Have Ram, Will Travel

Joe Donnelly's Truck and Travel Stories.

INSTALLATION OF THE CITY DIESEL ELECTRONIC TRUBOCHARGER ACTUATOR – PART TWO

In the last issue of the magazine, I did an interview with Jason Clifton at City Diesel. I was trying to get a better understanding of the Cummins variable geometry turbocharger (VGT) and the replacement of the turbo's electronic actuator that moves the sliding vane assembly in the turbocharger.

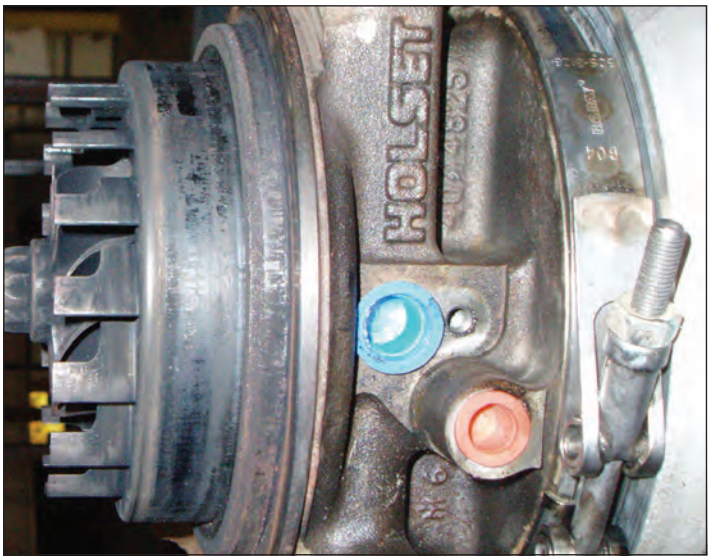
This VGT design, and its electronic actuator assembly, have been used since the introduction of the 6.7-liter engine in 2007.5. The editor noted the production numbers: over 1.5 million engines (2007.5-current) and he noted, "Will there be problems? Yes." I noted that the turbo actuator could be analogous to the Killer Dowel Pin problem that we saw in the '89-'98 12-valve engines.

Regardless of your level of concern, the Issue 114, "Part One" interview gave you the background knowledge needed to help you understand the problem. From your reading, you may have deduced that my Part Two article will give you a look at the nuts-and-bolts repair of the turbocharger's electronic actuator on my truck.

Your conclusion was correct.

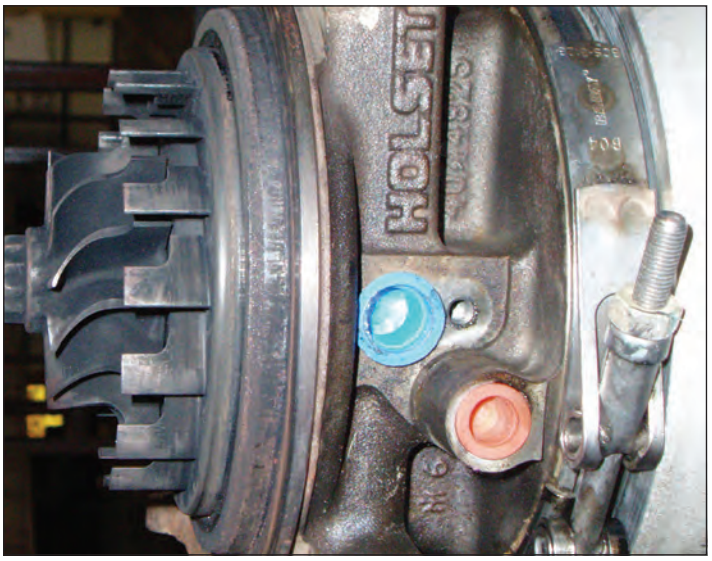
Up on a pedestal (and rightfully so), this Holset HE351 VGT is the key to managing intake air pressure for economy, power and emissions.

