

How I Survived adding OEM Power Steering to my FJ40

Foreword:

This story has gone through several stages. First it was a “hey, look at what I did” piece, containing pitiful stabs at humor. It then developed aspirations of maturing into a serious technical piece. Towards the end, it was transformed into a cautionary tale. For the grand finale, I’ve carefully embraced the worst aspects of each previous phase.



Thinking About It

I have an '81 FJ40 which I've decided to keep relatively stock in appearance and components – except for dents. I'm the third owner. The truck was originally sold in Santa Barbara, California without the stock AM radio, air conditioning (a/c), or power steering (p/s) options that were potentially available for these vehicles. I'm told that the number of USA Land Cruisers sold with a/c and/or p/s was relatively small – but I've also heard that the percentage of late-model FJ40s with these options was actually quite high. Be that as it may, today they are considered very desirable features indeed.

I first considered adding stock a/c, but soon changed my mind. It is already so crowded on the passenger side of the engine compartment, with the alternator, ignition wires, battery, fuel filter, oil filter, distributor, etc., that it is hard to check the timing and change the oil filter as it is. After noting how much room a/c parts take up in Toyota sedans – e.g., with 22R engines – I asked myself if I really wanted to add more equipment to the existing '81 2F, with its mass of pollution control spaghetti.

Then I got a hold of the Toyota parts list on microfiche for the late model '80/'84 North American FJ/BJ4 series 'Cruisers. It proved to be an eye-opener. In order to install a complete factory air conditioning system, I might have had to replace all kinds of standard parts. Not only are there the obvious air conditioning components themselves, but there are alternative versions of many seemingly unrelated items in several locations – e.g., a triple pulley on the crankshaft, a different battery tray holder, a different fan shroud, and so forth. Now maybe you need to change all these items and maybe you don't, but it put me off the idea of wanting OEM a/c once and for all.

I next considered the p/s option. Both off and on road experience told me that my unspectacular driving skills could really benefit from an assist at low speeds for the otherwise unwieldy steering. After all, my arms are not getting any younger.

Fortunately there was nothing wrong with my stock manual steering mechanism. Play was minimal – the vehicle only had 50,000 miles on the odometer. Therefore, when an opportunity to buy a used p/s gearbox and other parts for a good price from a fellow in Salt Lake City came along, I took the plunge...

Gathering the Parts

Buying and selling used equipment can be daunt-

ing, but it's also something that can become quite satisfying. How do you arrange the sale? Can you trust the other person? Why is the mail so darned slow?

Fortunately, I'm convinced that most Land Cruiser people are inherently trustworthy. Don't get me wrong, the ones that I've met love a bargain as much as the next fellow. Also, I take extra precautions with any that admit to being fishermen, but otherwise most 'Cruiser owners are OK people. Therefore, in no time flat I had a big box full of used goodies from Salt Lake City. What else was needed? Here's where the Toyota parts list came in really handy.

The stock p/s assembly consists of:

- Gearbox
- p/s ("vane") pump
- Pump pulley*
- Set of pulley hardware (nut, washers, key)*
- Pump bracket (to mount the pump to the side of the engine block)*
- Bracket hardware (3 bolts, 4 lock washers, 1 stud, 1 nut)*
- High pressure p/s fluid hose
- Set of 2 low pressure p/s fluid hoses*
- Low pressure connecting tube
- Set of 4 hose clamps*
- Fluid cooling tube (fits under the radiator) with bolt-on clamps
- Cooling tube hardware (3 bolts)*
- New, longer alternator-p/s pump-fan belt*
- "Secret" part and hardware related to the smog pump (see below)*
- A double-secret part related to the steering column (again, see below)

A check with my local Toyota dealer confirmed that the items marked with an asterisk (*) were still available from Toyota. I used the Internet and local pick 'n curse self-service auto bone yards for the rest.

I must confess that I love to visit self-service auto dismantlers. It's interesting how some small parts for late model Land Cruisers were also used in other Toyota models, including the sedans. For example, did you know that the optional center console ashtray from an '81-'83 FJ40 – the very same plastic ashtray that used to be available only from Japan for a zillion dollars – is also found in nearly every wrecked '80 Celica in jazzy designer colors for about a dollar? And what about good quality, high-rated, zinc coated hardware, which costs a small fortune from Toyota? It's all sitting out in your local auto junkyard.

