see how it goes once I attach the soft baffle to the brackets. It's kinda close in there!

Months later, the fuselage is in the hangar and I'm heading for final assembly. Time to finalize the oil cooler install. For a while, it's just been hanging on 3 Adel clamps. Time to bolt up the support bracket and get the Adel clamps tightened down.

The 6 bolts that hold the oil cooler need some support the way I'm hanging it. The flanges on the Positech can be used as is if you bolt them to the front and the back. I'm hanging it by bolting THROUGH the front to the back, and from the back to the front. The flanges are aluminum, and they'll crack if you tighten the bolts too much. So at the suggestion of Mark at TR (and others), I got some 3/8 steel brake line tubing for semi trucks at NAPA, and cut 6 each tubing segments that are 3 3/8" long.

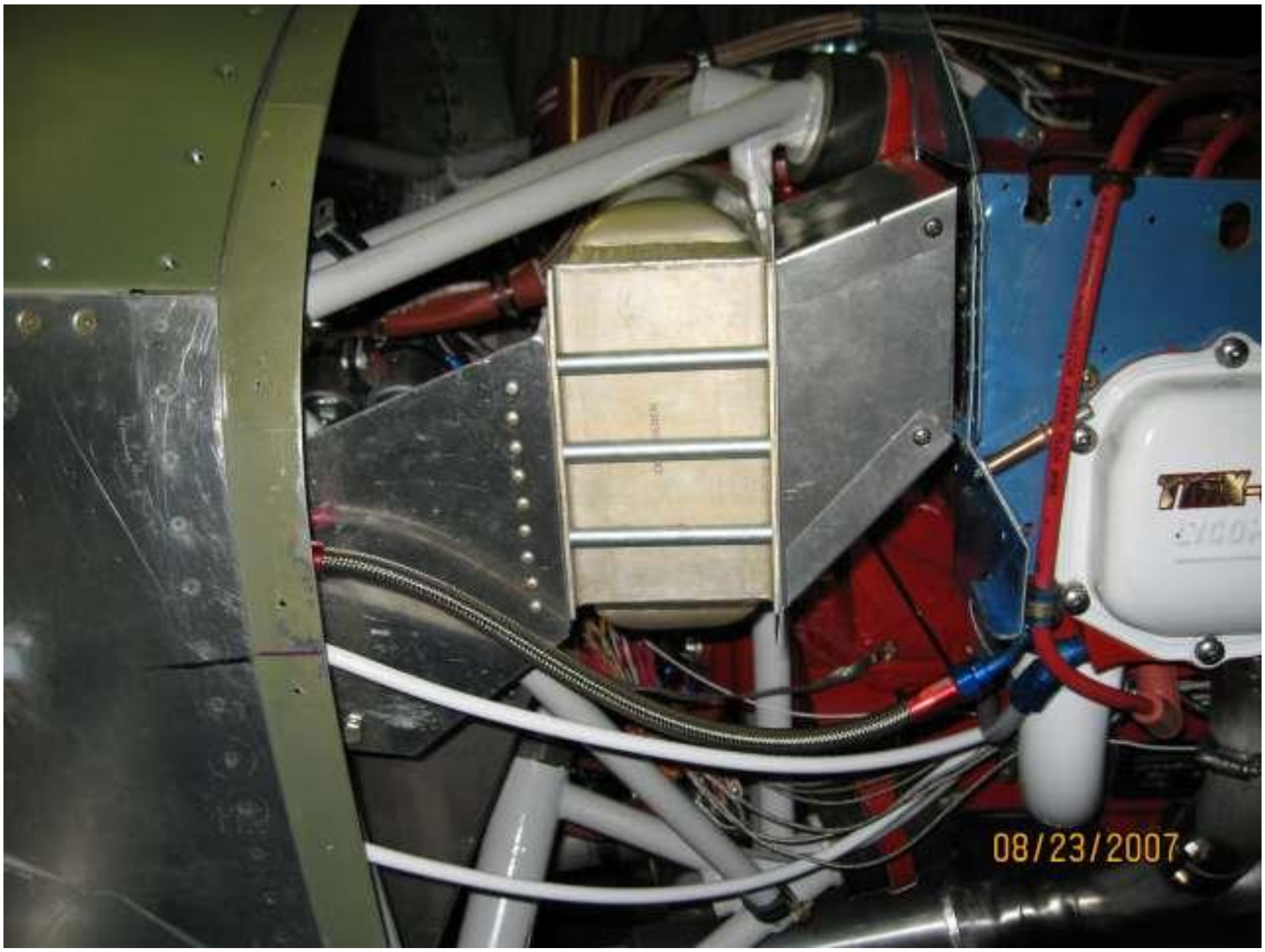


Originally, I was going to Rollo-Flare the ends to make the ends wider for additional support. They ended up flaring wider than a washer width, and I didn't want to reduce the size and more (got tired of hand filing), so I abandoned that idea. But I oversized them slightly, then dressed each one to sit flat and go between the flanges freely, but closely.

The pic at the left shows the 6 tubes sitting in place above 2 of the support bolts.

Time to take this all apart, insert the tubes and put the cooler in final position. When finished, the cooler will sit very close to the upper engine mount cross members, if not directly against them. I may also need to put at least one hangar above the cooler to stop it from sliding south on the Adel clamps. The cooler has to stay put to get the max cooling air from inside the baffles.

Hanging with Adel clamps was a bit of a bitch, but it worked, and the cooler is very secure with AN3 bolts, the mounting bracket/plate that I made, and 5 Adel clamps. I still may need to fabricate an additional hanger and an additional Adel cushion clamp, it just depends on whether or not the cooler slides south on the vertical tubes of the engine mount. I can't budge it, but a few hours of massive Lycosaurus shaking could send it south. If so, I'll make a vertical strip and connect it to the top horizontal engine mount tube that goes just over the top of the cooler.



Once the cooler was locked in, I went back to the baffles to try and finish that aft right corner. I didn't like the clearance between the oil cooler duct and the engine baffles. Two of the sides had about 3/8 to 1/2 inch clearance, and 2 sides were actually touching. So I'm going to bend up a new piece for the engine baffle oil cooler duct that allows more room for engine movement. I'll make those parts screw down to the baffle, then add the soft baffle material to seal between the two ducts. But for all intents and purposes, the oil cooler and it's hoses are finished. Later on, if I every have to remove the cooler, I'll probably cut some lightning holes in the big aluminum plate on the outboard bracket. I LIKE it!

Engine Hoses

Now that the exhaust and baffles are roughed in, I can start running the hoses and wires. A bit of a sticker shock (nothing new in building an airplane of this caliber) was that even though I bought and engine, and it came with one hose, I still need to buy over $500 worth of hoses. Part of this expense is brake line materials (I decided to go with stainless braid instead of nylon on the high pressure side).

Here's a break down of the engine hoses:

-4 AN from the FM200 controller to the flow divider. Mattituck provided one of these with fire sleeve. Regrettably, it's about 6 inches too long. I'm using it anyway. There is a purge valve on my Airflow Performance FI system, and that line is -4 AN. It has to go back through the firewall and be tapped into one of the fuel tank lines. The fuel pressure sensor needs a -4 AN hose from a special fitting on the mechanical fuel pump to the firewall. The manifold pressure and oil pressure sensors also need special fittings and a -4 AN hose to the firewall. The pressure side of the brake lines are also -4. I hope 20 feet of braided stainless steel -4 hose is going to be enough!

-6 AN Most of the fuel lines in the airframe are -6, or 3/8 aluminum. From the inflow of the fuel controller, back through the mechanical pump, back to the electric pump, tank valve and wing tanks, the lines are all -6 (dash 6, or 6/16, or 3/8 ID). Team Rocket provides a bunch of rigid lines that you can use, and the kit contains a bunch of AN fittings to work with it. *NOTE: The fittings into the mechanical fuel pump ports are actually -6 AN, and require special O ring fittings!*

-8 AN The oil cooler hoses are -8. The Positec 20006c takes 3/8 NPT fittings, and they should have -8 AN male ends to attach the oil cooler hoses.

I'm assembling my own hoses. Summit Racing has many high quality options for making your own flexible lines . That includes fuel lines. I opted to make my -6 fuel lines from braided stainless steel Summit racing hose and Aeroquip reusable fittings. I bought 20 feet of -6 braided hose (and 20 feet of -4 braided hose for the brakes, fuel purge, manifold, fuel and oil pressure lines), and then put together a list of fittings to get to either side of the firewall. I also bought about 6 feet of fire sleeve in -6 (and -4) AN to protect the fuel lines. I'll use stainless band clamps over the ends of the fire sleeve.

For the engine ***Oil Cooler Lines***, I chose to use Aeroquip's Socketless -8 AN hose and -8 AN fittings. I went ahead and bought the tool to help stick the oil cooler hose over the socketless (hose barb) fittings, although I'm sure I could just have manhandled them together. I emailed Aeroquip and asked about the strength of the hose/fitting connection. Aeroquip replied that the hose itself will fail before it would ever pop off or leak at the fitting. The oil cooler hoses are pretty straight forward. One hose from the engine to the cooler, and another hose from the cooler to the engine. I don't think it matters much which one goes where, so I'm just hooking them up however it is convenient. I did buy 45 degree fittings that a re 3/8 NPT to -8 AN for all four ends of the hoses.

The engine ***Fuel Lines*** are a little trickier. From the Top (output) of the AP FM200 controller, you need a -4 AN hose to make an immediate 90 degree bend, then run up through the lower cylinder baffles and in between the cylinders to the purge valve (if you have one) inflow and to the flow divider (spider). Then you have to have a -6 hose with AN fittings from the top front of the FM200 controller and run along the sump screws (under the intake tubes) all the way back to the left side of the mechanical fuel pump. That will probably require a 45 degree fitting on the hose. ***Both sides of the mechanical fuel pump require special -6 AN filltings!!!*** From the right side of the fuel pump, you run a fire sleeved -6 AN to the firewall. From the aft side of the firewall, you run a flexible line back to the electric fuel pump. Somewhere in there I have to tap in for a fuel pressure sensor (after the mech pump) and put my 3/8 NPT fuel flow turbine type sensor

My Mattituck TMX540 engine came with the AP system installed. I paid extra for a ***purge valve***, although I don't think I need it in service. So I have to also run an additional -4 AN from the purge valve, curve it down through the cylinders (or go over the top), through the baffles, then to an additional -4 AN bulkhead fitting. From there, another flexible line has to go back and "T" into one of the tank lines (aft of the tank selector valve).

