

The Trailing Edge

June 2025

Bearhawk Alternator Field Replacement

Sometimes it's better to just buy the right part rather than trying to save money on a "suitable substitute" that turns out not to be suitable at all.

Alternator "Suitable Substitute"

In 2004 I bought a Lycoming O-540 engine for the Bearhawk. It seemed to be a good deal, but it came sans accessories. One of the accessories not included was an alternator. Now I had heard that ordering an alternator from Lycoming would get you a big, heavy alternator designed for a car at least 30 years ago and you would get to pay a minimum of four figures left of the decimal point for the privilege.

Since I was building an Experimental Amateur Built, I wasn't required to use one of those overpriced, overweight certificated alternators. Looking for ideas, I contacted a friend and RV-6A builder to ask him what he had used. He gave me the name of a guy who was selling alternators for use on Experimental aircraft. This was the alternator that my friend had used on his RV-6A.

In my Bearhawk, the alternator was going to be on the engine, but the batteries were going to be in the fuselage behind the cabin, at least twelve feet away. According to Bob Knuckolls of The Aeroelectric Connection, the best charging voltage for the battery is dependent on the temperature of the battery, not the temperature of the alternator. If the battery were in the engine compartment, it would reasonably be approximately the same temperature as the alternator, and thus an internal voltage regulator in the alternator would probably be okay. However, the temperature in the engine compartment and the temperature at the back of the fuselage are generally quite different. As such, I needed an alternator that could work with an external regulator that I could position back next to the batteries so that the regulated voltage would be correct for the battery temperature.

I bought this alternator for \$137 (in 2004). It was a 60 amp Mitsubishi alternator that had been converted for use with an external regulator. It looked fine to me at the time, but it was clearly built for automotive levels of vibration, not aircraft engine levels of vibration. I installed it and it worked fine...initially.



60 amp converted Mitsubishi alternator modified for external regulation as originally installed



Side view of Mitsubishi alternator

Once I figured out the proper wiring of the voltage regulator, the Mitsubishi alternator worked just fine, alternating little electrons and providing electrical power for all of the aircraft systems. It continued to work just fine through all of the Phase I flight test.

Deploying Across the Country to Oshkosh

On Saturday morning, 25 July 2009, we set out to take the Bearhawk to EAA AirVenture at Oshkosh (KOSH). The crew of the Bearhawk was myself and my trusty copilot and navigator **Stormy Weathers**. On our wing was a Cessna 180 crewed by **Gary Aldrich**, **Jimmy Doolittle III**, and Jimmy's grandson **Hunter**. On the first day, we flew from the Antelope Valley of California to Rapid City South Dakota. The Rapid City Regional Airport sports my all-time favorite airport identifier—KRAP. We were shown to a transient aircraft parking area. This area had a real World War II vibe, as it was not paved, but rather was a dirt area covered with Pierced Steel Planking (PSP).



Stormy Weathers and me with the Bearhawk parked at Rapid City Regional Airport (KRAP)

On Sunday morning we returned to KRAP to load up the airplanes and continue our journey to KOSH. As I did my preflight inspection, I did as I always do and reached into the engine compartment to press on the alternator drive belt to confirm it was still there (hasn't broken) and that it still has appropriate tension on it. I pushed on it—it was still there, but there was no tension. In fact, when I pushed on it, the whole alternator moved. This was clearly no bueno.

I couldn't see what the problem was, so I pulled out the WRSK kit (War Reserve Spares Kit – tools and some spare parts) from under the pilot's seat and got out screwdrivers to remove the lower nose bowl to see if I could find what the problem was.



Jimmy Doolittle III and I work to remove screws and release the lower nose bowl. Stormy stands by as the official screw and parts holder

When we got the lower nose bowl removed, the problem was immediately obvious. Of the two brackets attaching the alternator to the engine block, the rear one had fatigue cracked itself into two separate pieces, thus allowing the alternator to move when I pushed on the belt. Additionally, the front mounting boss on the alternator had fatigue cracked itself free of the alternator casing. It's not clear which failure happened first, but a failure in either one would transfer the loads to the other one, causing the second failure. Apparently, this was in a very high vibration environment, because the alternator only had about 40 hours on it.

