

# Light Plane Maintenance<sup>®</sup>

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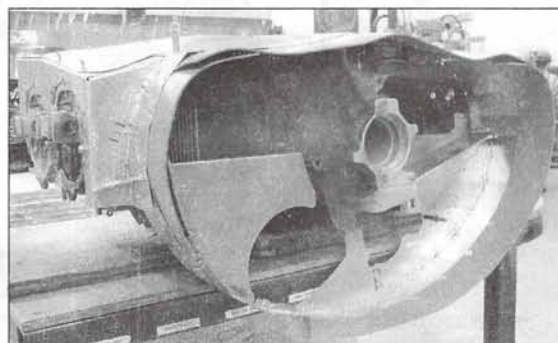
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# A Visit to Airforms, Inc.

*New engine baffles for the world is the watchword for this niche aviation component company.*

BY LEE BUDDE AND THE AIRFORMS STAFF

*Ed Note: In preparing to update an article on engine baffles we were made aware of a company that was deeply involved in the fabrication of new and replacement FAA/PMA baffles for many GA aircraft—even those parts, which are no longer available from the factory for popular older planes. We thought it would be a great opportunity to make our readers aware of the capabilities of this company as well as have Airforms provide us with a guide for the readers of how to best install replacement baffles.*

**N**ever underestimate the aviation folks in Alaska, as it can feel much more like the center of the flying world than the edge. Airforms is located 60 miles from Anchorage in the town of Big Lake, and has wheel, float and ski plane access. It's well organized, clean, and bright with state of the art computer numerically controlled/computer aided manufacturing (CNC/CAM) sheet metal fabrication equipment.

Being a FAA/PMA part manufacturing facility for the last 13 years makes them very much a part of the global aviation world with 95 percent of their baffles shipped outside of Alaska and globally. These folks are dedicated to supplying baffles for all common piston planes.

They currently have complete baffle sets available for 53 different aircraft models with 20 or so aircraft types currently in the approval process, from the Cessna 120 to the 402 and from the Piper PA-18 to the Navajo PA31-350. They provide complete sets, individual assemblies, silicone seal only sets, and if you ask they will usually sell just that one little subpart that you need or some silicone stock.

## COMPANY HISTORY

Founder, Lee Budde, embodies the entrepreneurial spirit and Airforms reflects that. With a background as self-employed commercial pilot, A&P and

CFI he understands flying, the mechanic experience and airplane ownership first hand. Started in 1999 under the name Airframes, Budde began by building Super Cub fuselages and numerous other structural components, developing many STCs and FAA/PMA part approvals.

Five years ago he started on the path of engine baffle building with the addition of CNC equipment and computer organization to handle the complexities of the numerous and intricate baffle components. An opportunity to sell the Super Cub parts line came along in '07 and was taken, and the company name changed to Airforms at this point. From then on the main focus has been engine baffles.

## COMPANY PHILOSOPHY,

"Our goal is to be not only the best aviation business experience you have, but the best business experience you have that day, period. We view all our customers as potential long term relationships. Having a staff of seven people we are better able to understand our customers who typically have similar sized businesses," states Budde.

## THE STATE OF THE NATION'S BAFFLES

If you're an LPM reader, chances are you are already aware of the often poor condition of the commonly neglected sheet metal and rubber engine baffle assemblies that exist on piston powered planes.

For many aircraft, for example the Cessna 170 and O-300 powered 172s, baffles are out of production and are available only from Airforms. The historical long lead times or unavailability and high costs associated with baffles in the past has been the cause of a lot of baffle patching, hence the Airforms' efforts.

## THE PART APPROVAL PROCESS

New part approvals and FAA

liaison is a big part of a business like this. With over 3000 part numbers (including subparts) so far, they are well on their way to their goal of being the one-stop shop for engine baffles for the GA fleet.

Work on new FAA/PMA approvals is continuous, and a large flow chart on the office wall lists the 41 steps in their PMA approval process with individual projects listed representing the various stages of progress of each. Engine cores sporting prototype sets are a constant part of the décor in the shop.

As the last step in the approval process each set is installed on an airplane for an FAA compliance check and the final fit and improvements are made at this point. When an airplane isn't available locally for this step, General Manager Levi Ward will often travel to where the first set is installed.