Mark Frederick recommends Permatex Form-A-Gasket #2 for all fittings, and consistently recommends ***never using Teflon tape*** on engine fittings.

When my 1st Summit Racing order arrived, I found out that I had next to NONE of the proper engine oil cooler fittings. Major bummer. I bought 1/2 NPT fittings to -8 AN *(WRONG!!!)* and it turns out that they are WAY too large. Looks like the oil cooler ports need 3/8 NPT to -8 fittings.


Oil Filter
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In the first picture, the red plug at the arrow is for oil going to the cooler. It requires a 3/8 NPT fitting, and needs to make an immediate 45 degree turn to get around the filter. In fact, when I hook the fitting up, I actually will have to remove the filter. I hope I don't have to remove the housing, too.

The second picture has an arrow pointing to where the tach cable goes into a 7/8 fitting. I bought a special cap for that nipple, since I won't have a mechanical tach.

At the bottom of the 2nd pic, the plug in the green circle is for oil return to the engine from the cooler, and that takes a 3/8 NPT fitting. For ease of hanging a hose, I will use a 45 degree fitting here, too.

Fuel Pump Hoses

I started with the -6 AN hoses because they are less flexible than -4 AN hoses. I'm trying to work with the hardest to install first and easiest last (wiring).

The mechanical fuel pump requires special fittings with O ring gaskets (available at Vans). I used a 90 degree fitting on the outlet side because it has a built in port to tap off a fuel pressure line. On the inlet side I used a straight fitting. Both are steel, and it is recommended that all fuel line fittings in the engine compartment be steel to resist melting in case of fire.

I had my fuel lines laid out in the cabin pretty well, and chose to penetrate the firewall in the center at a low point. The fuel inlet line ended up having about 10 inches of hose plus the fittings. I used straight on one end, and a 60º fitting on the other.


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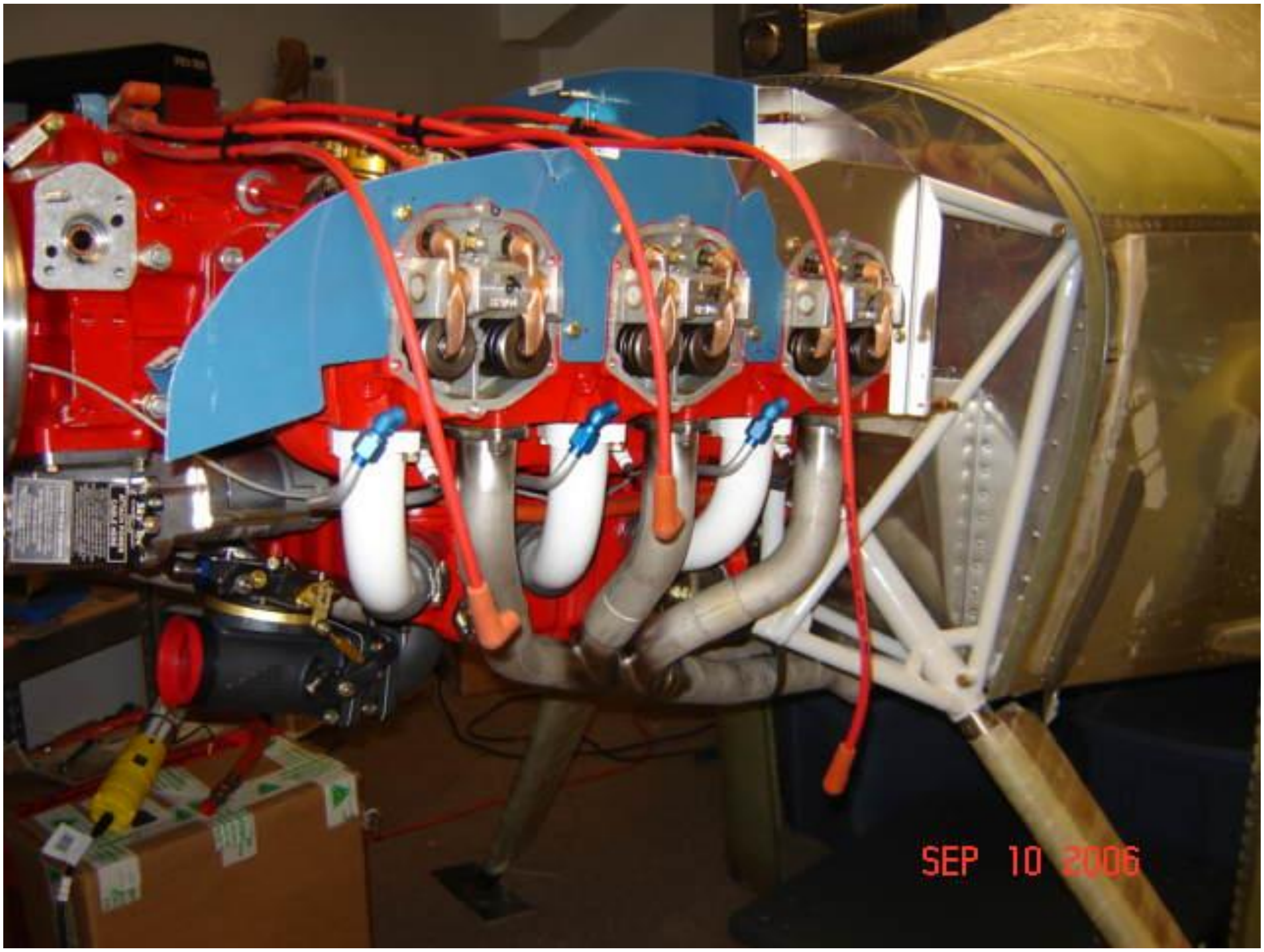
I made the mistake of making the 2 ***oil cooler hoses*** out of Aeroquip "Socketless" hose and fittings, thinking they'd be easy to work with. The hose seems very durable, and the ratings are much higher that what I require. The fittings are beautiful -8 AN fittings with barbed ends. I bought a special wrench to aid in assembly of these hoses. That was a waste of money because it's only good for straight fittings, of which I used one. I had to manhandle the other hose end fittings, and it was a major bitch. Even with Summit assembly oil, it took as much effort as I could muster to push/twist the hose onto the barbs. I won't use this system again.

Spark Plug/Wires

The LSE Plasma III system has coils that mount to the top of the engine (or elsewhere) and use spark plug terminals. The system came from Mattituck already bolted up with the plugs and wires in place. The plugs are automotive style plugs (14mm) in aircraft engine type plug hole adapters (18mm). That pretty much makes the $2 plugs "throw aways". Also, the plugs and wires have the normal automotive snap connector terminals and caps.

The wires sure looked pretty when I opened the crate. I was, however, a bit concerned about the length of the wires going to the bottom plugs. Some of them are WAY too long, perhaps as much as 6 - 8 inches. One or two are too short. YIKES! So I've contacted Mattituck to see about swapping those wires out. On most magneto fired engines, the wires come all the way from the rear of the engine. On the Plasma III, they only come down from the coils at the top center of the engine, then go on a short and rather direct route through the baffle, around the valve cover and to the bottom plug. I think I need shorter wires....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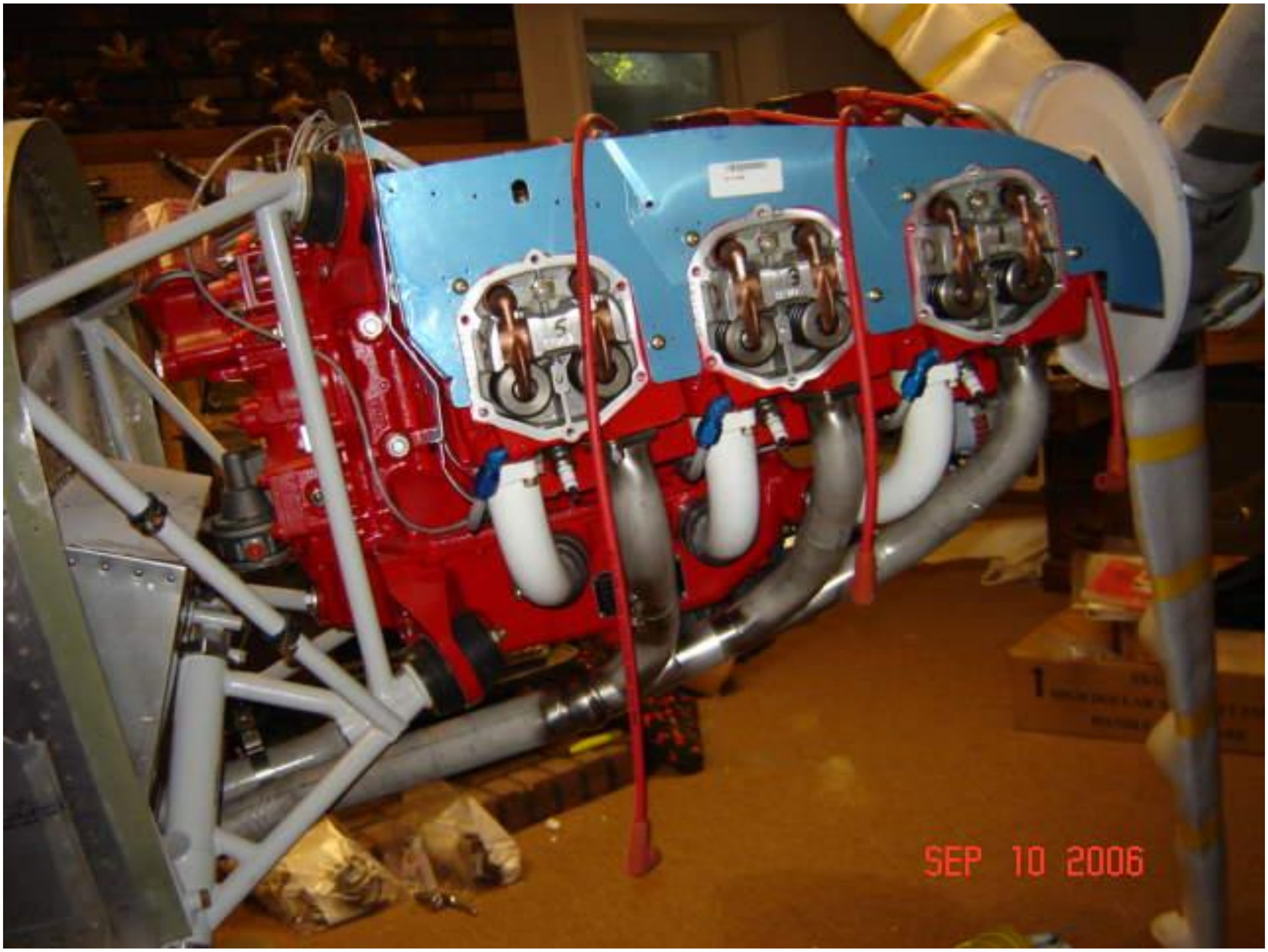