True, none of the big, important stuff for the FJ40 p/s system seems to be the same as that found in a Toyota pickup or sedan, but you can find some things. Like the pulley axle key, most of the hardware in the right length and at the correct structural rating, suitable high pressure hoses, and even connecting tubes, is available, all for peanuts. Naturally, you should verify that everything is in good shape, and you have to be willing to go and get it, or pay someone else to. I've also had good luck with classified ads. I advertised for FJ40 parts in *ToyotaTrails* and in the appropriate newsgroups and mail-lists on the Internet, bought some more p/s parts – pump, bracket, pulley, hoses, cooler, and a second gearbox – from a fellow in Georgia, and got to talk to some nice people nationwide. By this time I'd learned from the more experienced folks that gearboxes do wear out, and while they can be rebuilt, it might be a good idea to have a spare, especially since the price was a bargain compared to the new price. I would sell the extra parts later, I reasoned. A warning to you wives and girlfriends out there – don't listen to the "I'll sell it later" argument.

I first decided not to buy a used FJ60 p/s pump, though they are more plentiful. The FJ60 has a different frame, gearbox, and steering geometry so the pump specifications may vary also, I reasoned. While the FJ60 pump output may be slightly greater, I suspect, now, that either model pump may be used successfully.

Inevitably, there are disappointments when pursuing used parts. For example, I discovered that the p/s pump from an '81 Cressida wasn't quite the same as a 'Cruiser pump, despite looking very similar. Another heartbreak: the used p/s pump pulley from Georgia arrived broken. This particular pulley, an early one no doubt, had been made of cast steel – very brittle – and didn't survive the trip. Too bad. Then I discovered another peculiarity. Remember how I mentioned that the factory a/c option required lots of supplementary parts changes around the engine compartment? Well, the p/s option has a little trick of its own... the smog pump adjustment bracket.

Turns out that when a p/s pump/bracket assembly is installed it buries the smog pump and its bracket, making manual adjustment of the smog pump-fan belt difficult, to say the least. So Toyota engineers designed an alternative smog pump bracket that used the same threaded hardware for adjustment as is used on the alternator over on the other side of the engine. The idea was to make it easy to tighten the smog pump belt with a wrench and to move the smog pump bracket out of the way of the p/s pump/bracket

assembly. The alternate smog pump bracket attaches directly to the p/s pump bracket, not to the engine block as is the case when the engine lacks p/s. And no, this special bracket is not available on any other non-'Cruiser Toyota model I'm aware of.

Luckily another Land Cruiser owner on the Internet came through with both a used p/s pump pulley and a smog pump adjustment bracket at a good price. His pulley, from an '83 FJ60 p/s pump I believe, though the same size as the first one I received was constructed of milled steel, and arrived in one piece. I was saved.

*"...the smart mechanic
– who?, where? – would store all
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labels, safely away, or at least
temporarily insert as many bolts
as possible loosely into their
threaded holes pending reassembly.
I didn't, and my clumsy cat made
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pile resting on top of a fender."*

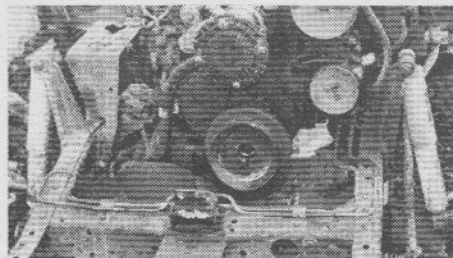
After cleaning everything off I stared at it for awhile. Next step, install the parts and look for a new girl friend.

Of Barked Knuckles and Red Fluids

One look at the engine compartment confirmed that in order for new parts to go in, existing parts had to come off first. Parts like the radiator, air cleaner assembly, and left-front fender. The radiator comes out pretty easily. Of course, it helps if you drain the cooling system first; always a wise move. The fan shroud is somewhat difficult, but with some effort it comes out so that the fan can be removed. At this point, the smart mechanic – who?, where? – would store all the hardware, with descriptive labels, safely away, or at least temporarily insert as many bolts as possible loosely into their threaded holes pending reassembly. I didn't, and my clumsy cat made a midnight raid on the hardware pile resting on top of a fender. Luckily I was able to find it all eventually, the next day.

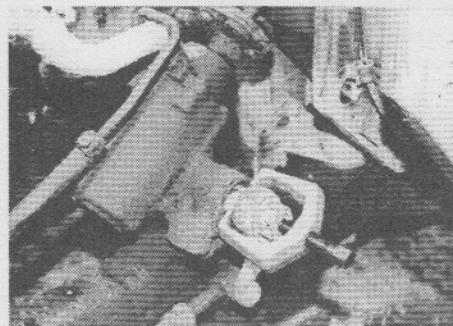
Once the radiator was out, I could see that the radiator support bracket also had to come out. It's held in place by two bolts in the bottom and two side rods. The reason it has to be removed is that underneath is where the p/s cooling tube has to

be attached. I had some trepidation about fitting this long, gangly piece of curved and routed tubing into the engine compartment. What if it didn't fit? Would it be shaped properly? But I was thrilled to find that it went right in.