We puzzled how we could repair this installation enough to continue at least to Oshkosh. We knew if we could get it to Oshkosh, there would be vendors aplenty to assist us in making a permanent repair. It would be easier to do at KOSH than if we chose to remain at KRAP.

We asked if there was a maintenance shop on the field at KRAP. There was, but it was normally closed on Sundays. Fortunately, however, there was a jet on the field that morning that needed a repair to fly its scheduled mission, and they had already called out the mechanic to the field. Also, fortunately, the severed bracket was made of steel, so the mechanic was able to weld it back together. Since the jet had already paid the callout fee, he only charged me for the repair.



Note the crack around the base of the front mounting boss

With the bracket at least temporarily repaired, we investigated the mounting boss. Yes, it was cracked, but it seemed to be staying in position. It seemed that it had cracked in a somewhat conical fashion. As long as the boss and the alternator case were kept in compression, they would stay together. I pulled some safety wire out of the WRSK kit (yes, that's redundant) and wrapped it around the alternator body and the mounting boss in such a way that they would remain pressed together. You've heard of Barnstormers maintaining their airplanes with bubble gum and baling wire? This was very much the modern equivalent. Actually, the safety wire probably didn't do much more than increase my confidence that the boss would stay in compression. Most of that actually came from the tension of the drive belt.

With the alternator temporarily secured, we reinstalled the nose bowl and set off for KOSH.

Repositioning for Better Maintenance Opportunities

Continuing on to KOSH was very much a calculated risk. KOSH was 6.7 flight hours and one fuel stop away, but the options for a permanent repair there were better than anywhere other than back home at Rosamond. Needless to say, those flight hours were very stressful, keeping an eye on the alternator output and ready at any time for an alternator failure and immediate landing.

The temporary fix on the alternator held, but as we approached KOSH, the arrival frequency announced that the airfield was closed for a thunderstorm over the field. We were directed to circle around a point to wait. They said if you were low on fuel, you should divert to Fond du Lac or Appleton. Not only did I have an alternator that I didn't know how long it would last, but we were also down to about 20 gallons of fuel, which should have been good for two hours, but I didn't trust that since the airplane was still pretty new. Stormy and I decided to divert to Fond du Lac (KFLD). We landed successfully, refueled and parked the airplane. We caught a shuttle bus to the University of Wisconsin Oshkosh (UWO) where we were staying. Our wingman continued to hold, and was able to eventually land at KOSH.

After breakfast the next morning (Monday), we boarded the bus to KOSH, and there boarded the bus to Fond du Lac. I inspected the Bearhawk with special attention applied to the alternator condition. The alternator still seemed okay. We took off and flew the short distance to Ripon to enter the approach procedure for KOSH, which was fairly empty since it was still morning. We landed at KOSH and parked the Bearhawk on the display line. The vendor hangars would not open until the next morning, so figuring out what to do about the alternator would have to wait.

Time to Form a Plan

My original thought was to call the guy I bought the first alternator from to see if he happened to have another alternator available at AirVenture. However, I either couldn't remember his name or I didn't have his number, and **Gary Aldrich** was having none of that. He was convinced that the idea of an automotive alternator had already shown itself to be horribly flawed, and that I should look at getting a "real" airplane alternator.

On Tuesday morning, **Gary** said he knew just the vendor we should go see, and escorted me there as soon as the vendor hangars opened. He introduced me to the Plane Power representatives (now a division of Hartzell Aviation). I immediately liked the company for two reasons. First, Plane Power was an offshoot of SkyTec who made the starter that I really liked in the Bearhawk. The starter worked really well, so it was reasonable that their alternators would be of similar high quality. Second, (at the time) they were based in Granbury TX, which was also the location of a Scout camp where I went to summer camp a few times in the Boy Scouts. The Plane Power guys told us that they started the company when they realized they weren't happy with any of the alternator offerings for aircraft and figured that they could do better.

I told them of my plight, and that I needed a replacement alternator with an external regulator right away so that I could go home at the end of AirVenture. They recommended the Plane Power AL12-EE70/B 70 amp externally regulated alternator.