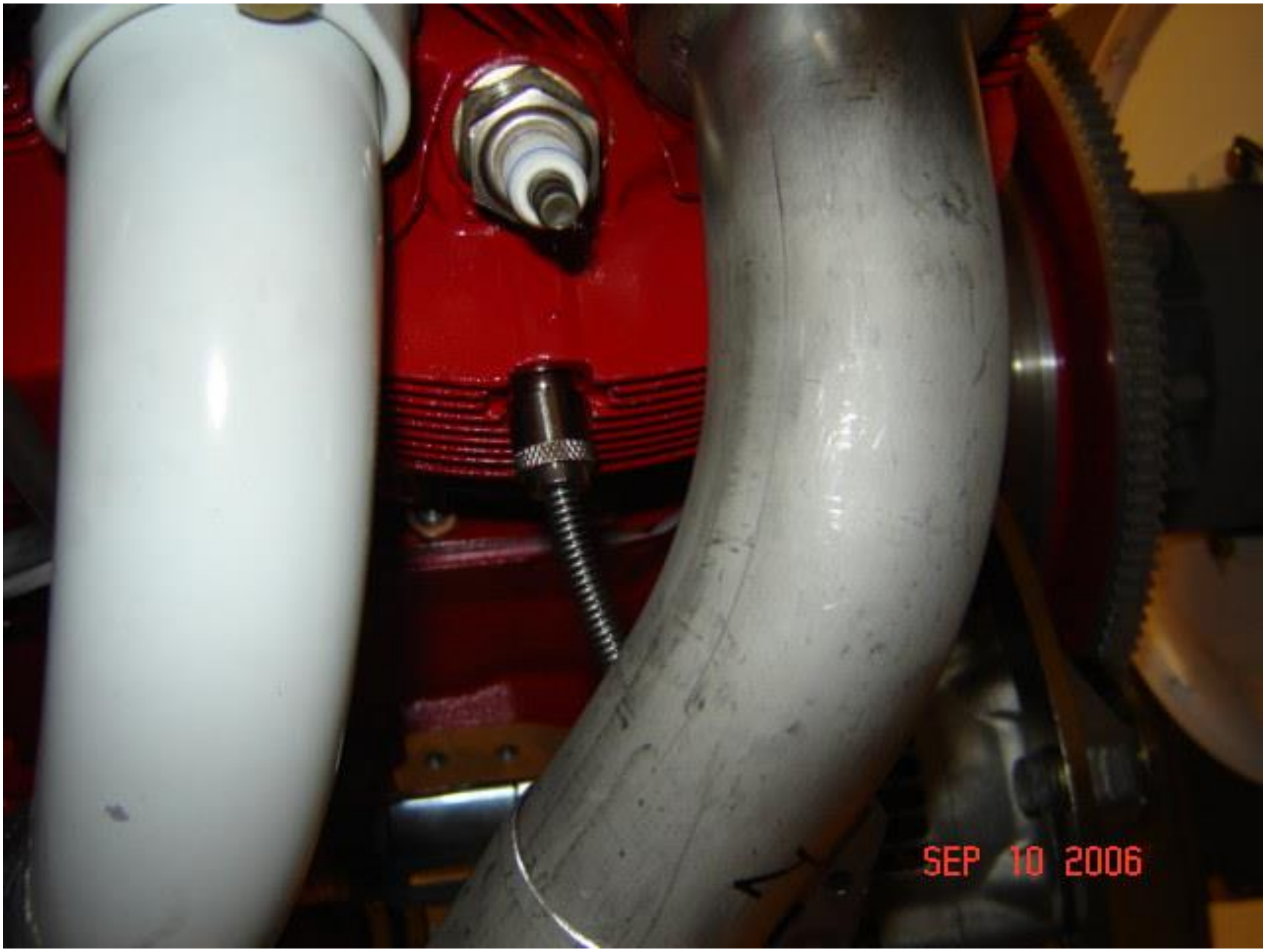
What I didn't know is that these spark plug wires are not molded and can be modified. The caps just pull off. So rather than mess around with going back and forth between Mattituck and Klaus Savier, I decided to just buy some 8.5 mm super conductor components from Summit Racing and make/modify my own spark plug wires.

A nice package of wires promptly came FEDEX from Summit. I ordered 2 replacement wires that are 50 inches in length with a spark plug cap on one end and distributor cap on the other. These babies are pristine, and have extra high temp and strength racing caps. The new MSD wires make the ones I got from Mattituck look like crap. The MSD wires from Mattituck look like they'd been sitting around for a long time. They actually looked somewhat used. Not in bad shape, just not as pretty as you would expect on a new engine that cost this much. Anyway, I bought a package of MSD replacement caps and double crimp terminals as well. The replacement wires also came with replacement terminals and a crimping tool (one of the reasons I bought a replacement wire instead of bulk wire).

I pulled apart one wire and stuck the cap on the spark plug. I then routed the wire and screwed it down with an Adel clamp. I gave the wire about 1 inch or so of slack, just in case. Then I went ahead and cut the wire to length. Cutting and crimping the wire was VERY easy. You do need a set of needle nose pliers and a vice. I slathered the inside of the cap and the wire/termianl with some dielectric grease and slipped the parts back together. Ahhhh, very nice! Now before going any farther, I need to go back and finalized the baffles.

CHT Probes

My Grand Rapids Technology EFIS came with CHT probes. Well, actually they came with the engine monitor. At any rate, the GRT installation manual has lots of "aircraft" parts, but no instructions how to install them. Now, as I have said many times before, for most of you, a lot of this would be straight forward. But for me, this stuff is kinda tricky. So I emailed Mark Frederick again to ask if I was putting the CHT probes in the correct location, which I think is just inboard of the bottom spark plug.



The CHT probe is a nifty unit. Simply, it is a thermocouple type bayonet probe with a spring sleeve. You thread a receptacle into the cylinder at the head and then you spin the locking collar up the spring on the wire. When you can barely get the pin on the collar into the detent, you lock the collar onto the receptacle and that holds the bayonet against the deep inner part of the cylinder head.

EGT Probes

The Grand Rapids Technology engine monitoring system can be purchased with their EGT bayonet type probles. It makes sense to buy them from GRT because they are already wired to mate with the GRT engine monitor.

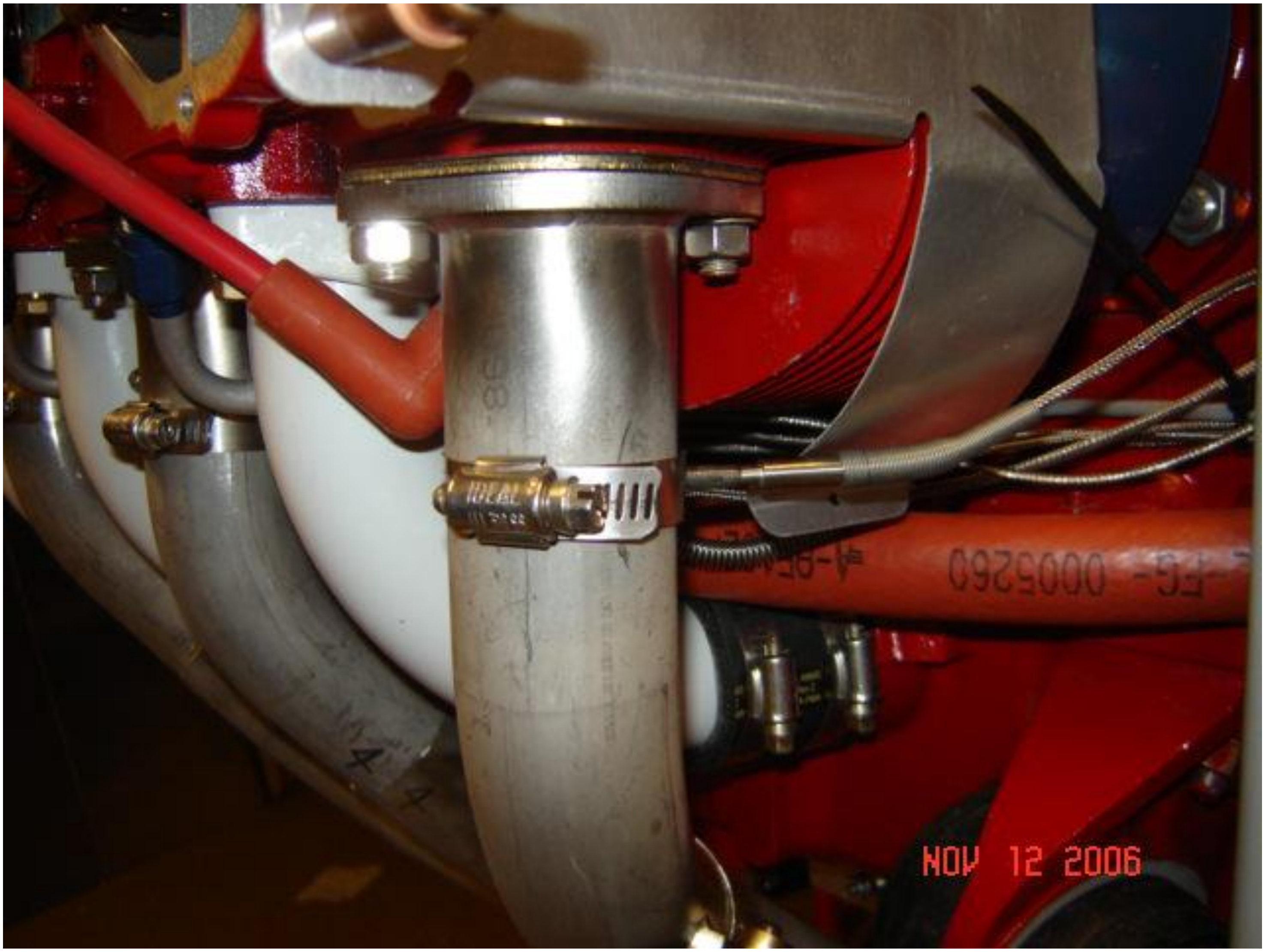
I bought an exhaust system from another F1 builder who got the system from Team Rocket. Mark gets the systems direct from Vetterman. There is no accommodation for the probes, nor is there any information in the manual. I gather that the important task is to make the #30 holes in the exhaust so that the probes are not near the spark plugs or going to interfere with anything. Most importantly, they all need to be equidistant from the mounting flange so that they read the gases from a similar distance from the exhaust valves.

