Twin Comanche Electric Fuel Pumps: Complex Issue, No Simple Answer (Feb 2005)

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Last June I heard about multiple Weldon fuel pump motor failures in a Twin Comanche being serviced by a reputable shop in Biggin Hill, U.K. ICS members John Keates and Peter Greenyer operate the shop, Shipping and Airlines. Then later, I had a report of the same situation here in the states from ICS member Robert Deloach of Florida.

The scenario is that the pump motor fails and a replacement pump motor unit is installed only to fail in less than 20 hours of flight time. In both instances a third pump was installed, only to also fail prematurely. When I say the pump fails, in actuality it is the pump motor that usually burns out.

This is frustrating for more than one reason. The unit is expensive, and access and removal for replacement is difficult and time-consuming.

I thought I would look into these failures and find a common factor and a simple solution. It turns out that the answers are not based on a common factor and there is not a simple solution. In the course of this investigation, I have had conversations with John Regier and Bob Weber at Webco, Aviation Innovations, Weldon, and two of the Weldon pump distributors.

Weldon's Position

I placed a call to Weldon pumps, and was connected to Gary Carleton. Gary was very cooperative and interested in the problem and has offered us a good deal of information.

Weldon provided the electric fuel pumps to Piper throughout the entire production run of the Twin Comanche. Unfortunately, we do not have any other choices other than the Weldon pumps for use in our twins. The following information is a history of the motor types that Weldon provided to Piper. As far as I can see, the fuel pump unit has remained for the most part unchanged over the years. It is only the motor that drives the pump that has changed.

The original equipment motor on the early Twin Comanche pump installations was a Globe motor, p/n 8800-12B. The 8800 pump series included a very large black motor. The pump/motor combination was designated p/n C8100-C. The Globe motor went out of production in 1979.

The motor Weldon used on the next production series for the Twin Comanche was p/n 8850-5A and the pump/motor combination was designated p/n C-8100-G. Only about 50 of these units were produced. It is now considered obsolete.

The 8850-5A motor was replaced by the 8850-5E. Weldon later discovered a problem with the 8850-5E when used in some particular installations where it was being run continuously. That is not the situation in our Twin Comanches.

The 8850-5E was replaced by motor p/n 8850-5. But the 8850-5 is about one quarter inch longer than the 8850-5E and doesn't fit in our Twins. If it is installed, it will need to be forced into place. The stress on the pump due to the tight fit will cause premature motor failure. Consequently, Weldon continued to produce the 8850-5E in limited quantities – just for our Twin Comanches. This motor pump unit p/n is designated C8100-J.

Weldon developed another motor, the 10154. It is supposedly a higher torque motor and is also only as long as the 8850-5E, so it is also okay for our twins and the motor-pump p/n is also C8100-J. The installations in our Twin Comanches are unique in another way. The pump is mounted to the airframe on a platform and the fuel lines are solid aluminum rather than a flexible material like neoprene. Consequently

there is not much accommodation for flexibility or misalignment. According to Weldon, the tolerances in the pump are one ten thousandth of an inch. So externally applied stress can cause an excessive current draw.

Considering the above stated facts, the two primary reasons for premature motor/pump failures according to Gary Carleton are:
1. The wrong pump/motor package has been installed;
2. The fuel lines were “gorilla” torqued (over-tightened).

I have had our Webmaster John Dunning post some Weldon pump drawings obtained from Weldon on our Web site in the technical section. These drawings include data on the maximum current draw of the motors. Using this info, you can check the amperage draw under load after making an installation. If the current draw is within specs, (according to Gary) you should enjoy normal pump service life. Using these drawings, our German Technical Committee member, Friedrich Rehkopf has assimilated the information into an Excel spreadsheet. This information is also on our Web site.

Webco’s Turn

Bob Weber had a different point of view concerning pump motor failures.

I had a long visit with Bob who has spent a good deal of time researching this problem, including a visit to the Weldon factory. Bob’s shop, Webco, has done testing on these pumps when new and they find they will often not start on 10 volts or less, which is often the condition of the battery when we prime our engines prior to starting.

When Bob was at the factory, he discovered Weldon was testing the pumps at 14 volts.

And, of course, they started and operated just fine. Remember, if you have generators on your Twin, and you start up at night and turn on avionics and lights, there might not be enough voltage to run the pumps unless you get your RPM well over 1000. With alternators you will probably get 14 volts or more at idle.

Bob believes another issue is the later model 10154 motors. They are a permanent magnet variety. Bob has received independent opinions that these motors do not have nearly the stamina of the early models. If you have an earlier model, non-permanent magnet motor, Bob recommends that by all means do an overhaul on that motor rather than a replacement.

On the “over-torquing” issue: Bob stated that it seems odd that prior to the 10154 motors, over-torquing did not seem to be an issue. Bob poses the question: “From 1963 until Weldon went with the permanent magnet motor, where were the ‘gorilla mechanics’?”

And regarding the statement from Weldon about the 1/10,000 of an inch, Bob is convinced that the statement is meant to confuse people. If the 1/10,000 means + or – in manufacturing, it would not be uncommon for any CNC to produce parts within those specs. But, if they are talking about 1/10,000 clearance between the brass housing and the rotor shaft, that would never work. This would be running a steel shaft in a brass housing and running it no lubricated except for the fuel on the shaft.

