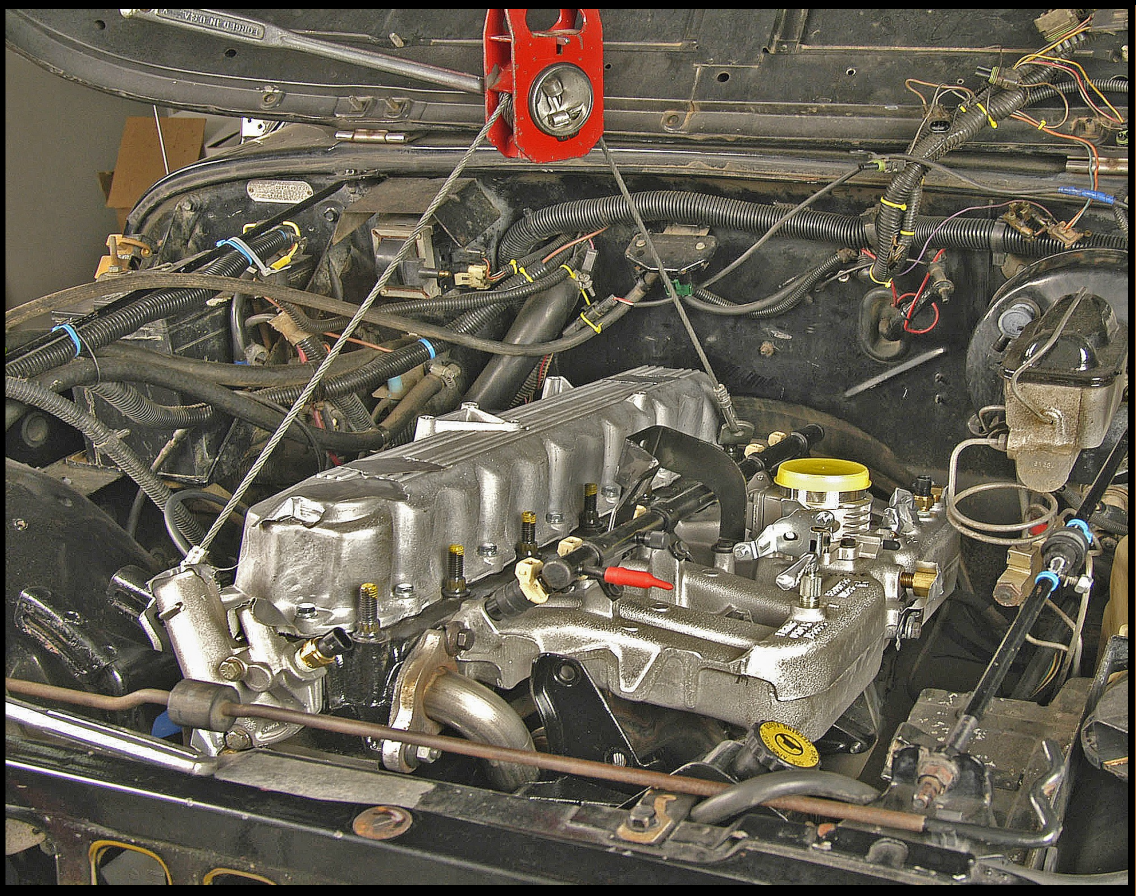
Moses Ludel's

4WD Mechanix©

"Monthly Technical News for Jeep® Owners and Four-Wheel Drive Shops"

Issue Number 1
February 2010

Tech Feature for the Month: *EFI Inline Six Swap*

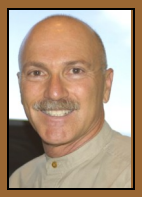


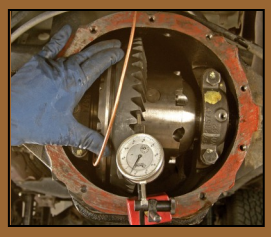
Within this issue's 'Q&A'

Question: *"Hi, Moses! A local shop just installed a variety of components on our '04 TJ Wrangler Rubicon. I'd like to share the list and see if you would add or modify any of the items…"—Joe M.*

Question: *"My 1971 Jeep CJ's Ross steering box needs a rebuild...I rotate the steering wheel 1/3 revolution before the front wheels begin to turn. I have another used box, seems tighter but the true condition is unknown. Does it pay to rebuild these gears?"—Mark*

Inside Content





'4x4 View' by Moses Ludel

The F-head engine droned with the downshift to 3rd gear. We were six hours out of Gardnerville, dead tired and overdue for a good meal. Tonopah and the Mizpah Hotel stood atop the long hill ahead. The next day, we'd be halfway up Monitor Valley by noon, with 60 miles of alkaline dust and two ghost towns behind us—and another seventy miles of corrugated dirt road between Mt. Jefferson and Austin…

That was 1965, the CJ-5 just months old. Since the mid-'sixties, Jeep vehicles have been an ongoing part of our family. A trail worn CJ-3A served as the very first restoration project in 1969. By the late-'eighties, when *OFF-ROAD Magazine* assignments called for a project vehicle, 'Project Trials Machine' originated from a rusty '81 CJ-5 four-cylinder model. Much like this month's feature, a 2.5L to 4.0L six swap, the CJ's Iron Duke 2.5L four and the light-duty T-4 transmission departed early in the project. In its place, a 4.2L YJ six crate motor and a Dodge truck version NP435 four-speed transmission transformed a sluggish, light-duty CJ-5 into a formidible multipurpose backcountry rig!

Back in 1987, the Jeep Cup Rally provided wheel time with AMC's first 4.0L EFI powered XJ Cherokee. AMC's visionary design became an economical and tractable SUV, the trend-setter of its class that established sales benchmarks. Jeep's XJ Cherokee served as the prime bargaining chip when AMC sold to Chrysler Corporation. Today, the 1984-2001 XJ Cherokees serve as affordable and economical multi-purpose 4WDs and trail vehicles.

In 2005, long-time colleague Phil Howell, then editor at *OFF-ROAD Magazine,* asked if I would do a magazine project, and I suggested the XJ Cherokee. My latest book venture was then slated for production at the publisher's offices, a YJ/TJ Wrangler shop manual featuring in-depth coverage of the 2.5L four, inline sixes, AX-5, AX-15, NV3550 and NP231 gearboxes, Saginaw steering plus Dana front and rear axle service. These were largely the same components found in the XJ Cherokee!