Mark suggests 1.5 inches down for the probes. I surveyed the exhaust flanges, stacks and cylinders and made my own decision. I want to keep the probes, easy to service (relatively) and away from the curve at the bottom of the stacks.

My measurements make the best location at 2 inches down from the flange. That clears the plugs and their wires, the lower baffles, the bottom of the cylinders, and the oil lines to the cylinders. That puts the probe at the very start of the bends on the front exhaust stacks. I wonder how much cooler they will read being at 2 inches down versus 1 inch down? Well, it's all relative, according to Einstein.

On the left side of the engine, the spark plugs are in front of the exhaust, so it's easier to get the probes in and run the wires aft. I'm choosing to put the probes in at about the 4 - 5 o'clock position in order to clear everything. On the right side, the probes pretty much have to penetrate directly in perpendicular to the long axis of the plane. The probes will sit a the 9 o'clock position (the nose/spinner being 12 o'clock). The mounting of these probes on both sides kind of suck because the stainless worm bands that hold them in position will have to screw down from the INSIDE. That pretty much means I'm going to have to drop the exhaust any time I have to contend with a bad probe. Which has happened more than once in my short tenure as a pilot.

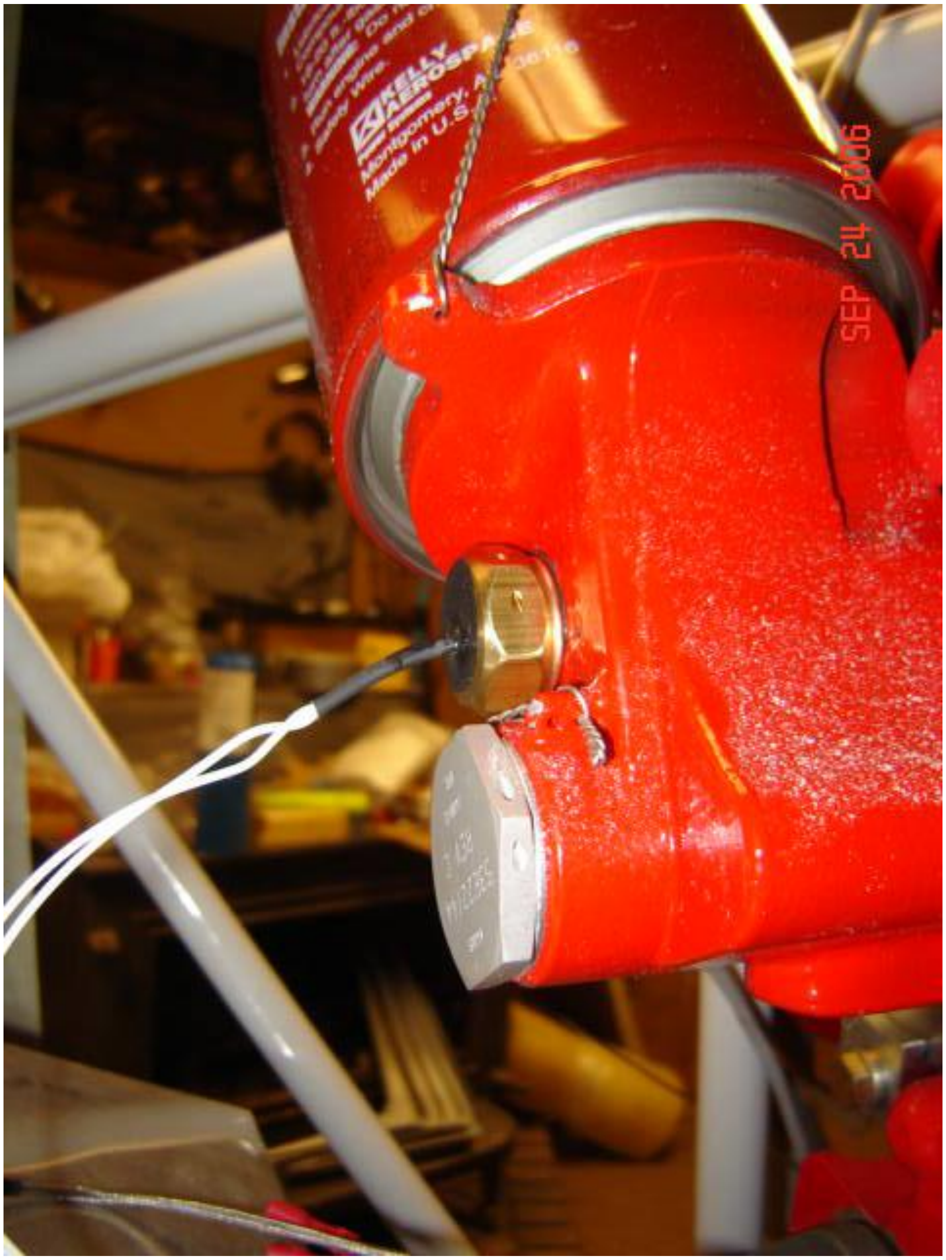
The only real trouble I had on this installation was interference on the #2 and #4 cylinders. I drilled those holes just a wee bit too far north on the stacks, and the probes got in the way of the oil lines to the cylinder heads. The rest of the install was pretty straight forward.



You can really see the probe on the #6 cylinder. There won't be anything behind it to interfere with it, once the cylinder baffle is tied back. I installed all of the probes from the back side so that they essentially wire out along with the CHT's. Man, there's two wires per each pair of probes on each cylinder. That makes a big bundle of heavy gauge CHT and EGT wires going through the firewall.

Oil Temp Sensor

The GRT engine monitor also came with an engine oil temperature sensor. My Mattituck engine, however, came with little to no instructions other than a Lycoming operators manual. Since the engine came with a funky spin on filter attachment, there wasn't any sensor housing in the normal location. There was a small cap closing a port, so I ASSumed it was for the temp sensor.



Team Rocket now has started a forum based information system instead of an email list. Mark hope to get away from emails so much and be able to have a common area for information storage. Also, a lot of the other 150+ builders can also share their opinions and methods there as well. So I put the question about my sensor location to the forum. Soon as I see confirmation on the forum, I'll crank the sensor down, safety wire it, and hook it up.

Remote Sensor Manifold

***Note: I"m not using this. Want to buy it from me?

If you are building a kit plane, better get used to ordering from Vans RV. Here is certainly a place where you really have to order from them, unless you know exactly what you need and are exceptionally handy. Well, I decided to keep it simple and just order the stuff from Vans. You don't have to use these manifolds, and in fact, I may not use one. But I thought I'd show it, regardless.

You have three choices for the remote manifold, and you have 3 1/4 NPT ports for each line. Typically, you bring the feeder line up from the bottom and then the sensor threads in at the front, and you just thread a plug into the top hole.

If you remote mount a sensor, preferably away from the harsh shake of the engine, you need to use a restrictor in the line. Simply put, if you get a leak in one of the lines with the restrictor in the fitting (on the engine side of the line) , you will be less likely to cause a fire or run out of fluid as quickly.

Also, it looks like it might be tough to get a line to the manifold from the bottom port with the unit bolted to the firewall. I'm either going to have to make a spacer for behind the manifold, or use a 45 degree angled fitting. Aha! The restrictor fittings from Vans are 45 degrees, so more than likely they go right under the sensor.

<u>Restrictors on Sensors</u>

The sensors for oil pressure, fuel pressure and manifold pressure require restriction. Vans and Aircraft Spuce sell premade restrictor fittings. Another option is to pup a rivet into a fitting and then drill a very small center hole. A restrictor hole reduces the fluctuation of pressure and helps keep those gauges from bouncing all over the place. Nice to know, even though I don't remember ever reading that information or getting it from the instrument suppliers.

Oil Pressure Sensor

The oil pressure sensor, as well as the fuel pressure sensor should be remotely mounted off of the engine. The remote mounted sensors are going to be subjected to a lot less vibration and fatigue (theoretically) on the firewall than on the engine. Vans sells a manifold that you can mount on the firewall that will accept 1/4 NPT fittings. You tap the source at the engine with a restrictive fitting (also available at Vans, or you can make them) and run a hose to the manifold. From there, you can just run the wires through the firewall.

Again, the TMX didn't have an over abundance of information, so based on the Lycoming operators manual, I surmised that the oil pressure ports (blocked with a plug) were on the right side of the engine just above the magneto cap.

It's hard to tell by the image above, but there are two plugs inside the pressure ports (according to the Lyc manual).Either of the two plugged holes will accept a restrictive type fitting suitable for a -4 AN hose.

