AOD – AODE – 4R70W SILVERFOX MODS

This is a technical supplement regarding modifications to the AOD/E/4R70W to improve reliability in performance applications. Before you begin to understand the "performance mods" outlined here or even simple rebuild upgrades of any transmission you must understand some basics of transmissions in general and the particular trans you are working with. A manual or rebuild video is critical tool and highly suggested before you attempt any work to your transmission.

This is considered a guide to help you understand and perform modifications to this trans. This is a valuable tool for DIY'ers and for shops looking to make an upgrade to their standard practices – **I know you are watching** ☺. There is many ways to perform some tasks. This guide only suggests modifications, their function, and critical-ness.

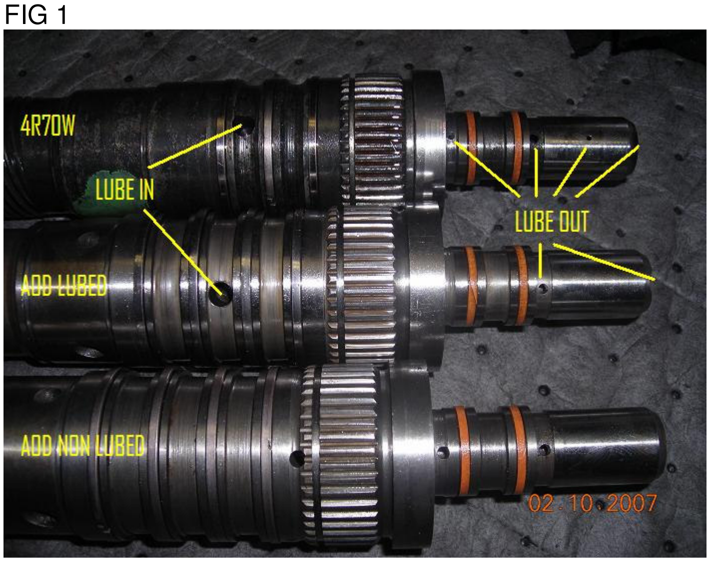
Note that most mods outlined here are to be made *during assembly* of the transmission upon rebuild. I do not suggest intentional disassembly of your trans just to perform the mods. This is also NOT A GUIDE THAT OUTLINES HOW TO BUILD a transmission.

Discussion of this material and all related transmission questions please visit the <u>General Click Click Tech</u> forum.

REAR ASSEMBLY LUBRICATION

Starting in the late 80's Ford built the AOD with forced lubrication design output shaft. Known as the "lubed output" or "4 governor hole" style shaft (Fig 1). Though many transmissions lived happy lives without this upgraded shaft, I do not suggest its use in any condition. The rear assembly (everything past the center support) is lubricated using line pressure via the output shaft up through the direct drum tower. Lubrication is critical for the planet and helps remove heat. The lubrication hole in the governor feed area was increased in diameter for the 4R75W in the late 90's. I take the chance to increase the diameter of this hole to 1/16 – note that it is very hard material.

FIG 1



Now that you have forced lubrication you have to ensure that the lube gets placed in those critical areas. The cast AOD direct drum splines wear quickly (FIG 5), causing the direct shaft (lockup shaft) to contact the tip of the output shaft cutting off lube flow to the rear assembly. This will eventually cause damage to the planet, sun gears, and related bushings. The most common cause is stock converter ballooning. Fig 2 shows the input shaft tip of an AOD with ballooned converter. Scared rings or ground indentation is dead giveaway there is/was an issue.