Closed

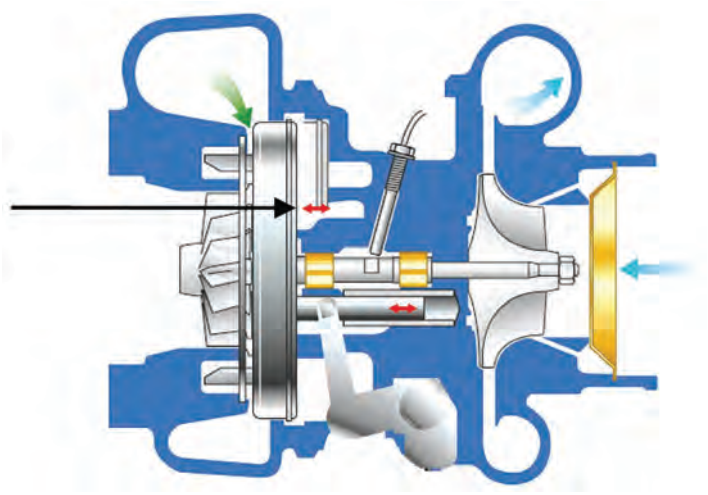


With the sliding vane fully extended, the turbo blades are closed to exhaust flow. This creates exhaust gas back pressure (the exhaust cannot escape) and the turbo acts like an exhaust brake.

Open



With the sliding vane totally fully retracted, the turbo blades are open to exhaust flow. Exhaust flows freely and the pressure on the turbine blades builds intake air boost/pressure.



In this picture the sliding vane is closed. Exhaust gas flow (small red arrow, top left) is restricted and, thus, the turbocharger is acting like an exhaust brake. Allow the vane to move to the right and the exhaust gas flow is "full-on" causing the turbine (exhaust) blades of the turbocharger to spin faster and ceate more boost.

Joe Donnelly Throwback Photographs

If you will recall, we read a full page story about the carburetor in Issue 114, page 53. So, here is a photo of my Oldsmobile with its three Rochester two-barrel carburetors. Memories of yesterday!

Factory triple two-barrel carburetion on 1966 Oldsmobile 4-4-2.

Joe's replica "Rund" Oldsmobile in action.

The Installation

Let's get started with Part 2 and the installation of a replacement actuator from City Diesel.

Before I pull the tools out from my toolbox, here are three installation-related questions that I posed to Jason Clifton of City Diesel:

- **Should the turbine housing be clean and dry, with lacquer thinner, or lightly oiled, etc.?**

  The biggest thing by far is it must be *dry*, including behind the gear. There should be no oil or coolant on this part. Spraying with brake cleaner and blowing dry is acceptable. Just be sure its "real" brake cleaner and not the soy oil cleaner that calls itself brake cleaner. Emphasis on the *dry* because this is the number one reason we see for failures or failed installations.

- **Is there anything needed on the gasket between the halves of the actuator, or just dry?**

  Dry. Nothing goes on the gasket. When it is clamped with pressure the heat from operation of the turbocharger that is added will glue both halves and seal.

- **Do you put anything on the gears or leave them dry?**

  We recommend dry. Not because it's necessarily better, but because over-greasing was the number two reason for failed installations before we changed the recommendation. So, no grease is far better than too much. If you want to grease it, use a white lithium grease only. (Permatex 80345 is a 1.5 oz, tube of white lithium grease.) Apply a small amount of grease to the gear teeth of the smallest gear in the gear housing and the end of the gear on the motor rotor. Spin the gear housing gears to mesh the gears all the way around, then try your best to wipe all the grease off with your fingers.

  To be precise, you want a thin film with no clumps or build ups and a very small amount. Again, no grease is better than too much. Take a very small amount of lithium grease and apply it to the smooth surface above the gears (the part that slides into the linear bushings on the electronics half). Like before, apply a small amount and smear it around. Then attempt to remove most of it with your fingers so only a light film remains.

Having inspired you regarding the advantages of the City Diesel turbo actuator, let's look at what it takes to replace it.

Let's look at what it takes to replace it.