I didn't have an Adel clamp large enough to hang this sensor on the firewall. Originally, I was going to use Vans' sensor manifold, but through it just took up too much space. I only have 2 fluid sensors to mount, not three like on the manifold anyway. I decided to use Adel clamps (made one of my own) and hang the sensors on existing screw holes. I made an Adel clamp/bracket for the oil pressure sensor with 2 layers of 1 inch wide silicone baffle material, and a 1 inch strip of .032 scrap. The scrap was about 10 inches long when I started, and by the time I trimmed it, I think it would be closer to about 8 inches.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The oil pressure sensor has a large lip around the outside, and the baffle layers are more for spacing than for shock absorption. There is a flat area on the sensor, and I tried to get that to the flat spot on the back of the clamp. My little apricot colored shadow "indy" was there helping me, while my fat grey shadow "Belle" was snoring over on the couch.


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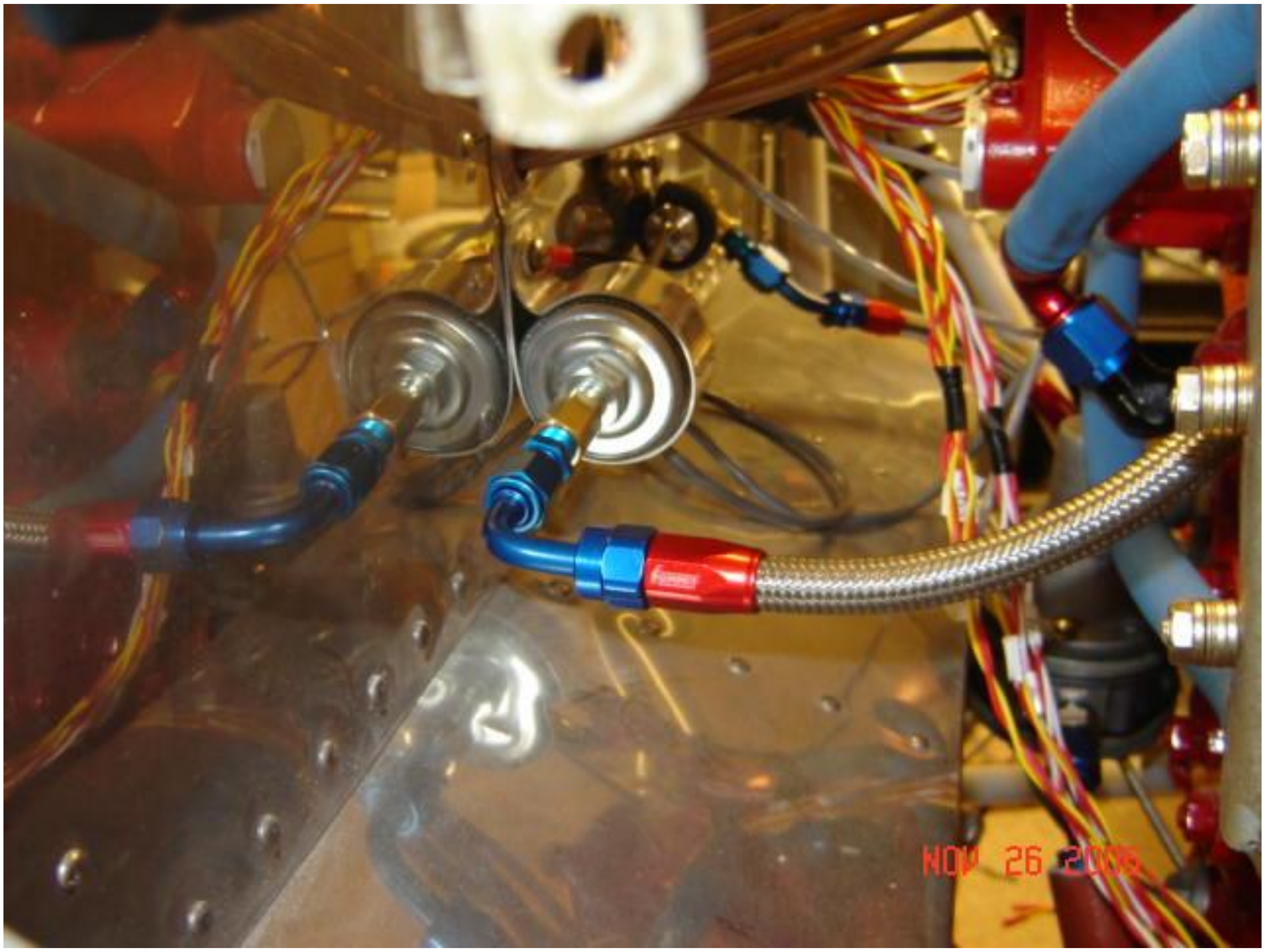


The oil pressure sensor hose comes from a port next to the right mag hold down bolt. I had to remove the hold down to get a 45° restricted flow fitting in there. Sealed with #2 Formagasket. A -4 AN 45° Summit Racing reusable swivel hose end fitting leads to the stainless braided hose, then a 90° fitting on the other end into a straight -4 AN fitting mated to the oil pressure sensor by a brass coupler. I probably won't use fire sleeve on this line, unless I happen to have extra laying around. It's too expensive to have extra, and too expensive not to use if you do have it.

The oil pressure sensor has to have the case grounded. There's no accommodation for this easily the way I have the senor mounted because it's attached with the silicone. So I soldered a ground wire to the body of the sensor and crimped on a ring connector. The ground is to the bracket screw. The firewall is a decent ground.

Fuel Pressure Sensor

The fuel pressure sensor that GRT sells is a nice little MSI pressure transducer. It has 1/4 NPT fitting that should be mounted remotely to a manifold on the firewall. Vans sells the manifold and restrictive fittings, as well as SPECIAL FITTINGS FOR THE FUEL PUMP!

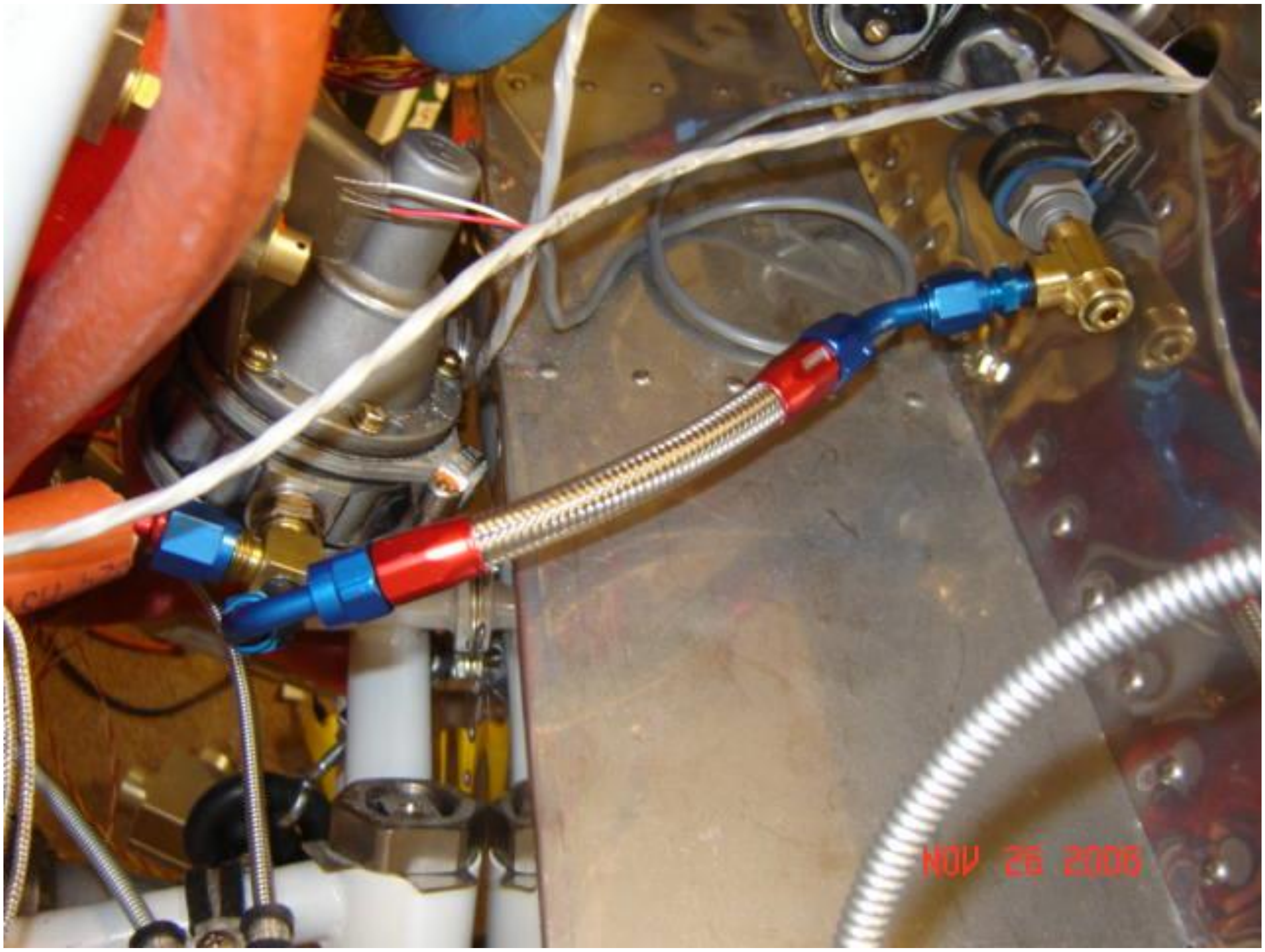
Mark recommends that you tap directly into a fitting just forward of the mechanical fuel pump output (left side). Vans also sells a fuel pump fitting Tee specifically for branching off a -4 AN line (actually 1/4 NPT at the Tee) to the remote manifold. Regrettably, this means about another 2 foot of hose and fire sleeve. The money is just adding up.