For the *OFF-ROAD* project, a stone stock '99 XJ Sport was my choice. In the June through December 2005 issues of *OFF-ROAD* magazine, this '99 XJ Cherokee metamorphosed into a trail-hungry 4x4…In April '06, the XJ proved its mettle at Moab, debuting in a *Four-Wheeler TV* trail segment. Today, the XJ Cherokee and '55 CJ-5 depicted in my *Jeep CJ Rebuilder's Manual: 1946-71* sit side-by-side at our shop.

***Spicer/Dana axles have been Jeep equipment since 1941. My* Jeep Owner's Bible*, two* CJ Rebuilder's Manuals *and twenty-five years of magazine tech stories have included scores of axle rebuilds and upgrades like this ARB Air Locker. Here, the XJ Cherokee's Dana 30 front axle undergoes a ring-and-pinion ratio change and a locker upgrade…You can expect this level of tech support in issues of* 4WD Mechanix©.

Gone is our classic '87 Grand Wagoneer—the one restoration project that Mrs. Ludel truly enjoyed! The '02 Liberty that served the *3rd Edition* revision of the *Jeep Owner's Bible* became a partial payment for our long awaited Cummins-powered Dodge Ram 3500 4x4 towing vehicle. The Grand Cherokee full-time transfer case rebuilds, scores of 4x4 axle overhaul and upgrade jobs, bumper-to-bumper mechanical restorations of YJ and TJ Wranglers, and oh, yes, let's not ignore the *new JK Wrangler*—which added a half shelf more of Mopar service information to my three bookcases full of Jeep reference material—and the projects continue!

In monthly issues of *4WD Mechanix*©, you will find professional, unbiased answers to your technical or off-road driving questions—the same level of detail found in my Jeep books and nearly three decades of magazine features. Whether your Jeep is a WWII MB, a Willys Station Wagon or Pickup, a CJ, Wagoneer, Gladiator J-truck, Grand Wagoneer, YJ or TJ Wrangler, XJ Cherokee, Liberty, Grand Cherokee or the latest JK Wrangler, I'm here for your vital technical questions—and off-road driving tips when requested.

Welcome!

EFI Six-Cylinder Swap

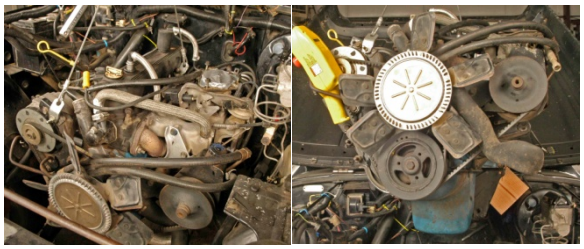
1987-90 YJ Wranglers were available with a throttle body EFI 2.5L four-cylinder engine or the carbureted 4.2L inline six-cylinder option. In 1991, Chrysler switched to MPI on the 2.5L engine and replaced the 4.2L with a 4.0L MPI six. The 2.5L four, derived from AMC's rugged inline six-cylinder designs, proved its exceptional stamina for two decades, powering many CJ models, Wranglers and XJ Cherokees.

With the addition of large tires, a winch, a hardtop, gas cans and hefty aftermarket bumpers, the YJ Wrangler can tip the scale more than 700 pounds over stock curb weight. Despite lower peak torque and horsepower than the sixes, the 2.5L is a peppy engine, easily handling most low range four-wheeling chores. For better highway performance and light towing, the inline sixes do a better job. The 2.5L develops its peak torque and horsepower at a higher, less efficient rpm than the 4.2L and 4.0L sixes. This is most noticeable in hilly pulls and at altitude. Under such conditions, the four often uses more fuel than a six-cylinder engine.

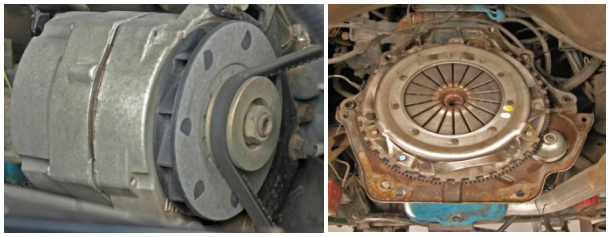
Given the readily available '91-up 4.0L MPI six-cylinder Wrangler and XJ Cherokee engines at recycling yards, converting to a six might seem practical. However, such a swap presents a major challenge: *Four- and six-cylinder YJ frames are not the same*. This applies to TJ Wranglers as well.

Note: Changing a 2.5L four to a 4.0L MPI six requires tools, welding skill and attention to detail. The project is comparable to a V-8 swap. The option of subletting this conversion to a shop could prove costly and tie up your Wrangler for a lengthy time. This is not a weekend task!

Four- and six-cylinder YJ frames have different part numbers. Shown is an '87 Wrangler chassis with a 2.5L four, the AX-5 transmission, a Dana 35 rear axle and an NP207 transfer case.



YJ 2.5L fours had throttle body EFI from '87-'90, MPI from '91-up. This '87 still uses V-belt drives, looking much like the front view of a CJ or YJ 4.2L inline six.

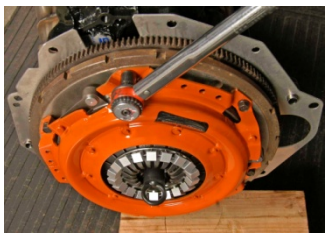


Alternator and V-belt drive components will fit the 4.0L if desired. Block reveals unique 2.5L bellhousing pattern.

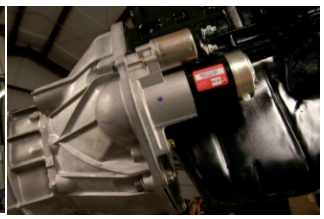
2.5L's AX-5 transmission is weaker than AX-15 used with sixes. Output spline count differs, too. Note motor mount positions on the frame rails. Six-cylinder mounts are further forward.


Careful removal of frame mounts requires scarf cutting with acetylene torch. Slight portions of original bracket material are intentionally left in place to avoid cutting near factory welds. Surface grinding is cosmetic. A reinforcement weld at sill plate ensures the integrity of the original frame section.


Side support strengthens L-mounts. Increase in metal gauge over factory mount brackets assures stamina. Wire is ER-70S 0.035" MIG type. Cushions are stock six-cylinder YJ parts.