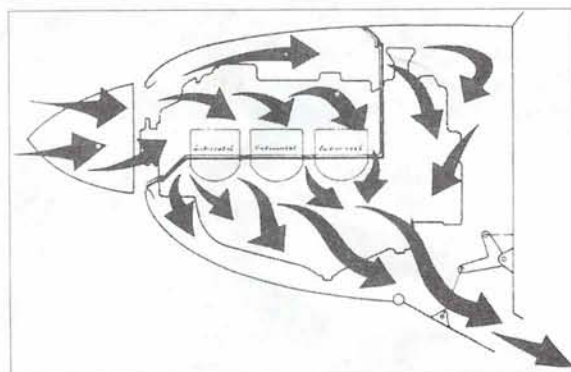
One of the nice things here is that when you call Airforms to purchase baffles or ask technical questions you usually get Ward, who is the person who installed the set himself and really knows the parts in minute detail.

## THE MANUFACTURING PROCESS

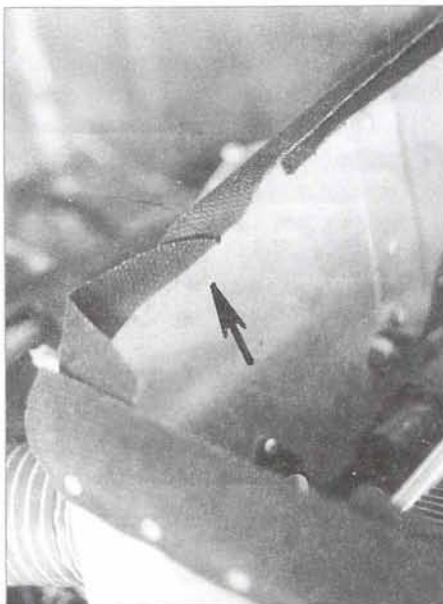
The level of precision and repeatability inherent in the CAD/CAM process makes it all possible. Complex parts with multiple bends and numerous rivet holes typically mate up precisely during assembly so that rivets can be installed without holes needing to be chased with a drill.

"When he started training on the machines and developing parts he was using three places past the decimal. I just

The basic airbox concept designs baffles to direct cooling air around each cylinder and accessory that needs cooling airflow. The most common form is downdraft cooling as shown below.







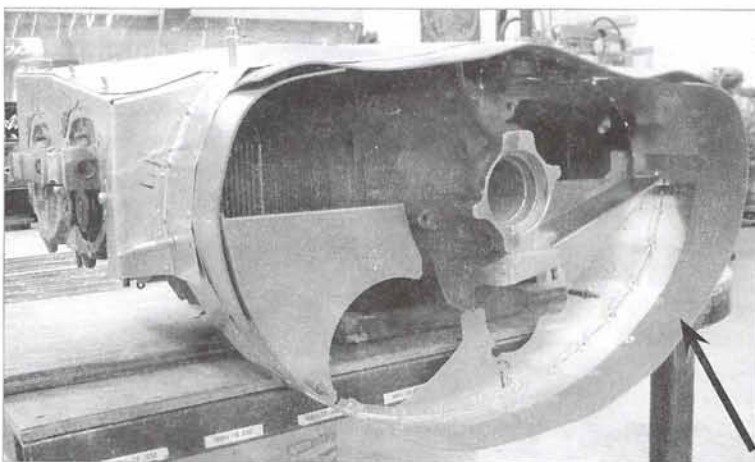
Old style baffle material was not very resilient or held shape well under air loads. Here it got bent by the cowl and allows a big air leak. Compare that to silicone material below.

chuckled to myself and let it go at that," quips Budde.

#### OTHER CAPABILITIES

With the CNC sheet metal cutting and forming abilities Airforms will make prototypes or one offs. They have recreated baffles for less common aircraft such as the Beech Travel Air for restoration projects.

New silicone baffle seal is stiff enough to not let air out in flight. Some air boxes are particularly tight, and a good seal is essential. An example below is an early Mooney M20B. The original factory baffles have been revised for a perfect fit for FAA approval. The use of engine cores during design helps assure that perfect fit.



They also produce parts for other FAA approved manufacturers. Their focus is really more about production but they do try to accommodate as many customer requests as possible.

#### BAFFLING STATE OF MIND

Engine baffling is one of the most important engine life extension systems, yet it's one of the most frequently ignored in terms of keeping it in good repair. While flying, the average airplane is pushing a substantial volume of air into the engine compartment. However, this huge amount of air would be inefficient at cooling the engine if the direction and flow of air were not precisely controlled.