FIG 2

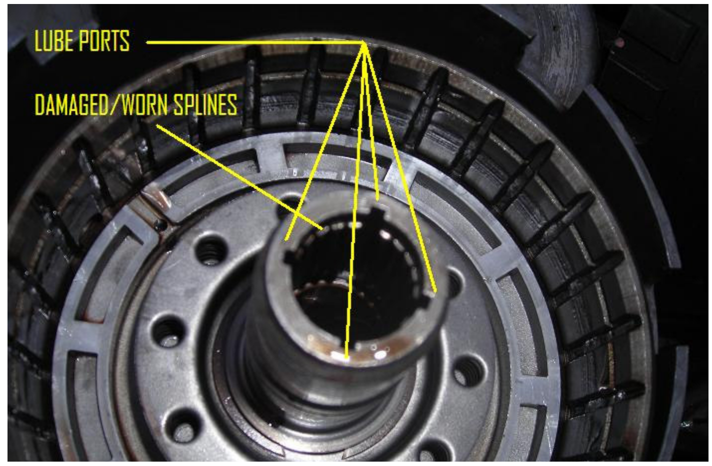
The simplest way around this during assembly is to grind a portion of the output shaft in the area where the lube exits the tip as shown in FIG 3. Grind a path for the lube to exit at 45 degrees. This will allow the lube to escape to the side and continue to reach those critical areas. Do not disturb the orifice plugged hole.

FIG 3

Another method is to use the Sonnax 76811-01K snap ring (FIG 4) or a simple tight fitting O-ring on the input shaft *during assembly* to hold the input shaft up off the tip of the output shaft enabling lube to escape most efficiently. Note that some additional mods may be required so the lube can exit the spline area shown in FIG 5. Make sure the ports are not blocked. Also after this mod is performed YOU CAN NOT REMOVE THE INPUT SHAFT without transmission disassembly, and you must insert the direct shaft before you assemble the planet into the case.

FIG 4

FIG 5



The last method is tried and true and can be performed at any step of the assembly or even after the trans has been assembled. The XCUT (FIG 6) will allow lube to escape through the X pattern. IF NONE OF THE previous mods have been performed, this is something every AOD owner should inspect/perform before you install the trans.

FIG 6

You can use an angle grinder, hacksaw blade, dremel, ect, to perform the cut. You need to make sure it exits each side. 1/16" wide and equally deep groove is as small as I would do.

When stamped steel drums became available in the early 90's with the AODE, the issue with input shaft falling due to spline wear was resolved with higher quality broached splines that came all the way to the tip of the snout of the direct drum. This holds the input shaft up where it should be.

The AODE/4R70W is also subject to poor lubrication in some instances as well. It is common for the stub input shaft to fall out of the forward drum splines and cut off lube as well in early units with poor direct drum splines. There has also been instances where I found the lube hole in the output shaft blocked or poorly machined/drilled.

FIG 7

FIG 7 shows what can happen if you demand too much from your trans without proper lube! Note the bushing in the sun gear, the direct drum snout and the hub bearing are all fried. I would consider the planet trash as well in this event.