Everywhere there was an attachment bracket on the cooling tube assembly, there was a suitable threaded hole in the frame just waiting to accept a bolt. (This obviously would not be true for FJ40s before 1979.) A little bit of WD-40 and an appropriately sized tap (from a metric tap and die set) took care of the rust in the threaded frame holes.

At this point, I had to worry about getting the manual gearbox out and the p/s gearbox in. The Toyota repair manual – Pub. No. 36044E – and/or special p/s repair manual supplement – Pub. No. 98344 – tell you to detach the (a) hoses, (b) steering shaft coupler, (c) heat shield, and (d) pitman arm, in that order. Then the gearbox can be carefully removed.

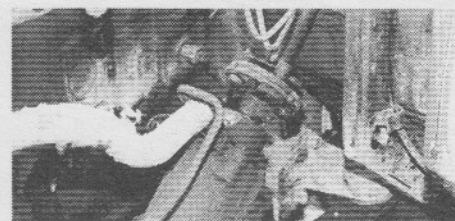


Ever try to remove a 15 year-old pitman arm? Oh sure, I had a removal tool, but not the NASA-approved, made-for-work-on-Jupiter tool that Toyota mechanics are issued. After a brief but frustrating period I cleverly decided that I wanted to leave the pitman arm on after all. That meant making enough space somehow to get the gearbox out with the arm still attached. What to do?

A night's sleep solved the problem. The whole vehicle comes apart, after all, usually by removing just nuts and bolts, right? I would just remove the left front fender. Actually, removing several bolts allowed the fender to be carefully moved over to rest on the axle/tire, far enough to the

side to allow the gearbox transfer without much of a problem. The used p/s gearbox had its own pitman arm and drag link connector, so that was no problem.

The gearbox bracket is luckily the same for both the manual and p/s gearboxes. I tapped out the threads for the bolt/stud holes and cleaned the 2 bolts and 2 studs and attached the p/s gearbox. I used the Toyota repair manuals to guide my efforts and occasionally to kneel on. Both types of gearbox rely on a flexible coupler piece, clamped to the splined gearbox axle, to attach to the steering column.



I noticed when installing the p/s gearbox that the fit with the coupler and steering shaft was very tight, but it finally went on after first loosening the steering column. More on this later.

With that part out of the way, it was on to the vane pump.

Out came the smog pump. Off came the front exhaust header heat shroud. Since I had already replaced the crumbling, original shroud (made with asbestos) with the newer all-steel replacement during an earlier manifold gasket repair, I had no problems with this step.

These removals exposed the three side- and one forward-facing bolt-holes, already pre-drilled into the left-front engine block.



(If you have a '78 or earlier 2F engine, it will probably not have these holes.) The holes and a flat mating surface are there to mount the p/s pump bracket via three bolts and one stud (no snide comments, ladies).

Because these holes had been unused for 15 years, they had to be tapped, a tricky maneuver on cast iron. I used caution not to break off a tap inside the holes – that would have been bad, very bad. The three bolts had been sent with the used bracket. I purchased a new metric stud from Toyota to occupy the fourth hole in the front of the engine block.

On went the bracket, with pump pre-attached. It fit like a glove. The manifold shroud, smog pump, and new (used) smog pump adjustment bracket went back on relatively easily. As I indicated before, the adjustment hardware for the smog pump/alternator brackets is still available from Toyota.

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Hooking up the hoses between the pump and gearbox was relatively straightforward. I wanted to be sure I knew which gearbox hole was for incoming high pressure and which one was for low pressure return flows, so I once again relied on the Toyota manuals. The two FJ40 gearboxes I had acquired actually differed slightly. One had two threaded openings of the same size. The other had openings of different sizes (the low pressure opening being smaller). I assume that changes were made at some point in the design for some engineering reason. At the junkyard I found that the same was true for other gearboxes in Toyota sedans of the late '70s to early '80s. So I collected several attachment tubes of different lengths and of different connector sizes from the various models. I also got some spare union seats (little brass pieces) in each of the two sizes, though I later found that new ones were still available from Toyota.

When I attempted to connect the stock low-pressure attachment tube to the cooling tube with a short piece of hose I found that the two ends didn't align satisfactorily. This was apparently because the gearbox and its tube were from one model-year, and the cooling tube from a different year. No problem. At this point my trips to

the local boneyard really paid off. A shorter attachment tube (from a Celica, I think), fit the gearbox and was the right length so that its end lined up closely with the start of the cooling tube.