The Mechanical Steps for Replacing the Stock Turbo Actuator with City Diesel's Unit

1. Removing the plastic inner fender and right front tire.

The various instruction sheets and videos I have seen give no detailed discussion of this. It is clear that the inner fender needs to be removed, as you cannot even see the actuator with it in place. To get decent access, it is also clear that removing the right front tire is necessary. Yet, I found removal of the inner fender to be a lot more difficult than expected. (A major reason not to attempt the process at the side of the road.) The 8 mm (5/16") headed sheet metal screws are straightforward. The rearmost two also hold a black plastic trim piece, which additionally has a plastic retainer clip whose head can be popped out to allow its removal.

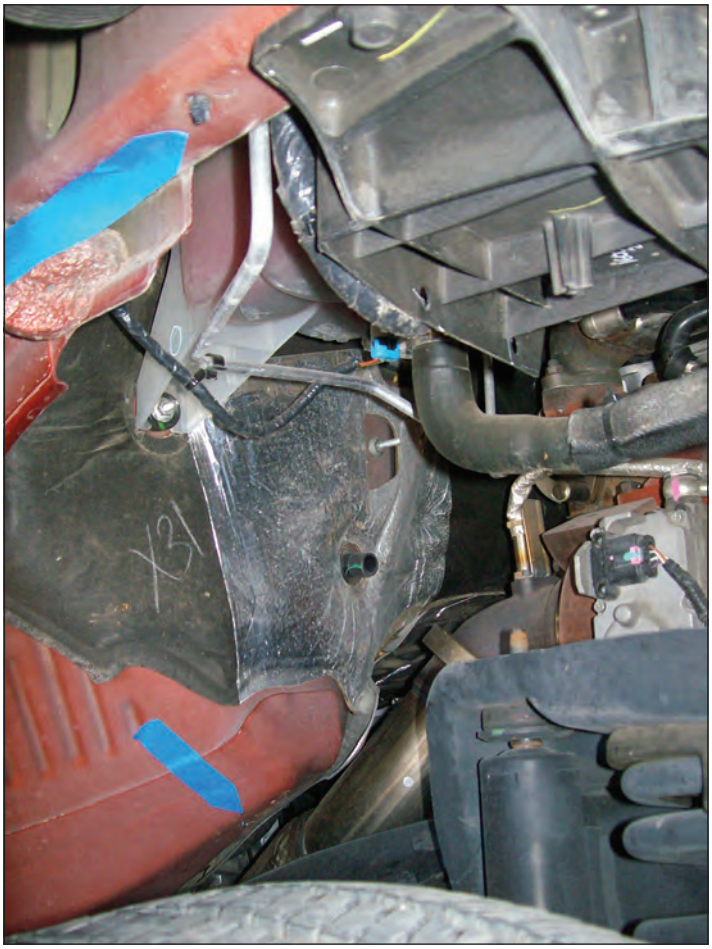
Initial view above right front tire with turbocharger covered by plastic inner fender. The shock absorber/ coil spring tower can be seen, but not the turbocharger.

It is easier to remove the plastic inner fender after jacking up the corner under the suspension arm and putting jack stands under the arm and the frame behind it. Again, remove the tire for access.

Now we are left with the real problem. Ram used three "Christmas tree" fasteners with 1" flat head tops that are in recessed pockets of the inner fender.

Tire side of inner fender with red-handled screwdrivers in the three "Christmas tree" positions.

It is very difficult to get under the fasteners with a sharp putty knife or a forked removal tool. The front two hold the inner fender tight enough that you can't get behind them with a long chisel, either. They make it very difficult to use the putty knife to pop the outer edge of the inner fender out of the outer fender lip. The fasteners are the non-reusable type, so I used my die grinder to cut through the center of the head so the head would pop off. After removing the inner fender, you can either push the rest of the stalk ("Christmas tree") through the 0.25" hole in the truck's sheet metal or pull it out with pliers.



Blue arrows show rear and middle Christmas tree fastener positions. Turbo and actuator can now be seen.

The various instruction sheets and videos I have seen give no detailed discussion of this.

Coolant draining with ratcheting retainer clamp pliers and cotter pin removal tool between hose and plastic Y. Front Christmas tree retainer position is shown with blue arrow.