Normally, they would have directed me to one of their dealers, such as Aircraft Spruce, to purchase an alternator. There were many of their dealers in attendance at AirVenture, but alternators are not the kind of thing that most people purchase at AirVenture, so the dealers generally don't bring alternators to sell at the show. Because of my emergency requirement for an alternator, the representative gave me the phone number for a direct line to their shipping department with directions to tell them that he had directed me to call them. He asked me where I was staying. When I told him we were in the UWO dorms, he gave me the shipping address for the dorms and instructions for how to get overnight shipping to the dorms. Apparently, I was not the first person to ever have this sort of problem!

I immediately went outside to call the number he had given me. I told the person who answered all of the details that I was told to say. I read them my credit card number for something just south of \$600 (still only three digits to the left of the decimal point) and they grabbed an appropriate alternator, slapped a shipping label on it, and put it out for overnight shipping.

With that taken care of, we proceeded to enjoy the rest of Tuesday and Wednesday at AirVenture. Upon returning to the dorms on Wednesday night, I went to the front desk and asked if my alternator had been delivered. They handed me the prettiest little box with a brand new alternator inside.

Pre-Op Preparation

Thursday morning we proceeded after breakfast to the airfield. I took my favorite new box along for the ride. Inspection of the new alternator showed me that this was not going to be a simple remove and replace operation. On the original alternator, the field and ground wires were potted in the alternator, and were terminated in a Molex plug to the wiring harness. On the new alternator, the field and ground wires were connected to studs, which required

terminals on the wires. Additionally, the stud for the power output was larger in diameter than the stud on the previous alternator. I don't carry electrical terminals or the tools for installing them in the WRSK kit, as that is an extremely rare repair requirement.

To address the field input, **Stormy** and I proceeded to the Fly Mart to find some ring terminals for 20AWG with the right size hole. Those were reasonably easy to find. However, the power output wire was 4AWG, which used terminals that were big enough that they required a different type of crimping tool than the usual hand crimping tool. We didn't even bother looking for those terminals. The existing terminal had a lot of edge distance around the hole, so I decided that I could just drill the hole in the existing terminal out to the larger required size. Of course, I didn't carry drill bits or a drill motor in the WRSK kit either.

One of the benefits of doing this repair at AirVenture was that I wasn't the first airplane that ever needed repairs at AirVenture. Many years ago, EAA Chapter 75 of the Iowa-Illinois Quad Cities area set up the Emergency Aircraft Repair facility. I went over there and signed out a terminal crimper, a cordless drill motor, and a package of drill bits. They don't charge for borrowing the tools, but they encourage donations, which are used to purchase more tools for future years. I did make a donation, and have made it a point to make a donation each year I attend AirVenture to support this important resource that was there for me in my time of need.

Into the Operating Room...er...Tie Down Spot

By Thursday afternoon I finally had all the parts and tools I needed to make the repair. **Stormy**, **Gary**, and I proceeded to the tie-down spot in the middle of the display area to do some airplane surgery. I would be playing the part of builder/mechanic. **Stormy** would be the Sous-mechanic, and **Gary** was the official documentation photographer. Just for fun, there was a light sprinkling of rain as we were doing this. In all the years of attending AirVenture, it has always rained on at least one day of the show. This was the day. I was able to do some work in the rain shade of the high wing, but actual work in the engine compartment was in the rain. At least a good hat keeps the rain out of your face.

The first task was to remove the nose bowl to get access to the alternator. With the nose bowl off, it was clear that the alternator condition had not changed since closing it up at KRAP. The alternator and its brackets were removed and the field and ground wires were unplugged at the Molex connector.