That short piece of p/s hose, attached with cleaned-up hose clamps from the boneyard, made the connection. Likewise with the low-pressure hose from the other end of the cooling tube to the return nozzle on the p/s pump.

New low-pressure hose is, of course, available from any parts shop. However, finding a proper new high-pressure hose may be a problem. Toyota no longer sells them! (An article about the growing number of crucial replacement parts that Toyota no longer offers may be in order. Potential authors take note.) Standard parts stores may not have a high-pressure hose that will fit the metric-threaded holes in the pump and gearbox. One trick is to take the metric-threaded ends from a used hose to a hydraulic or custom hose shop and have them make a new hose with the hardware you supply.

An Entirely “New” Truck

Maybe this is a good time to run down how the whole p/s assembly is expected to work. Theoretically, the engine would run and through one of its crankshaft pulley belts turn the p/s pump pulley, driving the pump to force out fluid at a relatively high pressure through the hose to the gearbox. The steering wheel is connected to the gearbox. Let's get down and technical at this point; something magical occurs inside the gearbox to make turning the steering wheel easier. The fluid, which is warmed due to the pressure and action inside the gearbox and its proximity to the exhaust manifold, and which has subsequently lost its high pressure, flows more leisurely through low-pressure hoses to the long cooling tube under the radiator, where it loses heat. The fluid then returns to the pump to start the process all over again. Pretty simple, except for the gearbox alchemy. I'll figure that out some other time, after I have had to rebuild a gearbox.

By the way, I did another – rare, for me – smart thing and bought a set of flare nut wrenches from

Sears for this job. Ever try to remove an old p/s high-pressure hose coupling? They are often on tightly, and with good reason. The brass union seat inside the gearbox mates with the end of the hose coupler to create a tight seal against leakage. Flare nut wrenches are like box-end wrenches, except they have a small opening that allows them to fit past the hose connection hardware and over the tightening nut on a high-pressure hose coupling. They can still grip the tightening nut more securely and safely than an open end or adjusting wrench and therefore lower the chance of damaging the nut. These wrenches are commonly used for hydraulic hoses – the kind used in air conditioning, refrigeration, brake, clutch, and similar applications. If you use a regular wrench, you run the risk of rounding the tightening nut – bad news.

Now it was time to put everything back together and try it out.

In order to test the new (used) p/s, I had to get the cooling system back in. One of the radiator hose clamps turned up missing, only to be found at the bottom of the container with the stored antifreeze. Darned cat! With the radiator back in, the two belts (smog and alternator-p/s) tightened (not too much), and all hoses attached and checked, I was ready to add fluid. Luckily I didn't listen to the kid at the auto parts store with the 235 tattoos who said to buy power steering fluid. Instead I did follow the Toyota owner's manual specifications and added the correct type of automatic transmission fluid.

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When I finally started the engine, and tried the steering I felt a twinge of panic. It was stiff as a board. Then I checked the pump reservoir. Where did all the fluid go? Oh yeah, I had to add enough to fill the gearbox and the return hose/tube system. With enough fluid in, the magic occurred. Suddenly, I could turn the steering wheel with one finger (this with the wheels firmly on the ground). After a short period I drained the p/s fluid and put in clean fluid. No telling what kind of residue was in the used pump and gearbox.

The factory system works great. Steering is rock-steady on the highway and it's a lot easier traversing the stones and debris on Sierra logging roads as well as the potholes of the cities. With the short wheelbase and p/s parallel parking in town is now a breeze. This add-on has truly made this truck a completely "new" and better vehicle, and using factory parts made the job somewhat easier and less stressful – no welding or cutting involved.

But unbeknownst to me, my job was not over...

One Last Trick Up Its Sleeve

Remember how the fit of the new p/s gearbox to the steering column was rather tight? There's a good reason for this. Sometimes, when really involved in a project, a person can overlook a really obvious fact.

Just about the time I was submitting an earlier draft of this story to *Toyota Trails*, I was alerted via a posting on the TLCA's e-mail list service that there may have been an alternate steering column offered for use with the factory p/s. Dusting off my Toyota parts list, I checked. Sure enough – Toyota had one final trick up its corporate sleeve. Truly the last, I hope.

It turns out that the FJ40 p/s gearbox is longer than the manual steering version. Why I didn't originally notice this, I have no idea. This means that the steering column assembly has to be shorter at some point. The inner steering shaft, running from the gearbox all the way to the steering wheel, is the logical place to do it.