Not wanting to use such fasteners again, I located three of my supply of re-usable plastic retainers (as used by Jeep for the grille) and drilled the sheet metal to 3/8" for them.

Jeep-style removable plastic fasteners open (head out), closed (head popped into base), and with 1" diameter washer. To the right are the inside of a Christmas tree fastener head and one that has been ground off with a die grinder. At the bottom are the sheet metal screw and the retainer for the bottom of the plastic trim at the rear of the wheel well.

Overall, this experience was unpleasant and unanticipated. I would not want to deal with it on the road. My answer to the question of carrying the City Diesel actuator and changing it on-the-road, when needed, is a resounding *no*. Note that while you can reach over the tire to the actuator, it would be quite difficult to get squarely on the bolts, even if there is no corrosion to impede their removal. During the process on my Turbo Diesel, I was glad the tire was not in the way.

2. Draining the coolant.

Once the plastic inner fender and tire are removed, you have direct access to the lower radiator hose at the plastic Y connection.

Coolant draining with ratcheting retainer clamp pliers and cotter pin removal tool between hose and plastic Y. Front Christmas tree retainer position is shown with blue arrow.

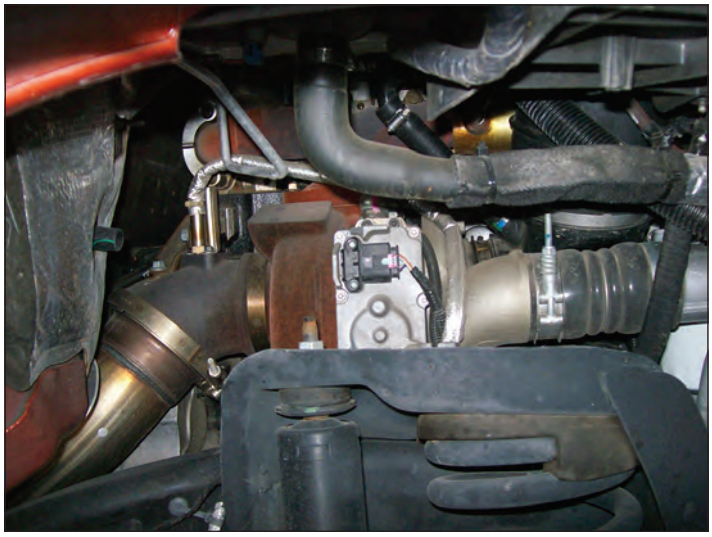
I discussed this easy method of draining the coolant in Issue 100 (pages 100-101) when replacing the water pump. A five-gallon bucket will catch the coolant, and I put a larger pan under it to catch any errant coolant. The coolant tank and banjo bolt for the upper coolant level air bleed are shown.

2013 coolant reservoir on left, red-handled screwdriver pointed to high-fill point banjo bolt.

I elected not to search for difficultly-accessed coolant hoses, and risk damaging them by clamping them just to avoid draining the coolant. I was not under extreme time constraints and preferred the certain approach to one that might not work as well as hoped.

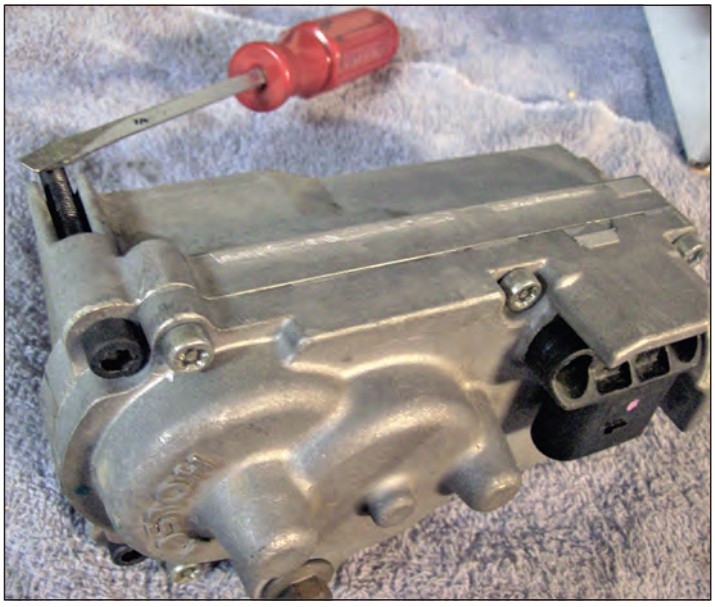
3. Applying rust-penetrant to the actuator mounting bolts.