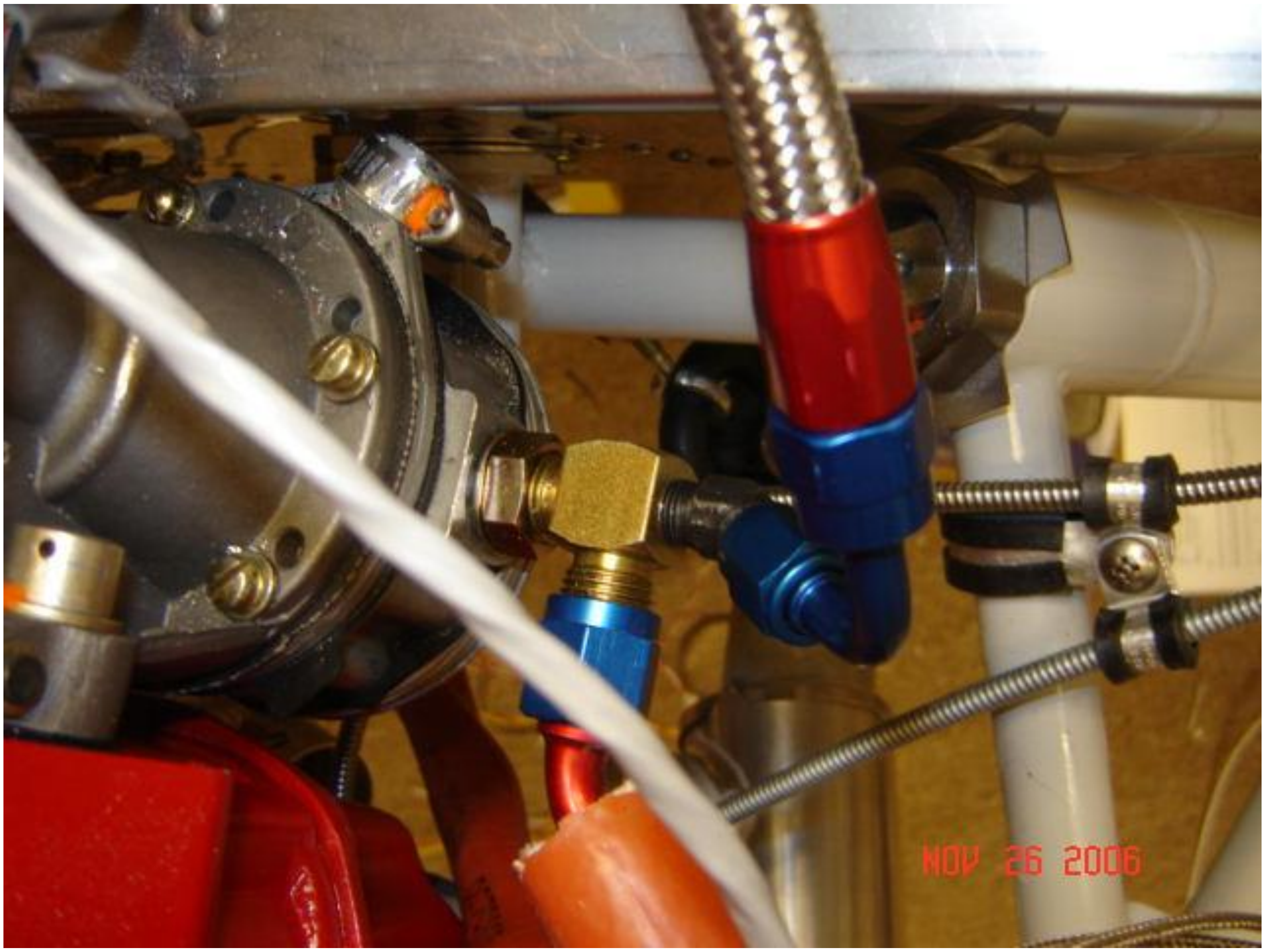
A #12 Adel clamp is about perfect for this sensor as a bracket. I used an hole I had already drilled for the grommet shields for the sensor wire firewall pass through to hang the sensor. That screw also holds the avionics tray on the other side of the firewall.

I used a tee fitting off the 1/8 NPT threads because I had it laying around. I plugged the unused end and sealed the parts together with a straight -4 AN to NPT male adapter. A 45° Summit Racing reusable swivel hose fitting mates from the sensor fittings and the stainless braided hose ends up with a 90° swivel hose end to a 45° flow restricted -4 AN to 1/8 NPT adapter (from Vans).

The restricted fitting fits into a special fuel pump fitting from Vans. The threads on the fuel pump are "straight", not tapered (NPT). The Vans fitting has a O ring to seal, a port just for the sensor and a -6 AN male end for the outflow fuel line hose. Very nice.

I'm not crazy about the immediate right angle turn in the fuel pump fitting, but there really wasn't much choice. I could have made two hoses instead of one from the pump to the fuel controller, then spliced in a tee for the sensor hose. I thought that would be more chances for leak and failure, and a bunch more money. I figure Vans knows whether or not the setup works, and wouldn't sell the part if the fitting caused a flow problem. The opening inside the fitting is cavernous, so there is lots of room for fuel to make the 90° turn inside the fitting. It's a done deal.

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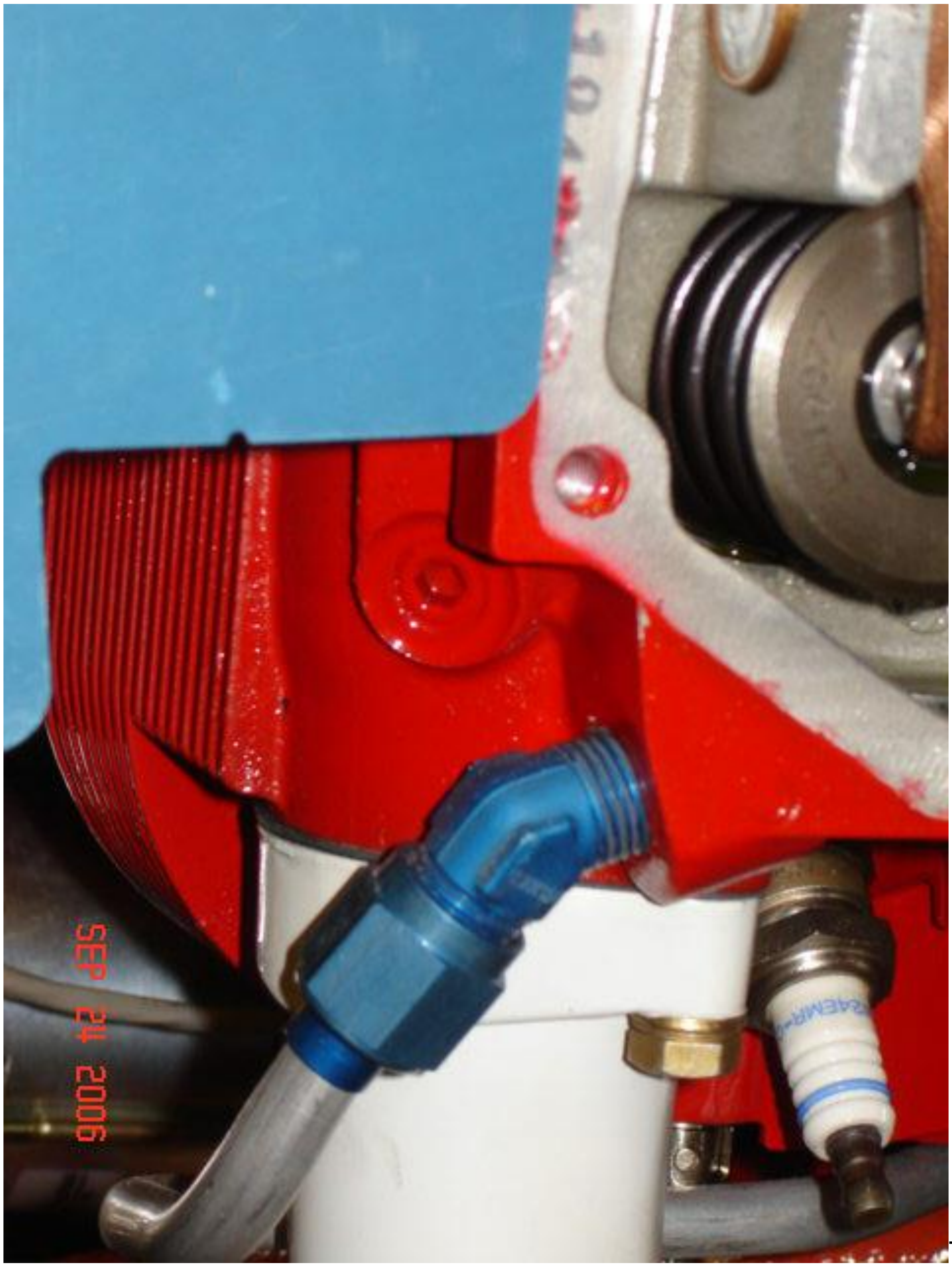
Manifold Pressure Sensor



The engine monitor and the EFIS system relies on accurate manifold pressure information. GRT sent a MAP sensor with the system. Now I have to figure out how to hook THAT up. The Lycoming operators manual suggests that you use the port near the intake tube flange on the #1 cylinder. Hopefully that just tells you where A port is, not where THE port is. It would make much more sense to tap into the intake system at the #5 cylinder. That would point the fitting aft and get it a lot closer to the firewall.

The GRT MP sensor unit appears pretty chintzy. The thing is almost all plastic. The nipple on the end of the unit has no barbs and is recessed. It's going to be hard to even zip tie the tube on there. So the weak link in the MAP system is at the sensor unit. Now I'm wondering how much trouble to go to to get the vacuum back inside the cabin. Just use regular vacuum hose, or make up a REAL hose with threaded ends, at least to the backside of the firewall. Guess I'll be buying another bulkhead fitting, too.


Manifold Pressure Sensor 5-31 in Hg
Manufacture Date 1206
AuxSF = 198 AuxOff = 60
Grand Rapids Technologies, Inc.
(616)245-7700
SEP 24 2006

I decided to go with a real -4 AN hose and aircraft grade An fittings for the MAP line. Probably wasn't necessary. Simple fuel line hose and NPT fittings would work. The main reason I did the MAP install this way was because I didn't want to use a hose and grommet if I didn't have to. So I used a bulkhead fitting. And I still had plenty of braided stainless hose. And it looks cool!