Like their predecessors, North American FJ40s with p/s from 1979 and early 1980 used a one-piece steering shaft. A check of the appropriate parts list shows that two different shafts were offered – one longer, one shorter I'm guessing. In 8/80, Toyota switched (probably due to North American DOT rules) to a 2-piece, collapsible steering shaft assembly. In these later FJ40s and BJ42s a short "intermediate shaft" attaches to the gearbox and couples to the longer main shaft at the firewall. This change proved to be beneficial to me, since the intermediate shaft became the part that was offered in two sizes. It is relatively small, and it's easy to remove and replace or modify.

Once I confirmed that a shorter steering column was in order, I decided to make the needed change. Although I had attached the p/s gearbox to the original shaft without shortening it, I don't recommend this. I suspect that it places unnecessary strain on the flexible coupler and the joint between

the two shafts, and could prove unsafe over time. What I'm going to describe next applies to the 2-piece '80-'84 FJ/BJ steering column assembly.

"Well, that's my story, sad but true. What are the lessons? First, that Toyota built a pretty darn good vehicle, both with and without power steering. I've since installed power steering on a '78 Toyota sedan and a Honda Accord of the same vintage. The Toyota design was much simpler, and seems to work as well, if not better."

The operation to make the desired change proved to be relatively painless – kind of anticlimactic. After detaching three electrical connectors next to the steering column, I disconnected the steering column assembly from the (a) gearbox coupler (2 bolts), (b) inside firewall (4 bolts), and (c) dashboard (2 larger bolts) – the nice thing about FJ40s is that much of the connecting hardware is relatively easy to get at. A snap-ring holds a rubber grease-gasket seal in place at the joint between the intermediate and main shafts – invest in some snap-ring pliers to make removal easy. The intermediate shaft is apparently meant to have some freedom of horizontal motion within a grease bath at the junction-joint at the end of the main shaft. With the snap-ring removed, it is relatively easy to use the intermediate shaft to help force the seal up the shaft and out of the joint, freeing the end of the intermediate shaft from that joint.

The driver's-end of the intermediate shaft has a metal pin through it perpendicularly, about one-half inch from its end. The two exposed ends of the pin hold metal anti-vibration blocks in small track-grooves in the grease-filled joint at the end of the main shaft. If this sounds complex, don't worry. It is actually less confusing once you see it. Once separated, the rest of the steering column with steering wheel attached, can be carefully put aside. I first decided to try and find a used intermediate shaft from an FJ40 with p/s. After searching my previous sources, and calling around to Land Cruiser used parts suppliers, I came up empty-handed. Then I re-attached the steering column assembly, minus the intermediate shaft, and did some measurements in the empty space the intermediate shaft used to occupy. I calculated that a replacement inter-

mediate shaft would have to be 7/8 of an inch shorter. Be sure to measure, as the length change may vary slightly from truck to truck or among model-years.

I made the choice to have a professional machine shop do the work. Although the shaft is regular "mild" steel as helpful subscribers on the Land Cruiser e-mail list confirmed, I didn't want to slip with my tools and ruin a rare part. I was able to order a new grease seal and shaft pin from Toyota – they still have this small stuff. A local shop was able to press out the old pin, cut off 7/8 of an inch of extra shaft length, clean up the end, remove the old seal and slip on a new one, re-drill a hole for the pin – about 1/2 of an inch from the new end, and insert a new pin. Cost, about \$50.

For those of you without your own machine shop and with a pre-'80 FJ40 with a one-piece steering shaft, I don't have a clear answer. One possibility is to search for a used shaft from a truck with power steering – but these are probably pretty rare. Another is to have the shaft modified – e.g., by cutting out the necessary length and re-welding the two shaft pieces back together. A third is to have a new shaft formulated from scratch – probably the most expensive option. A good metal shop should be able to advise you. Any way you do it, once re-installed, the shorter steering column will fit much more easily than before, and you can rest easy knowing that proper steering function and safety is probably preserved.

Afterword

Well, that's my story, sad but true. What are the lessons? First, that Toyota built a pretty darn good vehicle, both with and without power steering. I've since installed power steering on a '78 Toyota sedan and a Honda Accord of the same vintage. The Toyota design was much simpler, and seems to work as well, if not better. A friend who received p/s very similar to my FJ40's on her Toyota Corona was thrilled with the results. As with my 'Cruiser, it made the Toyota sedan a much better vehicle.

Second, be careful. Watch out for cats – they're not to be trusted. Fortunately, by comparison, fellow 'Cruiser owners are a more helpful breed. Third, major factory options had more to them than may meet the eye. Fourth, using a factory shop manual is always important, but in the case of adding a factory option, the Toyota parts list is a lifesaver. Good luck with your own modifications.