Later 4.0L bellhousing and clutch release mechanism work nicely. This is not a hydraulic release bearing like the OEM four-cylinder type. Slave cylinder mounts externally. Flywheel is stock 2.5L type with a Centerforce II clutch assembly.

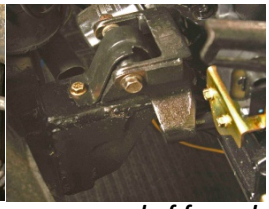



Mopar 4.0L long block, a freshly built AX-15 transmission, Mopar Performance MPI conversion pieces, the crankshaft sensor/trigger at the front damper, and a factory header pipe make an impressive package! Aftermarket EFI uses OEM induction pieces and sensors. Rebuilt Mopar starter motor is late Wrangler variety, an efficient, compact reduction type.

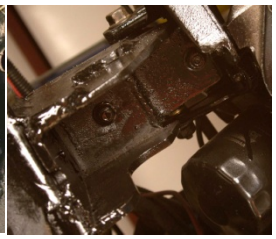

The engine fits as stock. '87-'95 inline sixes use similar engine mounts. At right is the fabricated mount, welded into place at the frame. Temporary hardware is for engine alignment.


The engine is aligned carefully—side-to-side, height and angle—to assure proper location of weld-in mounts. This swap is as involved as a V-8 conversion.

The Wrangler departed from the earlier CJ frame design. For the AMC-era CJ four-, six- and V-8 applications, each year and model uses the same frame. The CJs use bolt-on frame brackets attached at different sets of frame holes. This allows engine interchangeability unlike the YJ or TJ Wranglers.

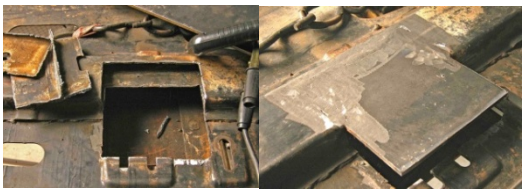



Added brace plate laps between upper end of frame bracket and top of frame rail, reducing torque stress at the frame.

In place with plug, stitch and lengthy, full-strength welds, the fabricated brackets accept six-cylinder YJ-type mount cushions. Engine block requires left and right YJ style cast brackets that attach to pedestal cushions with a through bolt.

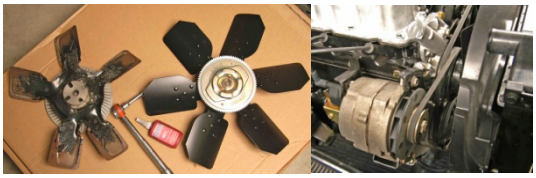
Mounts in place, through bolts and nuts secured, the engine is stable and well supported at the front. Rear mount fits at tailhousing of AX-15 transmission. AX-15's 23-spline output will mate with a 23-spline NP231 or Atlas transfer case.



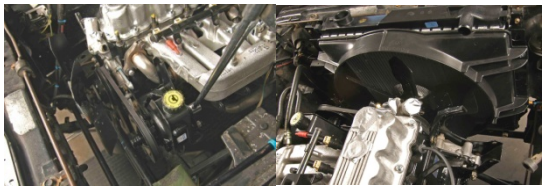
Stock skid shield fit AX-5 and NP207. A six-cylinder pan would work here. The option is to use the four-cylinder, AX-5 pan and fabricate a mount location for the AX-15 transmission support.

ER70S MIG wire and hefty steel plate create a strong boxed section. On the YJs, this skid plate supports the transmission and transfer case. Drill holes to match mount cushion holes.

Six-cylinder MPI engine has considerably more horsepower and torque than the 2.5L four. Horsepower is BTUs, and a six-cylinder "air conditioning" radiator serves well here.

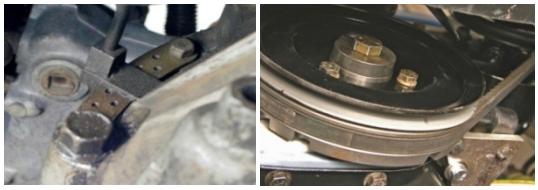


Fan upgrade is necessary. 2.5L fan (left) has one less blade and a smaller diameter. Note use of six-cylinder fan and fan clutch. Alternator and brackets are from original 2.5L engine.



Power steering pump is Mopar rebuilt unit for six-cylinder engines. Radiator and fan shroud are for six-cylinder engines.

Stock power steering requires slight modification to return hose pipe length. Engine package looks like stock '94-'95 YJ.



2.5L crank sensor (left) mounted near flywheel. At right is a Mopar Performance 4.2L EFI conversion damper with crank sensor bolted to a bracket at the oil pan. Fuel pump in '87 YJ 2.5L gas tank is replaced with '91-up MPI high pressure pump.

Fuel lines and an MPI pump, MPI wiring and a 4.0L engine computer complete the job. Mopar's EFI Conversion Kit for '81-'90 4.2L sixes is built around OEM 4.0L MPI components, providing a new engine wiring harness, coil, the computer, fuel pressure regulator, all new sensors, injectors and fuel rail, a throttle body, air cleaner and intake manifold. This package approach is an option to the recycled 4.0L Wrangler or XJ engine with a used computer and wiring harness details to sort out.

'91-up exhaust plus new drivelines with a slip-yoke eliminator will round out the chassis work. Before undertaking this swap, consider the costs, labor and needed skills. Weigh this swap against selling your 2.5L YJ and purchasing a clean 4.0L YJ or TJ Wrangler. Another option is to supercharge the 2.5L four. Do your homework before plunging!