Thus, of course, the need for baffling which, when properly installed and maintained, will direct cooling air to those areas requiring the greatest heat transfer for the longest engine life. Without well-maintained baffling, making TBO is unlikely. One engine rebuilder stipulates that their warranty is void if baffles are not in "like new" condition.

Some engine setups such as a tightly cowled Mooney are far more critical for good baffling than more open engines such as on a non-turbo Bonanza. Baffling directs the flow of cooling air through and around specific areas of an engine by forcing the pressurized air to take a route other than the easiest way out.

It does this by creating a "pressure box," which seals incoming cooling air inside the cowling (usually the top of the engine) and allows only those areas we need cooled to flow air to the bottom of the engine compartment. Because there is a pressure buildup on the top of the engine and a relatively slow flow of air to the bottom part of the engine compartment,

a low pressure would be expected immediately below the engine.

This pressure differential and the resultant air flow is what cools our engine and keeps the isolated tempera-

tures at exhaust valve ports and cylinder barrels from reaching critical temperatures. As with the engine itself, baffling is also used to direct and force cooling air to accessories and components like oil coolers, vacuum pumps, magnetos and fuel injector systems. Using scat tubing and aluminum elbows or blast tubes, cooling air is removed from the pressure box and sent to various components outside the sealed area.

A common area of baffle failure is on the tabs and holes where tie-rods or spring loaded wires are used to pull the forward and aft baffles together and hold them against the cylinders. If the baffles are not pulled against the cylinders properly, cooling air flow is lost resulting in higher than normal CHT. Both Continental and Lycoming are specific about the need for snug fitting baffling.

#### SILICONE SEALS

Because we can't allow the engine and sheet metal baffling to contact the engine cowling, a flexible, heat resistant silicone seal material is commonly attached with staples or rivets to the sheet aluminum around the pressure box perimeter. This material is also used to cover irregular holes and gaps that can't be controlled with aluminum or steel.

For years, baffle seal made from asbestos-rubber was used. The material was generally stiff and difficult to form around corners. When subjected to cleaning solvents, the old seal material would absorb the naphthas contained in the solvents and become brittle with the application of even a little heat.

Cracking, warping and stiffness (aside from the asbestos content) made this material less than desirable and routine replacement was found necessary, especially on higher-powered engines. In the past, aircraft manufacturers also used felt to wrap the perimeter of the baffles.

Felt is now uncommon as it can retain oil and grit unlike silicone. Airforms will install felt on the PA-18 baffle sets as an option but they use silicone seals unless you specify that you want the old style felt.

In recent years, the introduction of seal material made from high temperature silicone imbedded with a fiberglass weave has found its way into engine compartments. This material meets Mil Spec AMS-3320 and is flexible, far more



durable and resists temperature extremes from -65 F to 550 F.

Airforms has the fiberglass reinforced silicone seal material specially made for them in a .093 thickness, which they have found to be optimal to get both flexibility and maximum wear. The seals themselves are cut out of sheets on the radius of the parts, which gives a fit not attainable by bending a narrow strip around a curve.

Rather than the staple method of attachment of seals, Airforms uses aluminum washers attached with solid rivets. It's much friendlier than staples if you ever find a need to work on them.

To cut your own baffles from a sheet of silicone, you remove the old seals carefully so not as to destroy the pattern value and trace them out on the new sheet. Attaching a straight piece of silicone around the curved edge of a baffle is rarely satisfactory.

The average engine will use about 1/2 to 3/4 of a square yard of seal material for a complete reseal of the baffling. Otherwise you can purchase a pre-cut, drilled and ready to install seal kit from Airforms.

### IMPROVING DESIGN AND MATERIALS

A baffling system is made up of sheet aluminum, steel brackets and heat resistant, silicone seal material. The steel and aluminum pieces are typically installed between cylinder barrels, around oil coolers, along the cylinder heads, forward and aft of the engine creating the "pressure box." The baffles should be designed to fit snugly to the engine and keep all the cooling air flowing through the cylinder fins and oil cooler.

Most often, sheet aluminum is used to form the pressure box area, which will fit close to, but not touch, the top and bottom engine cowling. Not all the original baffles fit properly to start with. Airforms makes fit improvements necessary in their designs, for example in the early model Cessna 180s, many have a horizontal cut through the front of the cowl where the original baffles interfered with and wore through the cowl.