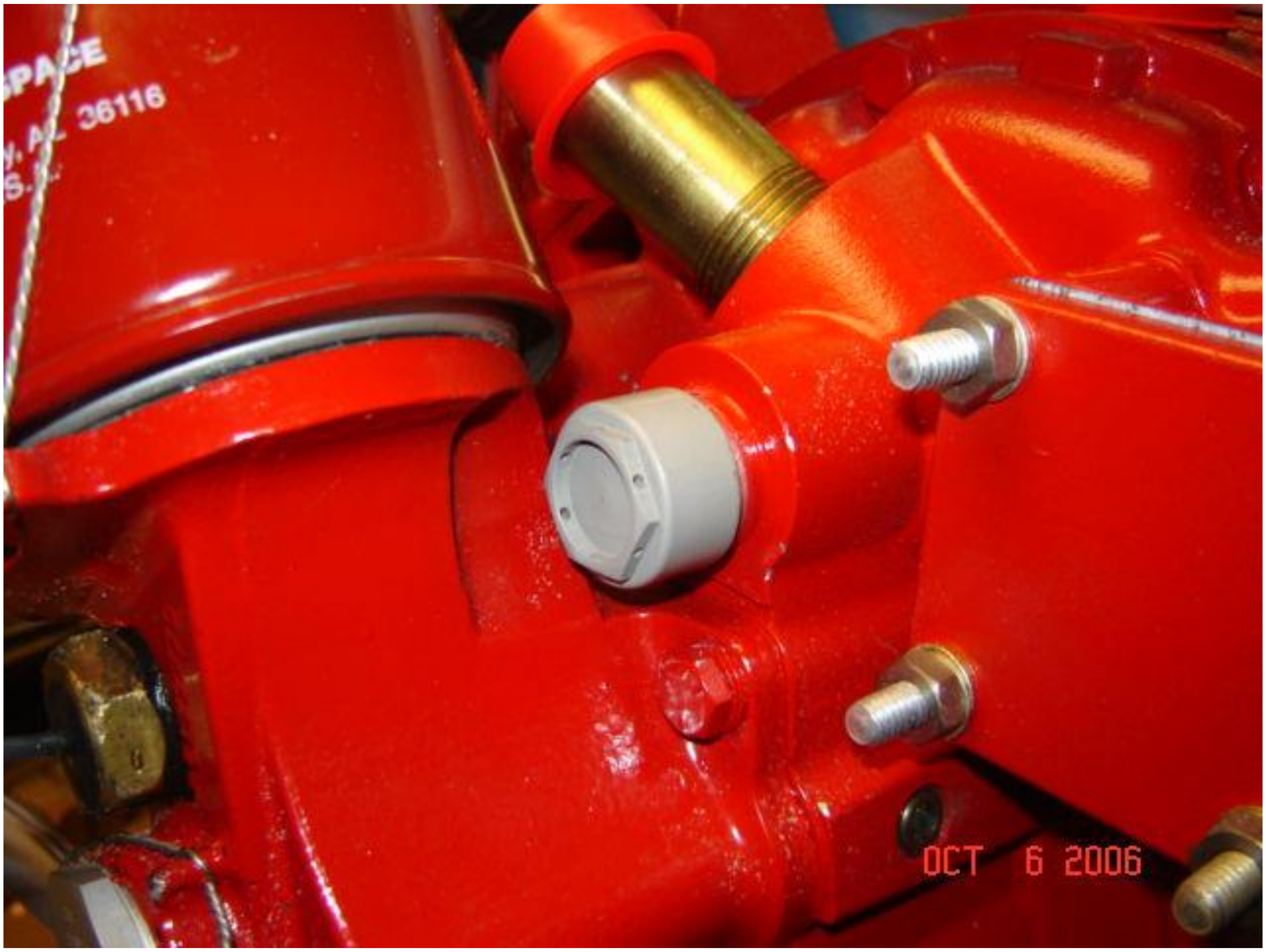
I tried to get this hose out of the way as much as possible. There's not much room outside the engine mount for much of anything, but a little -4 AN bulkhead fitting can get in there. I used a regular straight -4 AN to NPT male fitting in the manifold port on the cylinder head, a 45° swivel fitting on that end, and a straight reusable Summit Racing fitting on the other.

On the aft side of the firewall, there is a simple "tygon" 1/4 OD tube adapted to a -4 AN hose fitting. I used RTV to seal the hose to the fitting barb and create an airtight seal. That fitting makes a 90° turn and guides the hose around the brake reservoir toward the avionics shelf where the GRT MAP sensor will be mounted.

Somewhere in line, there will need to be TWO tees off the line before the sensor, feed raw MAP to the LSE Plasma III CDI units.

Tach Cap

Since I have dual electronic ignition and dual EFIS with engine monitor, just about everything is monitored electronically. That includes engine RPMs. Since I don't need a mechanical tachometer cable, I had to cap off the cable port (threaded 7/8 nipple) on the 540 engine. I could have done this with a pipe fitting, but I chose to buy a tach cap from Aircraft Spruce. You can get an open end wrench on it, it has a gasket inside, and it's already drilled for safety wire.



Plasma III Dual Electronic Ignition

****NOTE: the LSE Plasma III CDI analog tach and map output are not compatible with the GRT EFIS. The older version of the LSE CDI (Pre A & A1 serial numbers) do have a 10 volt pulse available from the input connector and may be used for a tach pulse signal. Klaus Savier can modify newer serial number versions to accommodate the pulse required for the GRT units, and in fact can configure the CDI units for just about any system.*

Now that the engine and firewall forward installation is coming along, time to think about installing the ignition. I need to penetrate the firewall to run a bunch of wires, and the biggest ones go to the alternator, starter and the LSI Plasma III ignition coils on the engine backbone. Ideally, the big starter and alternator wires are going to stay in the upper outside corners of the firewall as planned. The rest of the wires are going through the center of the firewall directly forward of the EFIS Screens and above the avionics shelf I constructed to hold the GRT AHRS and the EIS LCD unit.

First off, I decided that I did *not*need to cantilever the GRT EM LCD unit so that I could get to it and see it better. I can set just about everything up at the EFIS DU's. I took the swank brackets that I made for the unit and tossed them. In Fact, I ended up scraping the whole Plasma III shelf and made up a pair of individual brackets to mount the CDI's over the top of the AHRS and the EIS units. The bracket on one side is .025 and the other is .032. There's no offset and getting the screws out of the bottom CDI are a little tricky. But the new configuration saves a lot of space. The lower Plasma brackets are just "L" shaped brackets that screw into the center avionics shelf.

I made the upper brackets for the LSE CDI units out of scrap. It was originally the rear shelf in the baggage compartment. Already primed. Better than trash pickin'! The brackets are probably .025, I didn't measure. The units are not very heavy, so I really didn't need anything super strong. The Brackets are as wide as the CDI units (7.25) and raise the units to allow air circulation and heat dissipation.

One thing I also did was make a bracket for the GRT MAP sensor. I decided to make an .020 bracket for it that would mount on the top Plasma III CDI unit's case. There are two little machine screws on top of the CDI. Doesn't take much to hold the MAP sensor.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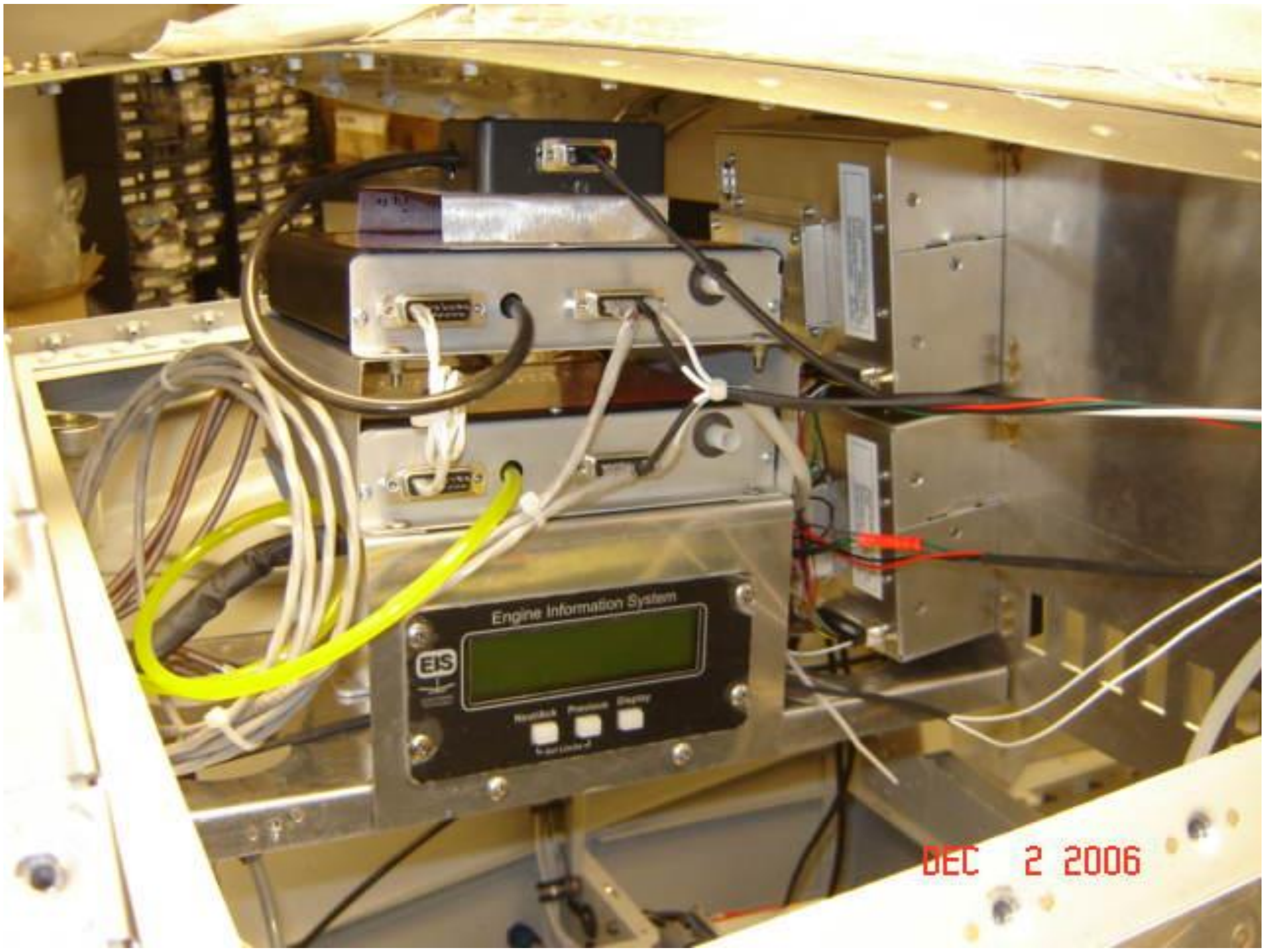


I put the cable sides over to the ship's right. The "computer" plugs that go in the other side of the units are much deeper, and would probably contact the avionics stack on the right side. So I put them on the left.