4WD Tech 'Q&A'

Two Jeep Cherokees Need Exhaust Upgrades

I saw your article on the exhaust upgrade you did on a '99 Jeep Cherokee. I would like to do the same modification on my 2000 Jeep Cherokee. Is this possible?—Jennifer

I talked to a Borla specialist. Their kit was not tested on the '98-'99 XJs. I will definitely go with the '00-'01 kit. Your article will be helpful if I run into minor misalignments. Thanks for your advice.—Vago

Note: Jennifer and Vago refer to my XJ Cherokee exhaust system article in* OFF-ROAD Magazine. *When routing the tailpipe between the frame and right rear spring, be aware that our XJ chassis has a 6-inch lift kit installed! Stock spring arch may not provide enough clearance here...Changing a 4.0L Wrangler, Grand Cherokee or XJ Cherokee exhaust manifold is a major task. In the article, I show how to save time swapping manifolds. Even so, this is a complex job that requires the right tools, time enough to get the job done right plus cutting-welding equipment for the hanger changes…

For the magazine project, I used the 1997 Borla XJ kit for our 1999 XJ Cherokee chassis. At the time, Borla only offered Jeep XJ systems to fit through 1997, essentially kits still supplied to Mopar Performance. The Borla header is identical for TJ and late XJ applications, including the '99 model. Borla's '97 XJ package includes the Borla header, header-to-cat pipe, a performance muffler and a new tailpipe plus high-quality clamps. For peak performance, I added the Random Technology catalytic converter. This package turned out to be a good approach. Only four modifications were needed to fit the system to this 6" lifted '99 XJ chassis: 1) a modification to the head pipe-and-cat support bracket that fits at the transmission mount, 2) careful routing of the tailpipe with a drop bracket to relocate the attachment point for the axle position tailpipe hanger, 3) making an offset bracket to position the tailpipe away from the fuel tank at the tank position hanger, and 4) careful routing of oxygen sensor wires and wires from the crankshaft-flywheel position sensor. *(Keep wires and plastic convolution shield routed away from the header heat!)* As for gains from this installation, Borla's superior quality pieces replace the crack-prone factory header and a stock head pipe that is highly restrictive. Dyne-tested, Borla's scavenging gains are legend. For quality and fit, Borla is tops. If the stock exhaust manifold has a crack, the Borla system is a *very* wise replacement. In terms of installation difficulty, a header swap is complex—*just like replacing a stock manifold*. Be aware that a major tune-up—including new plugs, cap, rotor, air filter and plug cables—accompanied this exhaust system installation. With the exhaust system upgrade and tune-up, mileage jumped 2.8 mpg on the highway at cruise! (Mileage gains tend to vary; realistically, though, the engine now breathes freely and accelerates much better than prior to this work.) Before investing this kind of effort, you might try a major tune-up first, and see how much of the 2.8 mpg gain is achievable with just tuning. As I emphasized in the *OFF-ROAD* article, periodically tuning the engine and installing a clean air filter will improve fuel efficiency and performance…For those interested, I do tune with genuine Mopar filters and ignition components…






Worn '66 and '71 Jeep CJ-5 Steering Gears

Are you able to rebuild a '66 Jeep CJ5 steering box? The chassis is a V-6 type, and I believe this is a Ross box. Is it wise to rebuild the gear?—Lavin C.

*My 1971 Jeep CJ's Ross steering box needs a rebuild or replacement. I can rotate the steering wheel 1/3 revolution before the front wheels actually begin to turn. I have another used box, seems tighter but the true condition is unknown. Does it pay to rebuild these gears?—Mar**k***

Lavin and Mark, you have great CJs! The 225 V-6 and reasonable gear reduction make these a time-honored package. The '66 and '71 models should have Ross TL gears with a one-piece column. Basic and often considered primitive, cam-and-lever two pin gears served the CJs through the Willys and Kaiser period. By the end of the Kaiser era, Jeep began using popular G.M. Saginaw recirculating ball-and-nut gears. I rebuild the Ross gears for Willys models and Kaiser CJs, finding that in nearly every instance there is pin wear. Pins on these basic Ross gears wear flat on the sides, as they do not rotate and continually press against the cam at the same points on the pins. *Adjusting the gear is hazardous if the gear has any more than the slightest amount of play on-center.* (Off-center, there will be backlash, and this is normal. The gear's adjustment is over-center to eliminate play *only in this zone of steering*.) Customarily, the project begins with hot cabinet washing and glass beading of all hard parts before inspection. In the build, the sector/lever bushings are replaced and fitted precisely for a long service life. A new lever shaft seal, service of the upper/lower worm cam bearings and replacement of the sector lever shaft with a new NOS item take place before buttoning up the gear with a new cover gasket. Adjustments of the worm-cam bearings and over center preload are critical to the safety and lifespan of the gear assembly. All adjustments must be on spec before a unit ships from our shop. I detail the finished assembly in durable epoxy primer and paint color of your choice. Cost for this level of restoration and use of NOS parts depends upon the latest NOS prices for the lever shaft and the current condition of your gear. *Note: I refer to "NOS" parts; the only assurance of high quality and a long service life is use of original Jeep replacement parts. There are off-shore repro parts that simply will not meet the standards for fit-up and metallurgy. Know your parts source and the origins of parts if you attempt to rebuild one of these gears yourself.*

Our shop reconditioned the Ross TL steering gear for this nicely restored '62 Willys Model 475. (Photo by Matt Fritz)

When checking steering play on stock '46-'71 CJs, look for looseness and wear at the bellcrank, tie-rod ends and steering knuckle "kingpin" bearings. Some Jeepsters and '70-'71 CJs use front-mounted Saginaw steering gears with a one-piece tie-rod between steering knuckles. Ross TL applications have the steering gear mounted rearward of the axle and use a draglink, bellcrank, tie-rod to the right side knuckle and a one-piece tie-rod between the knuckles. *Make sure you know the origin of the steering play*…If you opt for a Saginaw steering gear swap, there are several concerns: 1) mounting the gear properly to the frame, 2) using the correct steering linkage and pitman arm plus 3) fabricating the steering column support if your original column ran from the gear to the steering wheel. In my *Jeep CJ Rebuilder's Manual: 1946-71*, I show the steps for rebuilding a Ross gear like yours and also outline the steps for converting to Saginaw manual steering. Historically, Advance Adapters has been a source for Saginaw steering conversion kits for the vintage CJs. Their catalog can also be useful for identifying the parts needed. If your CJ has collectible value or you wish to maintain a stock profile, proper restoration of the Ross TL

steering gear can add years of safety and driving satisfaction. To eliminate the more primitive gear design and busy bellcrank, draglink and two tie-rod steering linkage, consider the Saginaw conversion.