With the inner fender removed, the turbocharger and actuator can be seen.



View of turbocharger and actuator with inner fender removed. Access to lower actuator mounting bolts is restricted by the shock absorber/coil spring tower.

The shock absorber/coil spring tower impedes access to the lower actuator bolts. For me, the next preparatory step was applying Mopar rust penetrant to the shoulders of the four actuator mounting bolts, and the exposed area of the bottom rear bolt. This bolt is the source of misery for a lot of people changing the actuator. By leaving the outer corner of the actuator open, water, salt, and dirt can enter and corrode the bolt to the actuator housing.



Stock Holset turbo actuator, with red-handled screwdriver pointing to the exposed left lower bolt from the cut-away design of the actuator housing. Here is where dirt, salt, and water enter and corrode the bolt into place.

I read stories of stripped-out hex sockets making removal of the bolt a very difficult undertaking. Because of my desert climate, I anticipated less trouble, but wanted to explore an approach to help ensure that the bolt could be removed even if some corrosion was between its shank and the actuator housing. In a “perfect world” an allen bit with a ratcheting box end wrench would work great. If your turbo actuator housing looks corroded by the elements, you will likely round out the hex of the left lower bolt by simply trying to turn it. Thus, the addition of “impact” in Step 5.

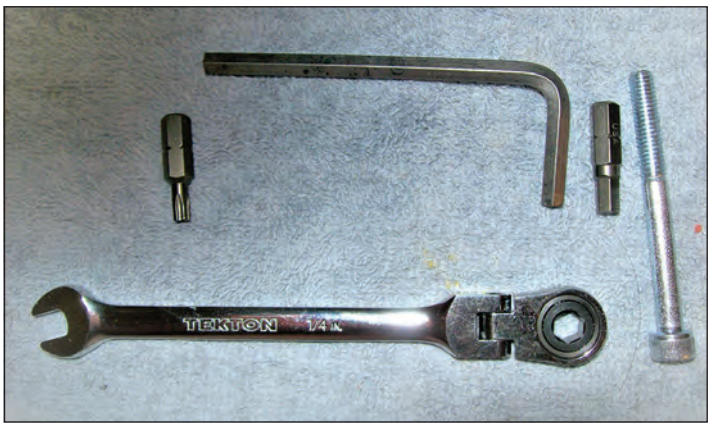
4. Creating an access hole for the lower rear (left) actuator mounting bolt.

Next is removal of the shock absorber with a 21 mm socket on the bottom bolt, and an18 mm wrench on the top nut, holding the stalk with 11/32” six-point socket on the hex end. I carefully lined up the travel of that bolt with the spring/shock tower to get horizontal and vertical lines, and then drilled a 0.125” hole in the 0.190” thick shock/coil spring tower. If very close, I could simply enlarge it. If not, I could partially enlarge it, and partially use a carbide bur in the die grinder to open the hole in the direction needed to get direct, unimpeded access to the bolt. I did drill pretty close but used the latter approach to end up with a hole that is exactly where needed.

Blue tape-wrapped power bits on top two and bottom left actuator bolts. 5 mm allen key on bottom left actuator bolt. Bottom left bolt is easily accessed through hole drilled in shock absorber/coil spring tower.