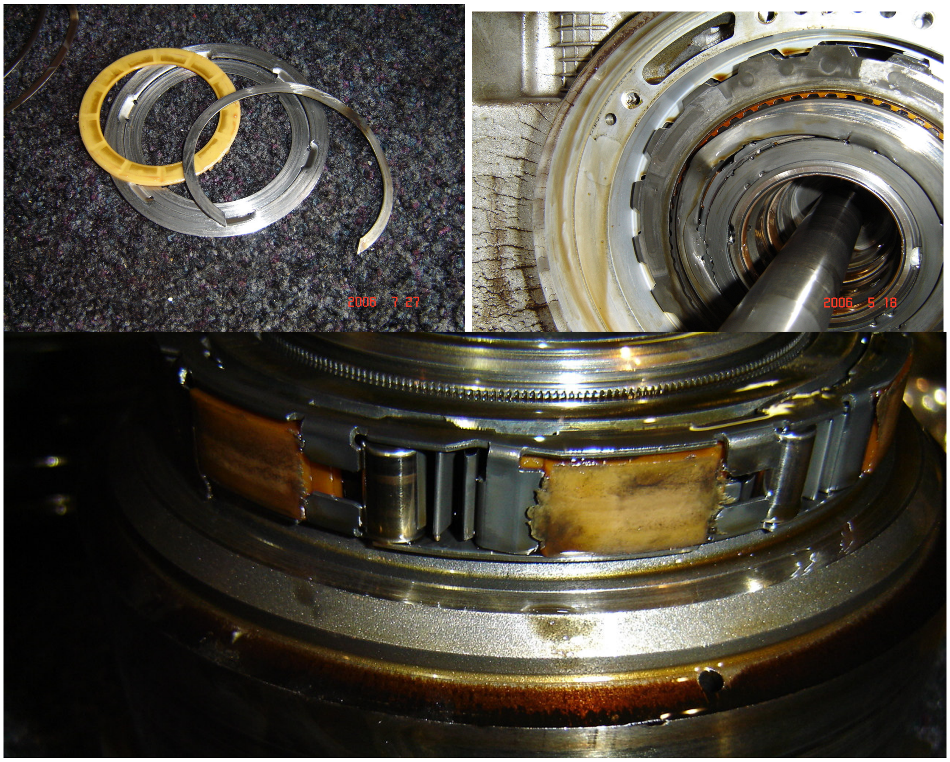
INTERMEDIATE ONE WAY CLUTCH

The intermediate OWC, or what I should say - reverse drum, is subject to very high RPM in 3rd gear, especially when you are beating it at the track or even on a street car jumping down from 4th to pass a car. These RPMs take a toll on the related components and are a major point of failure on the AOD/E/4R..

The snap ring that holds the Intermediate one way clutch (OWC) and retainer has a very high failure rate. At high rpm the snap ring flings off. An upgraded spiral ring is mandatory in my opinion. There are many ways to retain the OEM snap ring such as tack weld, cut and bend tabs in the retainer, and even a new option in 04+ 4R75W with oversized hardened snap ring. Sonnax 76554R and Superior offer a spiral ring upgrade.

Failure of the snap ring lets the OWC race and retainer creep off the roller which leads to increased wear of the race and rollers and ultimate failure of 2nd gear engagement. FIG 8 shows what you will often find. Bent retainer, destroyed snap ring, failed OWC, and thrusts washer damage. Warning signs of snap ring loss is slipping on 2nd gear engagement and odd clicking noises or squealing. I have not seen damage from snapring loss with a mechanical diode, however once the ring fails, it will become shrapnel.

FIG 8



Lubrication of the intermediate OWC is also very critical. The 7 element and 14 element roller assemblies are very sensitive to heat and poor lubrication due to their plastic components. I always recommend you increase the lube feed hole for the OWC to 3/32" drill (FIG 9). Be certain you clean the metal debris from the ports.

The forward assembly (everything forward of the center support), which includes the intermediate OWC assembly, are lubricated by the returning fluid from the converter and cooling system. If the cooling system is inadequate and temps in excess are maintained for long periods of time the plastic in the roller element design of the OWC assembly become degraded. This heated lube and possible debris is injected straight to the forward assembly. By increasing the lube flow we can keep things cleaner and cooler.

FIG 9

The forward assembly (everything forward of the center support), which includes the intermediate OWC assembly, are lubricated by the returning fluid from the converter and cooling system. If the cooling system is inadequate and temps in excess are maintained for long periods of time the plastic in the roller element design of the OWC assembly become degraded. This heated lube and possible debris is injected straight to the forward assembly. By increasing the lube flow we can keep things cleaner and cooler.

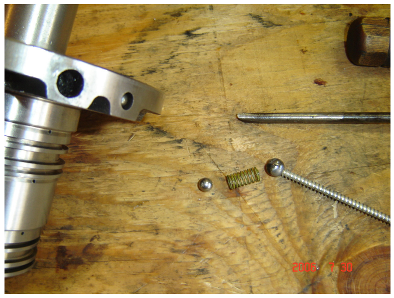
The AOD and AODE used the 7 element roller OWC. A heavier duty option over the OEM roller is available. I call it the "Green" or "Blue" option. I have discovered it has higher quality plastic. The Borg Warner "Tan" (FIG 8) 7 roller is still sufficient for all trans still utilizing this design.

Another option (history lesson) is the 14 element roller assembly with matching reverse drum. (Note stamped steel reverse drums do not directly retrofit to the AOD without additional changes suggested later in this article under STAMPED STEEL DRUMS) This OWC was utilized in police interceptor transmissions and some trucks. The design had superior holding power against slip of the OWC due to increased contact points on the race. It proved to be very frail against high rpm use and went obsolete quickly. Today however the newest 07+ mechanical diode has proven to be the best design yet, regardless.