Late CJ-7: Planning Some Gearing Gains

I have a 1985 CJ-7 with a 258 6 cylinder engine, T-176 transmission, Dana 300 transfer case, 3.73 gears and 31" tires. The Jeep is too high geared in low range. I hear there is a kit for the Dana 300 to lower the gearing in low range. Where to get one? What are the options?—George

George, your CJ-7 sounds virtually "stock" with the exception of 31" tires. The T-176 has a 1:1 ratio in top gear and a 1st gear ratio of 3.82:1. Your transfer case has a fairly low 2.61:1 ratio. While installing lower gearing for low range has gains (check with Advance Adapters for a gear kit), I prefer a T-18 or NP435 transmission conversion—*for several reasons*. A common approach is the Warner T-18, a relatively compact truck four-speed with a compound low gear and high gear of 1:1 like your current T-176. A popular conversion approach is the Ford 2WD version of the T-18, which has a 6.32:1 1st gear and a 2nd gear of approximately the same ratio as your current transmission. The non-synchromesh compound low gear is usable in *both* high and low range while 2nd, 3rd and 4th gears are each of synchromesh design. The T-18 offers more stamina by far than the T-176. If you opt for the NP435 transmission, this is even more rugged than a T-18 and has a compound low ratio of 6.69:1! If you do the math on either of these transmissions, you find that their gains in compound low gearing are equal to or better than a lower ratio gearset installed in the Dana 300.

For AMC-era CJ's like yours, I have outlined this conversion in both my *Jeep Owner's Bible* and the *Jeep CJ Rebuilder's Bible, 1972-86*. Having rebuilt the Dana 300 (steps also covered in my rebuilder's manual), I would note that the T-18 conversion is not difficult and provides a cost-effective solution for making your Jeep more versatile. There is also the NV4500 transmission conversion that I cover in the *Jeep Rebuilder's Manual: 1972-86*. This is the ultimate transmission for strength and flexibility, likely overkill for most applications! The NV4500 has versions with as low as 6.34:1 first gear plus a 5th gear overdrive on top. All forward speeds have synchromesh, and an overdrive can improve fuel efficiency. More costly than a T-18 conversion, the NV4500 is for those who need—*or want*—a 1-ton capacity transmission with an ultra-low 1st gear plus 5th overdrive.

Checklist: A TJ Rubicon's Latest Mods

Hi, Moses! The local shop just installed a variety of components on our '04 TJ Wrangler Rubicon. I'd like to share the list and see if you would add or modify any of the items…

Full-Traction 6" Long Arm Performance Suspension
Complete Exhaust System, cat-back
CV Driveshafts
HD Engine Skid Plate
Steering Stabilizer
3-Way Adjustable Rear Sway Bar
"M Force" Shocks
Skyjacker Transfer Case Relocation Bracket
Warn – Front Rock Crawler Bumper
Warn - Rear Rock Crawler Bumper
Warn - Tire Carrier
Warn - Fuel Tank Skid Plate
Warn - Differential Skid Plates
Warn – 2" Receiver Shackle
B&M - Short Throw Shifter
Mickey Thompson Classic II 16"x8" Wheels
Toyo Open Country M/T LT315/75R16 (same as the 35"x12.5Rx16" size)
Thanks for evaluating our Rubicon's modifications. We're headed for Moab!—Joe M.

Joe, this sounds like a thorough list for putting 35" diameter tires on a TJ Rubicon chassis. You have probably added an issue that I talk about often at my Camp Jeep™ workshops: *the impact on gearing created by the increase in tire diameter from 31" (OEM) tires to 35" aftermarket tires.* Any increase in tire diameter will create an "overdrive" effect. The Rubicon's stock 4.10 factory axle ratios work very well with 31" tires. Now, though, your change to 35" diameter tires requires 4.88:1 gearing (front and rear axles) to restore the vehicle's original

driving characteristics. Even lower (numerically higher) gearing than stock is of value when you add the weight of rugged bumpers, a winch and extra skid plates. Some builders use 4.88:1 gears even with 33" tires; however, 4.56:1 will actually correct and slightly improve performance over stock when running 33" tires on a TJ Rubicon. (This is a good formula—*as long as the transmission has an overdrive gear*—for any TJ, YJ or XJ Cherokee.)

Let's evaluate a TJ Rubicon's direct 1:1 ratio 4th gear (an NV3550 five-speed application), using various axle ratio and tire diameter combinations. For simplicity, let's use 60 mph as a benchmark for clocking engine rpm:

1) **Stock Rubicon 4.10:1 axle ratios with 31" OEM tire diameter = 2667 crankshaft rpm.**
2) **Stock Rubicon 4.10:1 axle ratios with 33" tire diameter = 2506 crankshaft rpm.**
3) **Retrofit 4.56:1 gears with 33" aftermarket tire diameter = 2787 crankshaft rpm.**
4) **Retrofit 4.88:1 gears and 33" aftermarket tires = 2982 crankshaft rpm.**
5) **Retrofit 4.88:1 gears and 35" aftermarket tires equal 2812 crankshaft rpm.**

Note that the closest ratio for preserving stock-like performance with 33" diameter tires is 4.56:1. (The slightly higher engine rpm indicates a gearing advantage that offsets the added weight of hefty accessories.) 4.88:1 gearing would raise crankshaft rpm even further and provides better performance in terms of acceleration, the ability to stay in a higher gear without lugging the engine, possibly better fuel efficiency and an improvement in compression braking. 35" diameter tires also gain slightly from 4.88:1 gearing…

Given the real-world cost for labor and parts to install 4.56:1 or 4.88:1 axle gearing, I always advise owners to be prudent. If you find that the 4.10:1 gearsets work okay with 33" tires and your driving conditions, it might be smart to adjust for the speedometer error and call it good. (4.56:1 or 4.88:1 gears, or any other choice, may require a slight speedometer correction.) The taller gearing effect with 33" or 35" tires and stock 4.10s does place a greater load on the clutch and reduces the compression braking effect, so adjust your driving accordingly if you stay with 4.10s...


Before and after poses of the '04 TJ Rubicon—6-inch lift is clearance for 35" diameter Toyo tires. (Photos by Joe M.)

Note: For those puzzling over why there is not a "perfect" axle ratio to compensate for, say, a 33" tire retrofit, the answer is very simple: Axle ratios available for Dana 44 axles would be 4.10, 4.27, 4.56, 4.88, 5.13 and 5.38s. The 4.27:1 gearsets make for 2610 crankshaft rpm at 60 mph in 4th/direct gear of the NV3550 transmission with 33" diameter tires. This is still slightly overdriving when compared to 4.10s with stock 31" diameter tires. Since there is no gain, and 4.27:1 ring and pinion gearsets are scarce, running slightly lower (numerically higher) gearing of 4.56:1 makes better sense…Because overdrive transmissions use various 5th or 6th gear ratios, I like to use a 1:1 4th gear ratio for illustrating rpm. For the curious, the NV3550 has a 22% overdriving 5th gear ratio, rated as a 0.78:1.