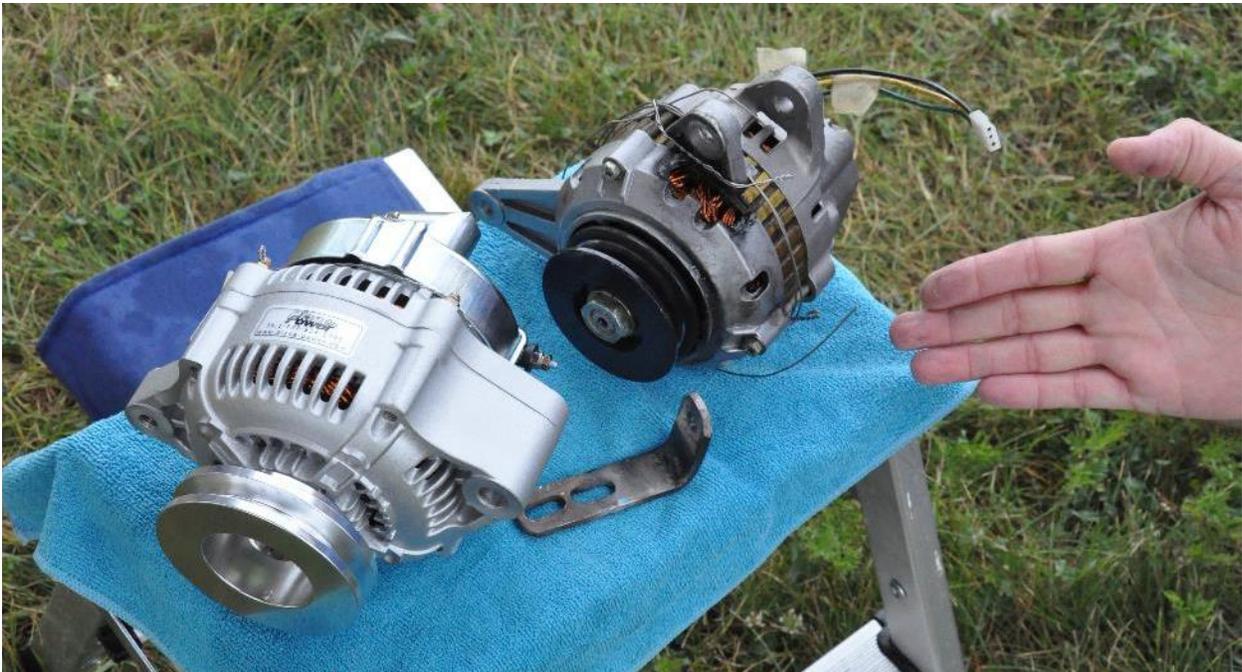
In this picture, the alternator has just been removed from the engine, with the precautionary safety wire still attached. The broken boss has been pulled out to show the extent of the damage.



In this picture, the broken boss has been laid over to show the unusual but fortunate conical break that allowed the boss to continue to support the alternator as long as it continued to be pressed against the case. Additionally, the wiring harness has been cut from the alternator.



Here we see the old busted alternator (BOO!) and the new, pretty alternator (YAY!). The new alternator clearly has a much beefier construction, giving confidence that it will stand up much better to the high vibration environment attached to the Lycoming propulsion package. And it has—as of this writing, the Mitsubishi alternator lasted no more than 40 hours in service. The Plane Power alternator has operated for over 850 hours with no signs of degradation.



This is the rear bracket for the Mitsubishi alternator that was repaired by welding at KRAP. It appears to be 0.125 inch (1/8 inch) thick steel.



Here the new Plane Power mounting hardware has been installed on the engine. The bolts have not been safety wired yet. The brackets are noticeably thicker at about 0.25 inch (1/4 inch) compared to the previous brackets, again instilling confidence that this installation will be much better. The brackets were installed per the drawings that came with the alternator. One of the differences from the previous installation was the part hanging off the front of the bracket. It was in the drawings, but the drawings did not specify what it would attach to. I figured that eventually I would spin it around and see if it conveniently lined up with anything reasonable.

My biggest concern to this point was if I could install the alternator using the same V-belt that the previous alternator used. If not, then not only would I have to find a source for another belt, but I would have to remove and re-install the propeller to get the belt on. That would complicate the repair by about a factor of 10, especially since I didn't have the special tools needed to do that with me. Fortunately, the existing belt worked just fine. Whew!