Another improvement is made on early model Cessna 200 series aircraft where the pilot side rear baffle is prone to failure due to the air filter and plenum assembly, which attaches to it and causes stress. Airforms makes this baffle out

of stainless steel solving the cracking problem.

Airforms uses 6061-T6 aircraft aluminum as the material for their baffle designs due to its mechanical properties and weldability. They have made wide use of stainless steel brackets, tabs and doublers in specific areas prone to stress cracking, vibration fatigue and fatigue from supporting extra loads on baffles that hold up oil coolers, etc.

### MANY DIFFERENT CONFIGURATIONS

For aircraft like the Cessna 180 there are several oil cooler options; congealing, non-congealing (9, 9.5 and 11 inches in length) and an 8 bolt congealing. On the Airforms Web site there are illustrations of each oil cooler to determine which baffles they will need for their specific installation.

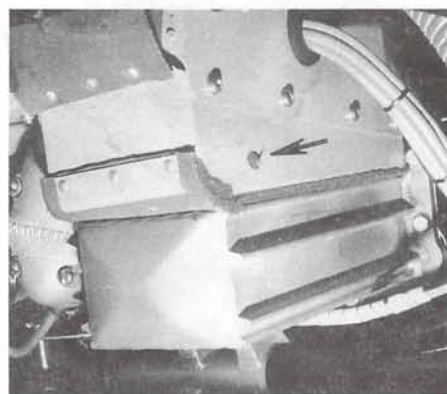
Occasionally there is the oddball oil cooler that requires Airforms to build special parts to get the proper fit, as oil coolers vary slightly between manufacturers. The PA-18 in particular has five engine baffle configurations, which covers a standard O-320 installation, O-320 with a rear mounted oil cooler, O-360 with rear oil cooler, O-360 with large 9 fin rear oil cooler and O-360 with a conical engine mount.

Aircraft with engine upgrade STCs to 180 horsepower such as the Piper PA-18 or Cessna 172 series with an O-360 can obtain baffles specifically designed for them from Airforms.

### WHAT ABOUT HOMEBUILTS?

Homebuilders have been buying baffle kits from Airforms for certified aircraft with the same engine and making them work by modifications. Airforms has just completed a kit for homebuilts consisting of tightly cowled pressure box style assemblies for the popular Lycoming O-360. This is the style of baffles commonly used for drag reduction as a speed mod.

It comes unassembled with pieces fully formed and rivet holes already in place. Key pieces can be made oversize to allow for trimming. This allows builders to get assembly credit for fitting and riveting while saving them the



Sealing of baffles with high temp silicone helps assure proper cooling. Above, a hole the size of a quarter can significantly decrease the effectiveness of baffles, especially when it's right over the oil cooler as it is here.

experience of starting from scratch.

### INSTALLATION TIPS

The critical item for baffle longevity is stress in the sheet metal that may be caused during installation. We recommend installing all baffles loosely in place before tightening any nuts and bolts.

This will give you a good view of how the baffles work together. Any interference or misalignment issues will show up and it will be easier to handle the problems before you route system lines. Often, enlarging a bolt or screw hole slightly will relieve the tension.

Once the baffles fit and fasteners are tight, route the spark plug leads, fuel and oil lines, etc. Be sure that all system lines

In the world of CNC cutting, economy of scale and perfect, repeatable copies are possible at the Airforms facility. Here, Cessna 206 rear baffles are cut out identical time after time. Here, again, is another improvement over the factory material by using stainless steel.







Above, shop employee is hammering solid rivets into Navajo air filter plenum chambers—no pop rivets here. At right, another employee is installing AD rivets into silicone baffle material using half inch backing plates. This is another improvement owners and mechanics have been very happy with.



dampen the vibrations and extend the baffle service life. Also, check the inter-cylinder springs by pulling on the lower inter cylinder baffle from the bottom.

The baffle should form tightly against the cylinder so the air flows through the cooling fins and doesn't escape. Check for baffles that have been secured by safety wire in lieu of springs and get things back to the original design as shown in the illustrated parts catalog.

Once the baffles are installed and lines are routed the next step is to install the cowling and inspect the silicone seals.

A common practice in checking baffle installation and seal integrity is to place a flashlight (or a similar protected light source) in the rear and lower areas of the engine compartment while looking for gaps or holes in the pressure box.

Do this in a darkened hangar or at night to get the best results. You may wish to alert airport security of your intentions lest the banging around you do in the dark be considered an illegal activity.