Troubled YJ and TJ Automatic Transmissions

I have a '97 Jeep Wrangler with a 32RH automatic, Currie high-pinion 9" axles and 4.56:1 gearing with ARB lockers, three-speed transfer stack-box and stock 4.0L engine. I need professional advice or suggestions about the best option: The 32RH has been good, but it has to come out. So, what would you do?—Nick

My '91 YJ 4.0L has an automatic. The transmission needs a rebuild. We use the Jeep for a combination of street-driving and off-road wheeling. We have the Rubicon in mind. I'm interested in upgrades you would suggest for the transmission. Are there shift kits available? Is it possible to change the gearing to provide better wheeling? Would changing 1st gear provide some gear ratio upgrades without the need to substantially change axle ratios? Sometime in the

future, I also have a transfer case swap in mind, which should improve gearing as well.—Brad P.

Brad, your questions coincide with some of Nick's concerns, so I'll start by sharing that the YJ's A999 three-speed is a non-electronic shift version of the transmission that Nick's TJ uses. Both designs have roots in Chrysler's rugged A904 Torqueflite three-speed, which worked well in full-size cars with lower output V-8s. While not quite the A727 Torqueflite of renown, the 904 did an excellent job for Chrysler and AMC. Brad, since you already have considered a transfer case swap, I suggest that unless you need overdrive, the quickest means for getting better off-pavement performance would be a blueprint build of the A999 with either a lower-gearing kit for your NP231 transfer case or an Advance Adapters' Atlas assembly with lower gearing in low range. The blueprint rebuild of the A999 can include upgrades of all friction materials and even a mild "shift kit" for improved shift performance. As the torque converter needs a rebuild, there is room for a stall speed change here for improved back-country performance in terms of compression braking and crawling on rocks. Our shop can do blueprint rebuilding of these A999 and 32RH transmissions; we take care of the converter work and balancing, too…

Stock 3-speed Jeep automatic (left); AW-4 core (right).

Nick, you have a rugged TJ—nice equipment! I blueprint build both the 30RH and 32RH series automatics to perform very well in your driving environment. An option is the AW-4 conversion, mostly using XJ Cherokee components. I can build an AW-4 to perform well, too, and you would have the added bonus of overdrive…Regarding the AW-4 conversion, the concerns would be transmission length, linkage and driveline lengths. Electronics, including the engine management computer, also need consideration. Some XJ donor models use the same PCM plug and harness features as your TJ. Parts interchange to a large degree between the TJs and XJs; however, the AW-4 uses its own shift controller. I would build a "blueprint" AW-4, using premium parts intended for your TJ's rugged service. The AW-4 is tough and could hold up well in your application. This might be a reasonable way to get a fresh transmission and an overdrive 4th gear. It would be necessary to iron out the PCM and wiring issues; perhaps an XJ harness and an XJ computer could be the bridge here. After testing and proving out the conversion thoroughly, if we were satisfied that this is a viable option, I would consider building up a core bank and peripheral parts for packaging such a conversion. Overall, I like the AW-4 transmission design and believe this could be the fix if a simpler "kit" approach were possible. TJ three-speed automatics are tough but lack an overdrive 4th gear for highway driving.

Another angle is the late TJ 42RLE automatic with overdrive—if this is not a major undertaking. The 42RLE is a tough unit, used in the KJ Liberty as well. A donor model would be the '03-'06 TJ with low mileage. Such a swap begins with a thorough comparison of parts differences between a '97 TJ and the last generation TJ. Items would include electronics, drivelines, shifter and transfer case positioning differences, wiring harnesses, shift module accommodations and the PCM. Powertrain management provides an engine and transmission interface via electronics. The sensors cover wheel speed, engine load, transmission gearing needs and a host of other inputs. Today, swapping an electronically controlled transmission is as much an electrical challenge as a mechanical feat. For that reason, it is sometimes easier to do a G.M. 700R-4 conversion into a TJ than to use a factory transmission that requires electronic circuits and a PCM interface…If owners have an interest in these automatic transmission conversions, I can cover them in tech features. Let me know!

Heavy-Duty Front Shackle Brackets for CJ-7

In the Jeep Owner's Bible, *you show a shackle that I need for my 1982 CJ-7. Is that a D-ring shackle to fit the bracket on my front bumper? Where could I find that shackle?—Mike S.*

Mike, I believe you're describing the heavy duty replacement bracket that supports the front ends of each front spring. (Full-Traction Suspension may still stock these replacement brackets.) This is actually a heavy-duty shackle support, not a D-shackle attachment point, that corrects weakness in AMC-era '76-'86 CJ front spring frame support brackets. The OEM bracket that bolts to the frame and serves as the pivot point for the upper shackle bushings is weakened by a factory punched hole that clears a frame rivet. Over time, the shackle bracket weakens from load and fatigue, and these brackets can bend or even break. The heavy-duty replacement bracket bolts to the stock bracket holes plus a front bumper bolt hole. They extend further forward and offer superior support. These aftermarket brackets are a practical solution to the weak factory bracket. There are variations on this theme from several aftermarket suppliers. 4WD Hardware might be a resource here.

YJ 2.5L Engine, Tuning and Performance Quirks

Hello! First, thanks for the great books, Moses, and for answering my questions! To begin, Mopar used to issue a book on Jeep engines, and I'm not sure how to get a copy. Any idea where to get a copy? I have a 1989 Wrangler YJ with the mighty TBI 2.5L AMC four!—Brian L.

The book is *Mopar Jeep™ Engines, Speed Secrets & Racing Modifications for Jeep-Built 4, 6 & V-8 Engines,* published as Mopar part #P4529529. It covers AMC-design engines, winning formulas from off-road and compact truck racing of the late '80s. Compiled from factory workshop manuals and racing data, this is the only official reference to racing these AMC engines. If you cannot find a copy through used literature sources, secure a copy of the Mopar *1989 Jeep Service Manual*, a two-book set that includes your YJ Wrangler.