Klaus Savier (owns Light Speed Engineering) confirmed that I can use 90º right angle adapters on the BNC cables that go to the coils. In fact LSE sells AMP® adapters for just this reason. They are about $5 a piece. Or you can get crimpable right angle terminals. I chose not to cut anything off, so I bought the right angle adapters from Radio Shack. Klaus warned me that the quality might not be good enough, so I may have to replace them down the road.

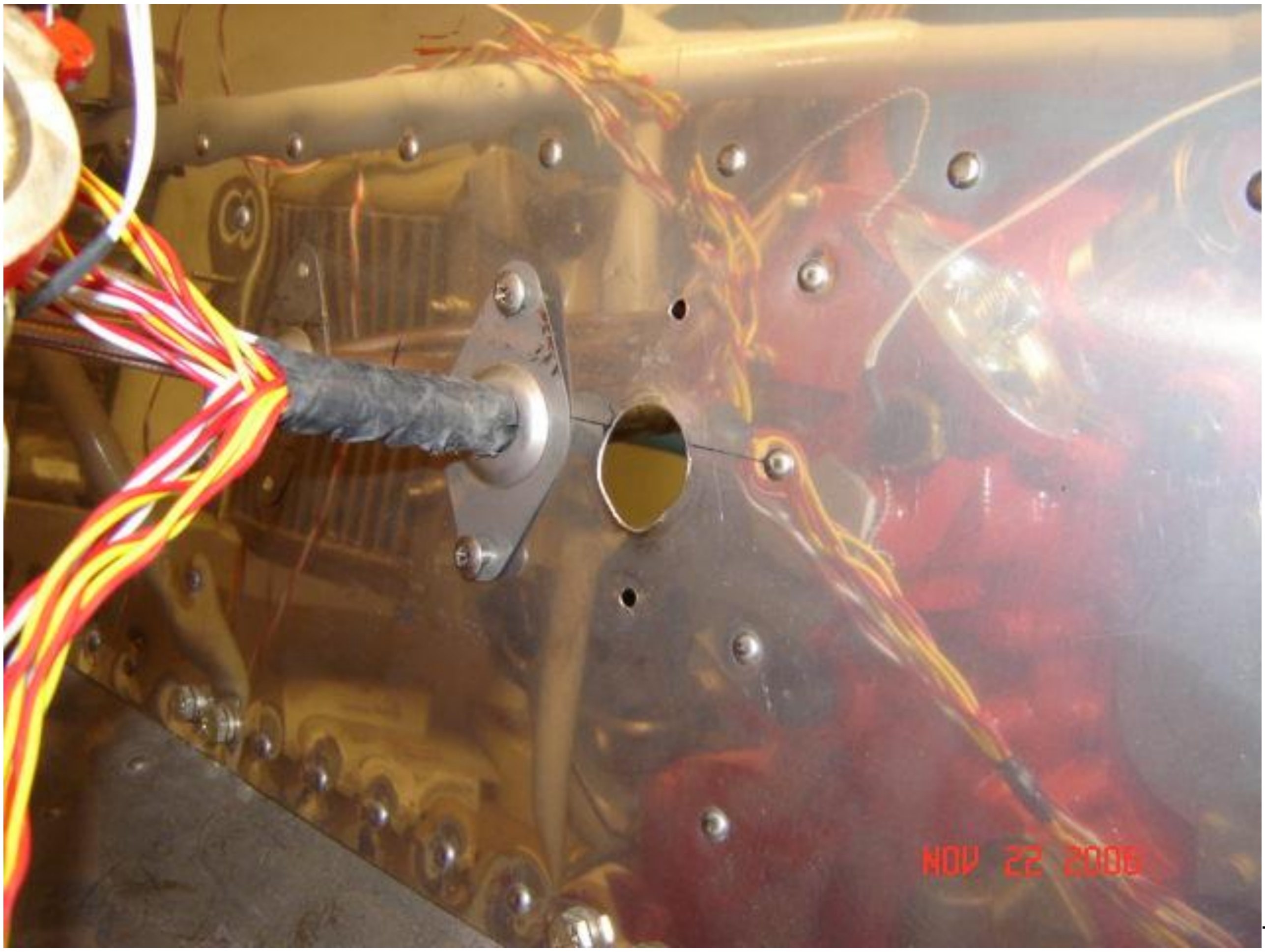
I learned from GRT that the manifold pressure (MAP) signal output from the LSE CDI units is not compatible with Horizon 1 EFIS, and that I would in fact have to use the MAP sensor unit that I bought with the EFIS. I was trying to eliminate one box, since I have to have the 2 CDI's in place and *both* of them have MAP output.

This incompatibility issue is bigger than I thought. After a couple emails with Klaus and GRT, it seems that the newer Plasma III unit tach output is not compatible with the GRT units, either. I just got my CDI units back from Klaus to be upgraded to the latest specs, and it's the later serial numbers (A & A1) that are not compatible. Well, my units are now configured A1. Fortunately, Klaus emailed me and told me that the tach signal was NOT changed on my units and that I am good to go. All I have to do is solder a shielded wire to the input cable D-sub connector(s) and splice it to the GRT unit. Sweet. Then all I have to do is make a big damn hole in the firewall to get the connectors of BOTH cables through as small a hole as possible. Easier without the covers on the pin connectors, but still going to be quite large holes.

The pre-made input cables from LSE come with a cover (computer looking). I removed it not only to solder the wire, but so that I could feed the massive thing through the firewall.

If you have a LASAR ignition, or certain kinds of Light Speed Plasma ignitions (1 & 2 ?), GRT has ado it yourself fix to their unit to make it compatible with the existing tachometer pulse signal. Or you can send your CDI to Klause at LSE and he can make it work at his end. Options. Good.

As the Input cable is supplied by Light Speed Eng., it's nearly plug and play. The only thing is that depending on the EFIS or tachometer you have, you get to choose where the tach signal comes from. The LSE unit has analog for a regular tach. (You can use a cable from the engine, too...stone age...) If you need a PULSE signal, you get that from the INPUT connector. You have to solder a shielded wire on there. The diagram provided with the system shows where to solder the return/ground shield and the center wire. Easy Peasy.



The hole I made for both these cables was the largest hole my step drill would make. Even then I had to dremel the hole oblong in order to get the connector through the hole. Fortunately, Aircraft Spruce sells just the right size grommet for this part of the project. I'll have to make a vertical radius cut to get the grommet over the wire.

Also, they don't make stainless steel "half shields" this big, so I'll use two shields cut with a dremel to be mirror images with a slot for the wires. More on that later.

I'm not sure how many wires will be going through the "sensor wire" hole in the firewall. The two LSE wires have to be at least 1.5 inches from the high energy coax cables that go to the coils on the backbone of the engine. My sensor wires are about 8 inches from those coax wires and about 2 inches from the EGT & CHT wires.

The output D-sub connector of the LSE system needs to have a shielded wire soldered to terminals 1 (pos) and 9 (ground shield). Then, that wire is routed to the rotary key switch. This is sort of a "P-Lead" type installation. I crimped on a few ring connectors and screwed the wires to the terminals 1 & 2 (left and right "mag") and both shields to terminal 5 for the common ground.

The input connector power cable goes from the CDI units, jumpers across a pull-able 5 amp breaker, then connects direct to the battery. In this case, I will hook one CDI unit to the left battery, and the other to the right. Doesn't really matter which is which. So if one battery croaks, the other should be good and can still keep the engine running. Also, I can isolate one side or the other and also power/charge one side from the other. Sweet. This cable was a bitch for me to work with. You have to split open the shield and pull out the center conductor, preferably without breaking the continuity of the ground shield. I butchered the first one trying to use a pair of dikes to separate the shield. I ended up having to cut the ground apart, lengthen the working end, then solder the ground mesh back together. It was pretty sloppy, but effective. The second wire turned out beautiful. I used a utility knife to slit the sleeve lengthwise, then peeled it back and cut it. No ground shield wires were harmed during the filming of this process (well, only a couple). I crimped on 4 ring connectors and screwed the terminals down. Then, after using some electrical tape to cover the ground shield, I zip tied each wire back to itself to help protect the ground shield from being pulled apart. Sometimes gorillas get in there and start yanking on my wires, you know!

Crankcase Vent Breather Tube

I asked Mattituck about a breather tube. They couldn't/wouldn't provide one and just quoted milspecs and the fitting dimensions. That's actually typical of them, short on information and extraneous help. But the are long on engine building, so I'm not disappointed at all. They just don't seem to be in tune with the experimental market and don't really go the extra mile to provide builder help, especially through the web. Old School works well.

Since I had no idea what to put on that big crankcase vent breather, I jumped on the net and started reading and asking. Lots of ways to tangle this little project. Finally, when I was ordering parts from Summit Racing for fuel line fittings, I went ahead and researched their radiator/heater hoses. I GUESSED at a 9 inch tube that starts at 1 inch diameter and tapers to 3/4 inch. It has two bends in it at almost the perfect position! That's a Goodyear 63002, Summit part# GTR-63002. TIme to round up a couple hose clamps, an Adel clamp and a foot or so of 3/4 inch aluminum tubing for the drip end that exits the lower cowl.