Another issue that the guys at Webco discovered is that the machining process of the new production pumps leaves much to be desired. The pump has a partial cam drive and the machining process leaves a notch in the rotor vane. If the rotor is polished, the pump will turn more easily without binding on the notch. Also there is a circlip-type spring around the vanes that applies pressure on the vanes against the rotor. The original spring was .030 thousandth thick. For some unfathomable reason, the new springs are .050 thick and apply excessive pressure on the rotor causing more drag and a higher current draw.

Webco has found a source for the lighter springs which work quite well. Bob has told me that he has discussed these issues with Weldon, or I should say he has “tried” to discuss these issues. According to Bob, they have been unresponsive.

Weldon is also sometimes unwilling to warrant its work. Bob recently sent in a new failed pump motor unit to Weldon. They returned the pump to Bob's shop, claiming that since the pump decal and paint had some 'scrape' marks on it; the pump must have been placed in a vise, so therefore the warranty is void.

Bob sent me a photo of the unit in question. First, the decal and paint scrape area is in a depressed area that a vise would not contact. Second, it is difficult if not impossible to install and remove the pump motor unit into the tight confines of the belly of our Twin Comanches without doing some external cosmetic damage to the unit.

Aviation Innovations' Solution

This article would not be complete without input from Aviation Innovations. They are one of our Comanche Flyer advertisers, and they have an STC to install the more commonly available and less expensive 8850-5 motors in our Twins. The motors are cheaper to obtain because of the higher number production runs. As stated earlier, the 8850-5E is now produced only for the Twin Comanche, so the production runs on the 5E are very limited resulting in a higher price.

The Aviation Innovations STC involves the loan of an angled pneumatic drill, air line fittings, and a hole saw to cut holes in the bulkhead. A set of dimpling dies finishes off the job. This provides for the clearance needed for the 8850-5 motors, which as stated earlier are one quarter inch longer.

The STC also makes for easier access and quicker pump removal and replacement due to revising the floor panel access. They also provide for modification of the pump and motor mounting system. Some of the changes incorporate improvements that exist only on the later model twins. With these changes, there is less internal stress on the pump and quieter operation. Pump drain lines and fittings are also modified. The modifications are advertised to take 2 to 3 hours, but once done, a complete pump motor change out takes three or four hours instead of up to 10.

I spoke with Dave Aldred, who developed the STC. He reiterated much of what Bob Weber told me. He has independently come to some of the same conclusions as Bob concerning the lack of quality control and design deficiencies of the Weldon pump/motor units.

In Dave's own Twin Comanche, he experienced six or seven pump failures in a two-year period. This is what led him to investigate the cause and eventually led to the improvements incorporated in his STC and the custom work he does to the pumps in the overhaul process.

One fact Dave discovered was shaft bearings on the early 8800 motors (the large black Globe motors) that were specially manufactured .003 thousandths of an inch oversize. Those bearings are no longer available from Weldon. If a standard bearing is used, the bearing will not be snug within the end frame housing.

Eventually the bearing will spin within the housing. Then misalignment occurs, resulting in high current draw and motor burnout. Dave recommends to not rebuild the early 8800 motors. Bob Weber agrees the bearings are kind of oddball. Most bearings are manufactured in millimeters. The bearing for this pump has a millimeter O.D. and the bore is S.A.E. Bob has found another source for the bearings, and he carries them in stock.

Dave pointed out that the pump motors each should draw only about 5 amps maximum when running, yet the two pump/motors are on the same 25- amp circuit breaker. This is the case in the early PA-30s and the early PA-30B models. The later PA-30B and C models and the PA-39 have a separate 10-amp circuit breaker to help protect the motor.

You could conclude from this fact that Piper designed the 25-amp circuit breaker to protect the wiring system of the Twin Comanche from the pump motor circuit, and did nothing to protect the motors from burnout. Therefore if an installation results in a high amperage draw, for whatever reason, the motor could simply burn out.

One of the features of the Aviation Innovation STC is an inline slow blow 8-amp fuse for the earlier Twins. The placement of the fuse is in the landing gear motor bay to allow convenient access. In the event of high-amp draw the fuse will blow. This results in a cost savings of up to $1,200, since the fuse is $1 and the motor/pump package is $350 or $1,200 depending on whether you use the 8850-5 or 8850-5E pump.

Bob Weber is of the opinion that installing the 8-amp fuse would be a mistake. He feels that this procedure could leave somebody, depending on the circumstance, with a dead engine. Bob would rather see the pump get hot for whatever reason and continue to operate. If the engine-driven mechanical fuel pump has failed and the Weldon pump quits, the engine will definitely quit also.

Dave related that the pump assembly is press fit together, and although it looks simple, it is quite easy to achieve misalignment during the assembly process. If this occurs there will be a “drag” spot on rotation of the pump shaft. If the motor stops at the drag spot, which is quite likely, the motor will probably not start the next time voltage is applied. The result could be a motor burnout, especially if you only have the 25-amp breaker.