Brian's questions— continued…

My 2.5L has non-adjustable, stamped steel rocker arms. The Federal Mogul stock pushrods for this are 9.486" length, and Clevite's are 9.520". What kind of lifter preload should I have when it comes to fitment of pushrods? I'm getting preload ranges from 0.085" to 0.100". It is my understanding that lifter preloads should be more in the 0.030"-0.040" range, my reason for double-checking. The engine is a stock remanufactured long-block from ATK and now has 15K miles on it. The vehicle has just over 111K miles, and I installed the remanufactured engine at 97K. The camshaft is within a few thousandths of new specs for lobe height and duration. Questioning local engine machine shops has left me with a variety of answers, and I'm not too sure which ones to trust. (One shop reassembles everything and doesn't check preloads.) It seems like this type of engine runs pretty warm although it may be just this particular unit. I have noticed that after 30 minutes or more of freeway driving, at idle, the oil pressure drops much lower (to 20-25 psi) than where it usually runs in town (40 psi). Bringing it just off-idle brings pressure back up to around 40 psi. It appears that this is due to the oil being so hot, as though its viscosity really thinned out temporarily. Once the motor idles for a while or is off for a bit, it returns and stays at the more normal 40 psi. Taking the vehicle on extensive or even moderate off-road use has the same effect in increasing the oil temp. When the engine gets this hot, and I notice the oil pressure, I can also tell that it is much more apt to want to knock/ping if I am doing something that requires mild lugging at idle. Is this high oil temp scenario typical for the 2.5 liter? Could the EGR valve and flame temps too high create abnormally high coolant and oil temps? I tried a new EGR valve, which didn't seem to fix the temps. Should I install an oil cooler? The vehicle sees 90 degrees F to -45 degrees F. If an oil cooler is called for, which style may perform better: one with an electric fan and thermal switch or an older-fashioned unit with a built-in thermal valve assembly?

Brian, oil temperature does play a role here. The "normal" factory-rated oil pressure for a 2.5L four

of your vintage is a minimum of 13 psi @ 600 rpm and maximum of 37-75 psi @ 1600-plus rpm. (Normal at an 800 rpm warm idle speed is 25-35 psi, which your engine may also achieve.) Despite the drop you describe at idle when hot, this is still adequate for lubing the engine. An engine oil cooler, unless thermostatically controlled, would be overkill in your cold winter conditions...If you do either kind of thermal control, make sure that there is no winter issue with oil temps being too cold...Also, if you want to know how "hot" the oil is actually getting, try using an infrared-sensing thermometer to check the surface temp at the oil pan after running. You can spot check the engine at the valve cover, block and timing cover. The block surface temp should pinpoint effectiveness of the cooling system. Check the radiator for hot spots or lack of flow, using the infrared to track heat…This can be a simple and effective diagnostic tool! As for the EGR valve, this valve actually *lowers* the upper cylinder temps if working properly. Its purpose, reducing the NOx emissions, demands lowering the upper cylinder temps to below 2500-degrees F. Without the EGR working properly, temps can reach 4800-6000-degrees F, much like an acetylene torch! I always recommend leaving the EGR in place and making sure it functions correctly…Pushrod lengths, which affect the valve clearance, are critical. (If needed, adjustable pushrods are available from Clifford Performance for the 4.2L inline six and other AMC-derivative inline engines.) There are two ways to measure lifter clearance: 1) *preload*, which is essentially zero valve lash with the plunger fully extended then add a fixed amount of compression of the lifter plunger and 2) *lifter plunger travel*, measured at the valve stem-to-rocker arm gap, with the lifter's plunger fully collapsed. Non-adjustable stamped rockers usually can only be checked for lifter travel with the plunger collapsed. Correct specs for plunger or valve stem clearance (with the plunger collapsed fully) should be available through ATK or Clifford. Make sure you measure clearance at the correct reference point—*specified typically as the valve stem-to-rocker arm gap with piston at TDC of its compression stroke, both valves closed and seated, the hydraulic lifter collapsed (without any oil in the lifter).* Specified clearance should account for the valve rocker arm ratio. (The stock ratio is 1.6:1 for a 1989 2.5L Jeep engine.) The blueprint build of an AMC inline six or four should include cutting the installed valve stem heights to compensate for both the cylinder head resurfacing and the amount of valve seat inset from reconditioning the valve seats…A bled-down clearance of 0.085"-0.100" at the rocker arm-to-stem gap is not out of the ordinary for modern hydraulic lifters. (Engines like Ford's 'FE' big-block V-8s rely on pushrods in various lengths to correct lifter clearances.) Mopar manuals do not offer a specification; they assume that the cylinder head has not been surfaced excessively, pushrod lengths are correct, head gasket thickness is right, and the valve seat depths and valve stem heights are correct. It's wise to confirm this and check actual bled-down lifter clearance if possible...Engines need adequate valve clearance to permit valves to seat. Shorter Federal-Mogul pushrods may be for remanufactured engines with a surfaced cylinder head and ground valves and seats. If your 0.085"-0.100" is clearance measured at valve stems-to-rocker arms with the lifter plungers collapsed, note that Ford 'FE' V-8s (with a *1.73:1 rocker ratio* and non-adjustable rocker arms) call for 0.100"-0.150" gap at the valve stem-to-rocker arm with the lifter plunger collapsed. Ford FE pushrods come in different lengths for adjusting valve clearance.

Brian's 2.5L tuning issues—continued…

I have found on this vehicle a normally energized-closed solenoid valve that controls vacuum to both the EGR valve and the fuel vapor charcoal canister. When I did the engine change, I put on a new EGR valve and replaced the rest of the engine sensors. Jeep discontinued supplying the G.M. Rochester vapor canister; it appeared to be intact. Recent troubleshooting led me to the canister's vacuum-operated control diaphragm. It turns out that this little rubber diaphragm has holes in it from being 18 years old. With a breach in the diaphragm, the vacuum that is constantly applied at the canister purge port can leak through and back-feed through the diaphragm to the canister's purge signal port.

Instead of the EGR solenoid valve controlling the vacuum to the canister's purge signal port, there was vacuum continuously coming from it. This was no real problem except that the EGR valve is also tee'd into the line for the signal port. When the canister back-fed vacuum, it constantly supplied vacuum to the EGR valve. This kept the EGR valve always on, during every aspect of driving. I don't know how long this went on, but when I recently tested my EGR valve, it had failed. I have replaced it and now am shopping for a replacement canister. Even with the canister's interlink to the EGR valve disabled so that the EGR solenoid controlled just the EGR and not the vapor canister, and even with a new Mopar EGR valve, the engine oil temp still gets so hot that it operates as I've described...