5. Removing the actuator bolts.

I bought some 5 mm hex power bits with 0.25" hex heads, 6 inches long. From other projects, I had found that there was much less chance of stripping the hex if I used a proper bit, applied constant pressure in the direction of removal, and hit the end with a hammer to provide "shock" or "impact" to aid in removal. The same 0.25" ratcheting box end wrench that you got to use the hex bit that Geno's supplies with the actuator will work nicely with the power bit. You can actually use the power bit on the top two and, with the hole you drilled, the bottom left (rear) actuator mounting bolt. Geno's short hex bit with the ratchet works well on the lower right (front) bolt which has better access from the factory. You can also use a conventional allen key to break the bolt loose.



5 mm Allen wrench at top, ¼" ratcheting box end wrench at bottom, City Diesel actuator bolt at right. Two short bits, tamper proof on left and 5 mm on right from Geno's.

You should not need "impact" on the other three bolts, especially if you treated the shoulders with penetrating oil in advance. If you drill the hole in the shock/coil spring tower, three of the four actuator bolts will have very easy access. The bottom front (right) is a bit more difficult, but there is plenty of distance from it to the tower. It is not worth considering an access hole for it, because the coil spring is in the way.

The factory four bolts holding the turbo actuator are grade 8.8, somewhat weaker than grade 5 in U.S. standard (110.000psi versus 120,000psi). City Diesel supplies plated grade 12.9 (170,000psi), which exceeds U. S. grade 8 (150,000psi). The factory bolts are sufficient for the torque specified, but marginal for removal after being in service for several years. They are also not plated, merely black oxide coated. Thus, we see good reasons why it is so easy to strip out the hex head of the left (rear) lower bolt, which is exposed to water, road salt, etc. Cummins created two unnecessary problems with low grade bolts, and an open channel in the actuator housing. Maybe they used the same engineer who gave our 12-valve engines the killer dowel pin.

If the hex head is already stripped out so the allen power bit won't turn the bolt, I would next try a T-35 Torx 6" power bit. Drive it into the socket, and then apply turning torque while continuing to tap on the end of the bit. If that strips, go larger and drill and/or chamfer the socket hole just enough so you can drive a Torx bit into it. Use discretion on the hammering part. You need some force to drive the bit into the socket and to shock the bolt enough to break loose the corrosion. You don't want to use so much force that you break the ear of the relatively tough turbine housing. I have had good results with Mopar Rust Penetrant, WD40, and Kroil, but there are other good penetrating oils as well.

6. Checking the turbocharger sliding vanes,

Once you remove the actuator, Geno's and City's instructions describe checking the turbo vanes for free movement. If the geared lever is really stiff, sorry, you will need to replace the turbocharger.

If you have been running very high exhaust gas temperatures and producing lots of soot (via a "tune") you may be a candidate for a complete turbocharger. If the movement is just a little stiff, say at one end of travel, and frees up after you use channel locks or a vise-grip to hold the lever and facilitate turning it, you probably just have some corrosion or soot build-up. If the truck sits a lot, perhaps for months between towing jobs, a modest amount of corrosion can be the culprit. According to Jason, the turbo will still be usable if some corrosion is causing a bit of stiffness in the movement of the actuator lever. My Turbo Diesel had 55,401 miles and 1161 engine hours when I changed the turbo actuator.

7. Installing and testing the City Diesel actuator.

With the lever pretty much freed up for one-finger movement, install the new City Diesel actuator. Note that the gear in the actuator has to mesh with the geared end of the lever on the turbine housing. You may need to turn the lever just a bit if the actuator doesn't just plug right on. When they do mesh, the new actuator will readily mount flush on the turbine housing. Tighten the four allen bolts, and you can hose-clamp the lower radiator hose, and refill with coolant at this time. Then, turn the key to "on" (not "accessory" or "start"). Using the connector at the actuator, plug it in, listen to the side-to-side gear movement, and disconnect afterwards. This self-calibration takes much less than a second. Repeat this cycle 20 times, then rest a while. After 50-80 cycles with the same noises, but no grinding, popping, or jackhammer sounds, you should be good to go.