Dave offers a rebuilt pump/motor assembly which has been test run for five hours and does not draw more than 5 amps and will run on as little as 5 volts. All of these motors need about 15 amps for a fraction of a second at about 11.5 volts to start. Some are a bit better, some worse, depending on the variables in tolerances.

Dave does a Voltage Cut Out test, and it is done while the pump is running as opposed to start-up. He has found that for a pump to continue to operate down to a voltage of 5 or less volts, the unit has to be running pretty true and free. Any binding will show up with a higher voltage cutout, or to put it another way, the motor will stop running (stall) at a higher value as the voltage is reduced.

As an example, a pump that will still run on 3 volts has less drag and binding than a one that stalls as the voltage gets down to 6. Dave finds that after running the units several hours, the current draw will usually settle down to 3 to 4.5 amps. In conclusion, if your installation will start and run on 10 volts, and draws no more than 5 amps, you should get good service life. Both Bob and Dave agree on this issue.

Aviation Innovations offer a number of options to their customers. Two overhauled pump sections with new 8850-5 motors with the conversion kit is $1,750. They will also sell one unit if the customer should want to continue one old unit in service that is still running well. The customer can make the modification and still use the good unit. Then, down the road when that unit fails, they will sell a replacement that can be installed with no further modification. That option, for the one pump and conversion kit, is $1,050. A single, overhauled pump section with new motor is $800. All the prices are with exchange cores.

They also do the same three options with all new pump sections. Those prices are $2,375, $1,425, and $1,025 respectively.

Banish Water from Your Fuel System

There are some other potential problems that can cause pump motor failures.

One of the most serious potential problems affecting your fuel pumps, and actually the entire fuel system, is water contamination. Any rust, scale or other contamination caused by water in the system, running through the Weldon fuel pump units is not a good thing. Jamming and binding from this foreign material is a very real probability. Therefore, in order for any of these units to have a chance to work well, the fuel system must be kept clean.

Of the various pump cores that are returned to Aviation Innovations, they are seeing about 20 to 30 percent with some degree of corrosion damage. Dave related one case where a customer returned one of their units after just a few months. Upon disassembly and inspection, extensive corrosion damage was found. Dave said it was surprising to see how quickly a new unit could be completely trashed.

Bob agrees about rust getting in the motors on the basis that they overhaul lots of PA30 fuel valves. A lot of them are full of rust. Bob believes that can result from the practice of not draining every port on the selector valve, including cross feed.

The importance of protecting the airplane from the elements cannot be overstressed. If the airplane can't be hangared, then covers such as bath mats with the suction cups or rubber floor mats can be placed over the fuel ports, and the sumps drained faithfully.

Keep in mind the fuel system is from the tank caps to the engine cylinders. Replacement gasket seals on the tank covers and the gas caps themselves can be obtained from Webco. If your door gaskets or caps are in bad shape, replace them. If debris gets to your pumps, the filter screen in the sump might be compromised. Again, our friends at Webco are the source for this part. Check to be sure the overflow lines in the tank fill bay are clear. An old piece of tachometer cable works well for clearing tank overflow lines and tank vent lines.

Is Your Electrical System Healthy?

Another factor affecting the pump motor startup and running is electrical system integrity. System switches, wiring, circuit breakers, grounds and other connections, which are 40-plus years old with many thousands of cycles on them, can be high resistance points. High resistance points cause voltage drop, which reduces the voltage available across the motor. This makes the problems described above more likely, and could cause the motor to stall on startup.

It's easy to forget that the pump motor needs an electrical system capable of starting, running and supplying the pump motor with what it needs to function properly. Run your pump motors independently when priming the engines so you can hear and confirm that each motor is running. If it isn't running, you could be sending voltage to a jammed-up unit. The motor will burn up rather quickly if there is not an 8-amp fuse or 10 amp breaker in the line to protect the motor.

As stated earlier, generators don't put out much amperage unless your RPM is above 1000. It's a good idea to reduce the current load on landing. If you don't, by the time you taxi back to parking with all the avionics and lights on, the battery voltage may draw down enough there may not be adequate voltage to run the pump motors to prime the engines next time you want to go flying.

If you are lucky enough to have alternators, this is not a concern, as they will put out good amperage and keep up the battery voltage even at idle.

Complex Issue Deserves Careful Planning

Personally, I see nothing wrong with having your mechanic overhaul these units if care is taken to adhere to the warnings stated above. This is especially true given that I have come to the conclusion that Weldon will do whatever they can to avoid warranty coverage on their product.

So if you elect to purchase a new unit from them or one of their distributors, keep in mind that you may have an uphill battle on your hands in the event of failure. If you and/or your mechanic are uncomfortable doing an overhaul, I would suggest you send your pump to Webco for overhaul or purchase an STC'd replacement-overhauled unit from Aviation Innovations.

As I stated at the beginning of this article, the issue is more complex that it would appear at first glance. There is not one simple, universal answer. Bob and Dave do not agree on all the issues regarding our Weldon pumps, although they do agree on most. One issue they do agree on: Quality control and performance standards at Weldon leave much to be desired.

Happy flying!