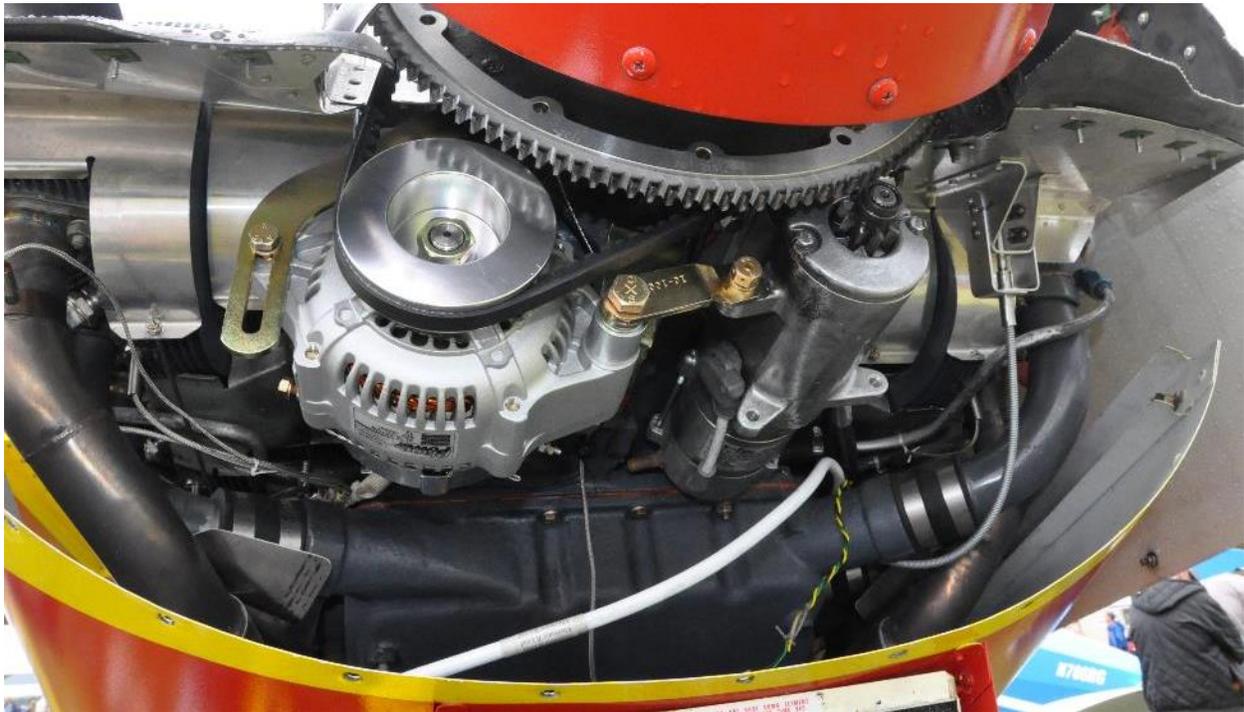


Here I am sitting under the rain protection of the wing working on the alternator installation. Sous-mechanic **Stormy** holds the new alternator while modeling the latest in stylish rain ponchos. I can't say much for myself, as I appear to be wearing shorts and a sweatshirt, a combination that I have often railed against as making no sense at all. Half of it says you think you're warm, and the other half says you think you are cold. I suspect what it really means is that I left the dorm that morning thinking temperatures would be hot, and when the rain started, I pulled a sweatshirt out of the airplane.

Also apparent is one of the benefits of a high wing airplane—the strut tie-down point is convenient for hanging your camera bag, keeping it off of the wet ground. Also shown are the efforts to keep the tools from disappearing into the grass.



Using the cordless drill, I drilled out the terminal on the output wire to a size that would fit over the stud on the alternator. Finally, I installed the alternator in its bracket. I found that the extra bit hanging off the alternator bracket was exactly the right length and shape to attach to the mystery boss on the starter motor that I had no idea why it was there. This gives even more rigidity to a mounting that had already shown itself to be prone to fatigue.



With the alternator tensioned, we see that I lucked out—just barely. If the drive belt had been any shorter there would not have been room left in the adjustment arm to attach the alternator.