It is common to see folds and bulges where the seal may not conform to the cowling. To relieve these use a marker to mark each deformity. After you remove the cowling slice the seal from the mark down towards the baffle. A scissors or razor blade type knife works well.

After you have made the cuts install the cowling and note the seal areas you cut. The seal should now overlap as they conform to the cowling of fit around bulb angle reinforcement,

etc. Note: this method is only applicable to seal material with the fiberglass reinforcement as the un-reinforced rubber may continue to tear from the cut.

While inspecting for defects, take into consideration that the air load in the pressure box will force the seal material up and back during flight. Gently push the seal material against the installed cowling to make sure the seal is secure and all gaps are closed.

### CHECKING YOUR BAFFLING

Understand that small holes or gaps in the baffling, the combined area of which is equal to or greater than the size of a quarter, will provide sufficient loss in the pressure box air to create a cooling loss as well.

Check carefully around oil coolers and make certain there are no leaks where the rear baffle attaches to the back two cylinders. Use a mirror to look down between the cylinders to check the security of the inter-cylinder baffles.

These baffles are usually small, pre-formed pieces, which are attached with hooks or bolts to brackets secured at the top of the cylinders. Generally, there is no seal material around these pieces but a close fit to the cylinder barrel is crucial.

On worn inter-cylinder baffles, a bead of silicone between the cylinder fins and baffle edge works well to seal the piece and prevent further vibration. Check the fit of the baffle between the engine and lower nose cowling bowl.

Make sure that all seals and supports are positioned so that air loads during flight don't allow the seal to blow back or deflect downward, destroying the "pressure box" seal. Inspect grommet cutouts and holes through which engine controls or wire harnesses are fed. In short, inspect for any areas where pressure air can escape the "pressure box."

### RTV SILICONE TO ELIMINATE LEAKS AND INCREASE EFFICIENCY

When all baffle and seal rework is finished, again remove the top cowl and look for any small areas, which could benefit from a shot of high temp RTV silicone sealant. A small bead placed around the holes cut for wire bundles or engine control cables works well.

Where a hard baffle is pushed against a cylinder, a little RTV will help seal the area and prevent vibration from wearing

are clear from chafing on the sheet metal edges. Proper sized rubber grommets should be used because they will give you the greatest protection from chafing and wear.

When installing inter-cylinder baffles a line of RTV silicone on the surface, which contacts the cooling fins will

Below employee is bending a Cessna 150 rear engine baffle using a CNC press brake. It's a combination of skilled staff and computer repeatable machinery that makes for a top quality product that fits properly.



*(Continued from previous page)*

the baffle away.

Some high-powered, turbocharged aircraft rely heavily on the use of silicone sealer in order to keep cylinder head temperatures down and insure proper cooling airflow. Use the silicone sparingly, but be very critical in the application. Allow six to twelve hours drying time and 24 hours before test flying your work.

Baffle jobs are money and time well spent. The results will show lower head temps and return on the investment in ways not immediately found but are, nonetheless, just as beneficial as changing the oil.

### THE ORDERING PROCESS

The experience of hanging that clean and shiny rebuilt or new engine and then realizing that those dirty, cracked and generally unattractive baffles weren't thought of until that point seems pretty common. This scenario has motivated Airforms to keep pretty much everything they make in stock.

Choices are bare aluminum or a powder-coated finish, either their standard grey silver "hammertone" or a color of your choosing for a few bucks extra. There is controversy over powder-coat finishes in aviation use. This is a non-issue here due to the nonstructural nature of these parts. Field use has shown it to hold up well on the baffles.

The fiberglass reinforced silicone seals come attached to the assemblies and are available in black, orange and blue. Prices are typically 1/3 to 1/4 the cost of OEM. Rather than the often used aviation pricing structure of really high prices and lots of discounting we decide on what we feel is a workable price for both the customer and ourselves and stick with that. You can call them directly to order at 907-892-8244, buy them online on their [www.enginebaffles.com](http://www.enginebaffles.com) Web site or go through their distribution network, which includes Aviall, and Aircraft Spruce.

Looking at their Web site with its layout of the individual pieces makes it easy to find what you're looking for. Buying a full set has a substantial discount over buying all the pieces separately.

All the normal shipping options are available including overnight service.

**Special thanks to Light Plane Maintenance for permission to include this article on our website. For any questions or comments, please contact Airforms at 907-892-8244**