

# Get More Cooling Capacity From Your Radiator

An Old Racer's Trick from Bud Warren

By Phyllis Ridings-Murawski

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**CONTACT!** Magazine readers will remember Bud Warren from the cover of issue #89 and the associated article written by Bud's daughter, Phyllis. In my editorial in that same issue I promised that I would be publishing a follow-up to a detail mentioned in Bud's article about "splitting the water tank" of his radiator. Faithful readers will also remember from the last issue that Bud's plane was lost not long after the article was published, making it difficult for everyone involved to write the follow-up as timely as promised. But nonetheless, here's the article as promised, just a little late. ~Pat

Just about anywhere there is a spirited conversation between auto engine enthusiasts, the topic will usually come around to water cooled engines and how to accomplish the most efficient cooling through the radiator. Automobile engine conversion philosophies for aircraft can differ so much from race car engines that there is typically not a great deal that is useful from the old drag strip days that would translate well when applied to aviation use; however, one of the tricks in Bud Warren's tool kit from those old racing days which is highly appropriate for use in aircraft is to modify the radiator in a way that dramatically increases its cooling capacity. The old timers refer to this customized radiator as a "three-pass" radiator, since the water in the cooling tubes will make three passes through the core, instead of one, after the modification is completed.

## HOW IT'S DONE

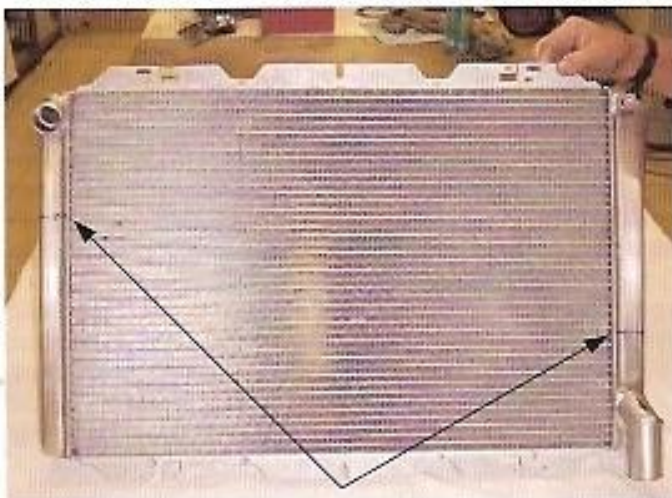
For this illustration we are using a new, all aluminum, Chevrolet style cross-flow radiator measuring 31" x 19" x 3", which can be purchased for around \$200 from a racing speed shop. Two good online sources for off-the-shelf aluminum radiators suitable for this modification are [stockcarparts.com](http://stockcarparts.com) and [summitracing.com](http://summitracing.com). Two-pass radiators can be purchased off-the-shelf, but you can achieve superior cooling by modifying your own stock radiator to a three-pass by following this procedure. So if you have access to a shop, are fairly handy and are a pretty good aluminum welder or have a buddy who is, you can save money by doing the modifications yourself.

To understand the process, consider that prior to these modifications, water will enter the radiator through the inlet, trickle down into the water reservoir on the inlet side, and make its way rather passively (but still under pressure from the water pump) across the core and into the water reservoir on the outlet side of the radiator.

Our objective with this modification is to cause as much of the water as we can to route purposefully through specific sections of the radiator core once, twice, then a third time before it exits the outlet and back into the engine. The theory is that more of the water will spend more time in the core which will exponentially increase cooling capacity. It is important to understand that when making this modification, a larger than normal radiator is needed, as this modification will add coolant flow restriction.

## GETTING STARTED

To create your own three-pass radiator, you will need to install two small baffles into the water tanks; one in the inlet side, one in the outlet side. To start, count the cooling tubes in your radiator, marking the sections into thirds. Mark your first cut at one third of the way below the inlet and the second cut at one third above the outlet.



The "before" shot with the tanks marked for cutting.

## CUTTING THE TANK

Use a square to keep your marks straight across the three sides of the tank and centered between the tubes to avoid placing a baffle in the middle of a cooling tube. Next, cross your mark approximately 1/4" to 3/8" from the



The inside of both tanks are comprised of a series of diagonal, rectangular tubes that allow the flow of coolant from one side of the radiator to another.

weld on either side of the tank to indicate where your cut is to end. You will not cut all the way to the weld or through it. Using a cutoff tool, start on one side and cut a straight line through the radius of the edge of the tank, remembering to stop at your crossed mark. Flip the radiator, then cut the other side, matching the slots you have cut across the width of the tank. Now you have a rather rough slot cut in the tank, so use a hack saw blade or other tool to remove burrs. Repeat the process on the other side of the radiator at the remaining location that you have marked.



Note that if your radiator has its inlet and outlet on the same tank, you will only be able to divide it once, making it a two-pass instead of three-pass radiator. In this case, you will divide the cooling tubes in half and install only one baffle in the tank, which is still very much worth doing to gain cooling capacity.

Once you have finished your cuts, wipe any remaining ink marks off of the radiator with paint thinner or any other non-oily cleaner. Do not use solvent or Varsol since it will contaminate the aluminum and it will not weld properly. Use a Scotch-Brite wheel to dress and smooth the slots and prepare them for welding.