With the new alternator successfully installed, the nose bowl was reinstalled, making a complete airplane once again. The WRSK kit was reassembled and put back in the airplane. The borrowed tools were returned in the same condition as they were received. The old, busted alternator and associated bracketry were loaded in the box that the new alternator had come in. Immediately after this picture was snapped, the box fell into the Oshkosh dumpster, and I walked away from it without remorse.



Getting a Waiver for Testing

There was one little detail remaining. While the alternator had been properly installed and the airplane had been put back together, there was still the small chance that something was installed or wired incorrectly, or that the alternator would not want to play nice with the voltage regulator or the rest of the electrical system. This could be easily checked with a short engine run to confirm proper voltage and reasonable amperage. I figured that it was better to find out now if there was a problem while I could still do something about it, rather than wait until departure day after all of the supporting organizations had closed.

However, in the interest of AirVenture attendee safety, there was a firm rule that no engine operation was allowed in the display area. One option was to push the airplane about 100 yards to the taxiway outside of the display area, run the engine for less than 30 seconds, then push the airplane the 100 yards back to where it was.

The no engine operation rule is a good rule, and one I support. However, over my many years in flight test, I have learned that rules can be waived, if you ask nicely and have a sound risk mitigation plan. I found the supervisor of the flight line safety team, whose usual job is to assist moving airplanes into and out of parking in a safe fashion. I explained to him that I had just installed a replacement alternator and I wanted to do a short engine run to verify it was working while I still had time to fix it if it wasn't. He wasn't too crazy about getting his teenage volunteers to push the airplane 100 yards just to push it 100 yards back. Perhaps there was a better way. After some discussion, we decided a better plan was to push the airplane out of its parking spot and turn it 90 degrees so that it wouldn't blow on the airplanes parked next to it. He would collect his 12 or so volunteers and arrange them in a circle around the airplane as a human shield to keep unwitting spectators from blindly walking into a spinning propeller. I would start the engine, run it just long enough to confirm that the alternator was alternating, then shut it down. After that, the airplane would be pushed back into its parking spot. We also decided to schedule the engine run for early the next

morning. In the morning there would be less spectators to have to worry about, and it would give him time to assemble and brief his volunteers.

On the next morning, the volunteers assembled. We pushed the airplane out as briefed, and the volunteers formed a circle around the airplane. Here we see two volunteers stationed off the left wing tip, ready to aggressively protect the airshow-going public. It did seem strange to me that all of the volunteers stood facing inward, watching the airplane, rather than facing outward looking for hapless spectators.



As briefed, I ran the engine start checklists. I hit the starter and the engine fired up. I looked at the EDM-900 engine instrument. When I had confirmed proper voltage and amperage, I shut the engine down. Total run time—less than 30 seconds. Confident that the new improved alternator would work properly for Sunday’s departure, we pushed the airplane back into its parking spot.



Finishing the Job

Even though the alternator installation was done in the field, it turned out to have been done quite well. In fact, the alternator was never touched again for ten years and 641 flight hours. At that time, it was touched because the propeller and thus drive belt had to be removed to replace the front crankshaft oil seal.

The only additional work that was done after returning to home base was to run a SCAT tube from the front baffle to the provided connector on the back of the alternator. This installation blows cooling air over the rectifier diodes to keep them cool and extend their useful life.

Feelings of Déjà Vu All Over Again

In 2023, I once again flew the Bearhawk to AirVenture, again overnighting at Rapid City Regional Airport. Once again, I was directed to the same PSP covered transient parking area. I couldn't shake the idea of what had happened the last time the Bearhawk was parked there, so before leaving for the night I took the time to inspect the condition of the alternator very carefully. It was fine.



It became clear that somebody at KRAP had found a way to turn a weird identifier into a commercial opportunity. My copilot for the trip **Glenn Nicholson** couldn't resist buying a T-shirt, which he proudly wore for his official rookie picture at the Brown Arch at AirVenture. His shirt reads "I Flew Through KRAP To Get Here". **Stormy Weathers**, the Sous-Mechanic and Parts Holder of the previous story, is the photographer in this picture.



- Russ Erb