Cycling the actuator when the vane assembly (slider) and its linkage inside the turbo is not completely free points out the need for a strong enough actuator motor, and supporting electrical components. Otherwise, unknown to the owner, some resistance to movement could occur, such as from leaving the truck in storage for several months, and the actuator will try to move the arm, loading the motor heavily. Once the motor is overwhelmed, you will get error codes relating to insufficient lever/vane movement. You will probably also have burned out the circuit board, etc. of the stock actuator. City Diesel's motor draws less current and makes more power.

In summary, the variable geometry turbo brings about better responsiveness and power potential with low emissions, at the cost of more complexity and chance for failure.

8. Finishing the process

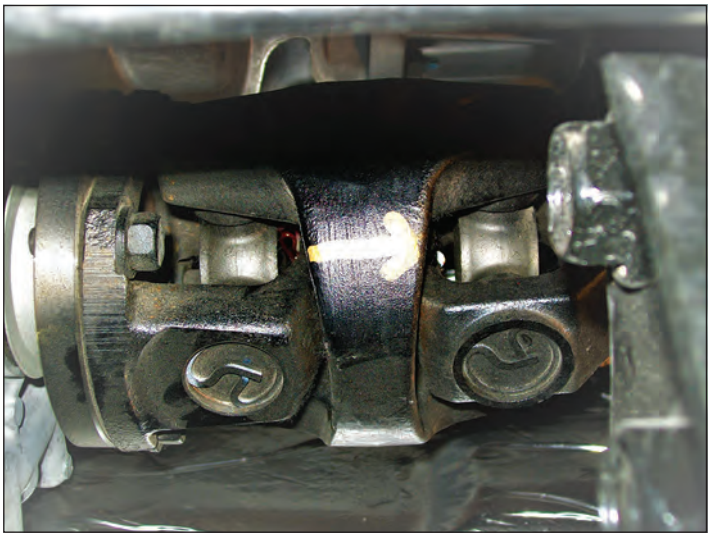
Zip-tie the actuator harness and reinstall the shock absorber (it will have lengthened, so use a jack to compress it after installing the top rubber cushion, washer, and nut). Install the inner fender and tire. Remove jack and jack stands.

You can mostly fill the cooling system by taking off one end of the upper radiator hose. Another question is what OAT-type coolant to use. When I changed the water pump, I used the current recommendation at that time, MS-12106, pn 68163849AA (and superseded to -AB) for the diluted coolant. I purchased some of the concentrate, 68163848AB, and it is MS-90032. A friend bought some concentrate a few months ago and it was the same part number but MS-12106. When a parts search pulled up my truck by VIN it shows it requires PN 68153921AA which supersedes to the latest PN 68163848AB (concentrate) or 68163849AB (premix). My owner's manual does not show any MS specification or part number, just that it must be OAT. However, my Owner's Manuals for the 2019 Caravan and 2020 Jeep show MS-90032. I have not found any reference in Mopar documentation regarding these two MS specifications being the same or different.

THE MAW (might as well) DEPARTMENT

With the coolant drained, you might as well replace the upper radiator hose with plastic Y coupling if you have a 2013-2014 Turbo Diesel. That hose is now on revision AD, the fourth iteration. There were a few failures with the first iteration, leading Geno's Garage to investigate replacement with a metal Y coupling (see Issue 101, page 84). No wide-spread incidences of failure came to the attention of Geno's personnel, so they decided not to market the stainless-steel Y that I showed in prototype form. I decided to replace that complicated fix for a non-problem with a new AD revision hose from Geno's (Mopar # 52014722AD). Well-designed plastic should work fine for the Y; after all, the radiator tanks are plastic. Geno's not only gives great services and fair prices, but you get fresh stock, when possible, not something that has been on the shelf for many years.

In Issue 114, both Stan Gozzi (page 108) and Andy Redmond (page 117) reminded us to grease the center bearing of the double cardan joint in the front driveshaft. These are good reminders of the procedure I described in Issue 86, p. 105. I showed how to find the flush-mounted fitting, included an extra one on the CarQuest label, and included the CarQuest needle attachment and angle adapters I use on my small hand-held grease gun.



Front driveshaft double cardan joint with arrow pointing to the flush-mount grease fitting.

Needle type attachment on hand-held grease gun.

Joe Donnelly
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