### **MAKING THE BAFFLES**

Pre-fit a thin piece of rigid cardboard to the slot in the tank, fitting the depth first. You will need to notch both interior corners of the pattern for the baffle so that the notched areas will clear the weld on the inside of the tank. Fit it so that the inside of the pattern fits flush with the inside of the tank. Since you will not be able to weld



the baffle inside the tank, the better the fit the lower the incidence of water leaking past the baffle and the more the water will route where you want it to go. Next, mark the outside of the pattern about 1/8" larger than the actual tank outside dimension for easier handling of the aluminum baffle as you are welding it in place.



You will need to cut a pattern for each slot, since each side of the radiator will be slightly different. Use .060 aluminum in 3003, 5005, or 6061, but do not use 2024 as it will not weld. You can use thicker material for the baffles if you like, as long as it fits in the slot.



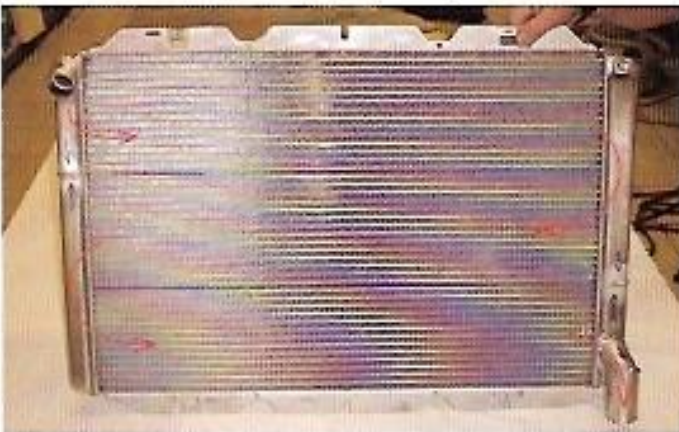
As you are welding, incorporate that 1/8" excess material into the head as filler. You might want to practice on some scrap aluminum to be sure you get the temperature right before you weld the radiator. Be sure to weld from one side of the tank to just across the radius of the tank, then stop, flip the radiator over, and weld from the direction of the tank weld again outward across the radius, then match the two beads in the middle to avoid

distorting the tank or having it draw up in one direction. While welding, keep a nice tight bead and continually watch for pinholes and resolve them as you weld in order to avoid leaks later.



**Use a soft wire brush to clean and check the weld.**

Dress your welds with a small brass or stainless steel wire brush and inspect for pinholes and your project is finished. You now have a radiator that will dramatically increase your capacity to cool that auto engine in your airplane! In the early stages of testing our V8 Chevy engine and the Geared Drives PSRU, we initially had a lot of engine cooling problems. We tried all kinds of double core radiators, two-radiator configurations, electric cooling fans, you name it. After much frustration and heading back to the drawing board multiple times, we found the combination that worked the best for us with our water cooled engines. We now experience ideal engine water temperatures in our aircraft using this radiator modification, and without the use of any cooling fans.



If you are experiencing engine water temperatures that are above the ideal, try making the above modifications to your radiator. If your engine water temperature continues to indicate higher than you would like, you may want to evaluate whether or not there is adequate fresh air circulation into your cowling and across the cooling fins of the radiator. By the way, we recommend that you do not use a thermostat in your airplane engine. Take the outer ring off of the thermostat and place it back into the housing in order to slow the water flow, but throw the center of the thermostat away. Good luck with your radiator project, and thanks for letting me share one of my favorite tricks with you.

**Bud Warren**  
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## Hello Experimental Aviation and Auto Conversion Fans

Bud Warren's LS1/Geared Drives PSRU firewall forward package for the RV-10 is nearing completion for presentation at Sun 'n Fun Airshow in Lakeland, Florida April 8-13, 2008. This package includes custom wiring harness, custom programmed ECM, engine mount for RV-10, fiberglass blister kit to modify the stock RV-10 cowlings, and much more. For more information log on to: [www.geareddrives.com/details\\_&\\_pricing.htm](http://www.geareddrives.com/details_&_pricing.htm)

Bud will be running this engine/PSRU RV-10 package complete with propeller and governor at Sun 'n Fun on a test stand which will be located at the engine workshop and demo area. Attendees will be able to watch as the unit operates at low engine RPMs, increased RPMs on up to idle, at cruise and takeoff RPMs, and watch as the prop is cycled right throughout the pitch range. The PSRU has its own 60 PSI oil pump which constantly pressure-lubricates all the PSRU components including the propeller and the prop governor. The incredible smoothness of operation and the sound are really something to witness.

Did I mention that you can use ANY prop you want with this PSRU, from certified-type constant speed to metal fixed-pitch, to any of the countless experimental props currently on the market?

Bud will be speaking throughout the week at the auto engine forums as well, and his booth can be found in the outside North exhibits area, in booth #52, near where he was located last year, just outside hangar "C". For more information on the Forum schedule, log on to [www.Sun-n-Fun.org](http://www.Sun-n-Fun.org). It may take a bit longer for the Forum Schedules to post on their website.

See you at Lakeland!  
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