Brian, the EGR open at idle will dilute the mix and confuse the oxygen sensor into leaning out the air/fuel mixture...Such a lean mix can cause engine heat-up...This could cause the oil temp to rise, too. The EGR is a valuable device that lowers upper cylinder temperatures. It is also passive and has little impact on performance with the 2.5L four.

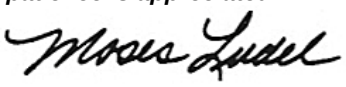
Brian added this question…

One last question that I don't believe is related: This motor has vacuum fluctuations from 20"/hg to around 15"/hg. I can hear the idle hunt a bit, and see it on the tach—up to 200 rpm fluctuation at times, sometimes barely any. Any vacuum gauge sits there and flutters very fast. The vacuum flutter seems to narrow when the engine rpm is brought up, yet it still does it to some degree. After going through every vacuum line on the engine to hunt for possible leaks (hence finding the charcoal canister to be bad) and after double-checking intake and exhaust manifolds (the engine pipe and rest of the exhaust system are all new), I am unable to figure this one out. I have verified all my valvetrain to the point of degree'ing everything out, removing valve springs and checking stems-to-guides for any excessive wear, etc. Do I need to remove my exhaust manifold and check for cracks, as the factory manifolds love to crack at the Y's, which are hidden by the preheat ducting? Is it possible that I am seeing the vacuum flutter from the power impulses since it's just a 4 cylinder, whereas a 6 or 8 might be smoother? Would some small cracks in the exhaust manifold have any effect on intake vacuum?

Four-cylinder power pulses should not be a factor. Vacuum flutter can be valves that do not seat completely. This can cause engine heat-up as well. Pushrod length and/or valve stem length control the lifter clearance on the AMC fours and sixes. The rebuilder must restore lifter clearance, and if valve clearance is too close, valves will not seat, which worsens at higher engine temps...This can cause heat buildup and eventually burn valves and seats. The EGR not seating at idle/low speeds also causes a vacuum drop or vacuum fluctuation. Lean fuel mix, air leaks, ignition timing errors and degrees of spark advance will also affect vacuum. Ignition timing is electronically controlled on your engine, with sensors feeding input to the module. The oxy-sensor "averages" oxygen readings from all four cylinders and adjusts air/fuel ratio accordingly. 2.5L fours are reasonably smooth by nature and shouldn't pulse or surge dramatically. This, again, points to dilution from the EGR or a vacuum leak, which can also be caused by an EGR that does not seat properly at idle. Make sure that the throttle position sensor is working properly and giving the right voltage readings from idle through open throttle...A defective TPS can cause idle roughness, fuel mix problems and tip-in issues.

Since you've ruled out valve timing and lift issues, the best diagnostic steps now would be a cylinder leakdown test (engine still, with each piston at TDC of its compression stroke). This will pinpoint any valve leakage or ring seal losses. Also check for intake manifold-to-cylinder head leaks and seepage at the throttle body base and shaft. Engine at idle, use a non-volatile penetrant spray; leaks will show up as a change in engine speed.

Note: The 'Q&A' section welcomes your questions! Whether a large or small issue, a needed part number, service tips for a project, questions about the value of a vehicle—whatever!…Questions get answered in the sequence received, and when volume is high, it can take a while. Your patience is appreciated!



Moses Ludel's 4WD Mechanix© Classified Ads

Each monthly issue of *4WD Mechanix©* will feature a classified ad section. While commercial advertising is available and very welcome, the classified ad section is strictly for readers' needs. Each ad appearing in the classified section will be viewed worldwide via *free* downloads of the magazine. Website browsers can access the published copy and view your ad.

THIS WEBSITE GETS A VERY LARGE NUMBER OF HITS EACH DAY!

Ad rates are available at the www.4WDMechanix.com website. The issue with your ad will be readily accessible to *any* visitor who downloads a copy of *Moses Ludel's 4WD Mechanix©* digital magazine from the website. Viewers often encourage friends to check out the ad as well. When you choose to include one or two photos, each photo will appear in a highly visible 3.0" width with properly scaled height. (When viewing the PDF version of the magazine, readers can increase the size of your photo to get maximum clarity!) There is no "skimping" on our ad display sizing or image resolution. The photo will draw attention to your vehicle, parts or equipment.

As for text, please do the best you can—our ad staff will perform light editing as necessary, strictly for readability and to make the ad look its best…The *deadline* for classified ads is normally 2-weeks prior to the issue's release date. (Each magazine releases around the first day of each month.) Ads can be run by any Jeep® enthusiast or private party—*you can run as many ads per month as you want!* Each ad will be screened for appropriate language and non-commercial nature.

We also offer highly visible display ad space within each issue of the magazine. Yes, these are real display ads seen by readers worldwide. Not flashing banners, click-links, pop-ups or other Internet gimmicks, just the kind of display ads that promote your commercial products or services! The goal is to provide traditional color advertising, laid out within the editorial pages of a widely circulated and respected download (PDF) publication. If you would like to promote your parts or service business, the products that you manufacture and sell commercially or vehicles that you sell through a dealership, please contact us. We present commercial ads in the most professional and artful ways possible. You can reach an international audience by associating your products or services with* Moses Ludel's 4WD Mechanix© Magazine*.

OUR GOAL IS TO MAXIMIZE EXPOSURE OF YOUR AUTOMOTIVE PARTS, 4WD EQUIPMENT OR THE VEHICLE YOU HAVE FOR SALE. ADS WILL BE GROUPED TO ASSURE QUICK READER ACCESS…HERE IS HOW A TYPICAL AD WITH PHOTO APPEARS IN THE MAGAZINE'S CLASSIFIED SECTION:

40-word ad with photo… 

FOR SALE—1987 YJ Wrangler, fresh 4.0L EFI six with AX-5 trans, ARB's Lockers front and rear, 4.56:1 gears, 4-inches aftermarket lift with 33" BFG tires. Runs great on- and off-road. $6,800. OBO. xxx@yahoo.com or call (619) XXX-XXXX.

<u>Note:</u> The ad deadline for the March 2010 issue of* Moses Ludel's 4WD Mechanix® *magazine will be February 20, 2010. Please submit your ad prior to that time if possible. This will be the first issue to contain widely distributed classified ads. Commercial advertisers are welcome to consult with us regarding display ads in the March-forward issues of the magazine. We look forward to serving your ad needs!