For all AODE/4R's with stamped steel reverse drums I highly suggest the use of the mechanical diode option found in 1998+ units for all builds. It has a ratcheting design that makes a clicking sound. It is reliable in all applications and is often considered "bullet proof" by many transmission builders. However, it is still subject to failure and should be inspected thoroughly before use.

FIG 10a

FIG 10b



PUMP / STATOR UPGRADES

"The heart of the beast." The pump supports pressure to the system and lube flow to the converter and cooling system. The AOD/E/4R pump and stator assembly in stock form is efficient and reliable There are a few upgrades I perform to help it out a little more.

Most of the mods to the pump assembly are related to the stator which feeds the forward assembly with lubrication. The first mod has already been mentioned; as an increase in the diameter of the lube port for the OWC.

For the AOD, the next supporting mod is to remove the drain-back valve to increase cooler flow and help the entire forward assembly lubrication system. The check ball is a huge restriction. This mod has been performed successfully on Ford C4 transmissions since the 60's and 70's. This mod is not critical for all builds and should be noted that it significantly increases flow to the converter as well – in some instances it has caused change in stall in the order of 200 RPM lower, and allow the cooling system to empty back to the trans.

Start by placing a screwdriver down into the bore noted in FIG 10a where you can see the spring (yellow) – try to force the aluminum plug out a little. Drill the aluminum plug half as deep with a 3/32"-1/8" dill at an angle. Thread a screw (drywall screw) into the hole and pluck the plug out of the bore (Fig 10b). If you can get the plug out far enough, you can take a gasket scraper and chip it out of the hole. Remove and discard the spring and check ball. The ball is often stuck and needs some help by tapping the stator. Replace the aluminum plug flush with outside.

The AODE/4R pump body and stator is different than the AOD. There are added provisions for the lockup system, different route for cooling, different orifice placement, and bolt pattern. The AOD pump remained the same for the life of production, while the AODE/4R has had several updates. Most notable updates are 94+ (F4 casting) pumps have 0.608" wide pump gears and the stator was upgraded with deeper castings that increase flow (FIG 11). 2004+ stators use teflon rings, and bonded intermediate pistons. I do not suggest the use of the F1/F2 casting pumps or stators. The check valve was moved to the valve body on the AODE/4R so there is no mod needed like the AOD.

On all the pumps it is a good idea to go ahead and use a ¼" drill to clean up the supply orifices as well and slightly chamfer. Enlarging the cooler offices in the assembly is also not a bad idea – don't get too carried away, the 5/16" case fittings are the true bottle neck.

FIG 11

Always replace the pump bushing and seal for preventative maintenance. In the past I have used the EXTRA WIDE C6 pump bushing, (0.697" vs. 0.76") however recently I have had problems sourcing a bronze replacement in the wide bushing. I do not recommend the use of babbit (aluminum) bushings – especially in locations where hi rpm forces are seen. The other critical bushings are: planet, stator support, rear case, sun gear, and tail housing. Often some 1K grit paper can clean low maintenance bushings well enough to reuse. Don't forget to stake the pump and tail bushing to prevent it from spinning. I use Red Loctite on them as well. There is no need for drain back orifice enlargement popularly modded on GM trans.

PLANETARY UPGRADES / LUBRICATION

The compound planetary design of the AOD/E/4R is tough and reliable. The 4R70W and now the 4R75W have significant improvements over the original FMX and AOD/E designs including harder gears, roller bearings, and welded seams. The AODE/W, known as the 4R70W, was produced with a WIDE RATO gear design that reduced the 1st gear ratio to 2.84 vs. the 2.4 of the AOD/E. The result also affected other gear ratios but not enough for concern. This reduction in ratio helps with acceleration of larger/heavier vehicles and produces more torque in low gear. It led to special hardening of the output shaft as a preventative measure. The deeper ratio and new design over the AOD/E planet allows it to handle significant power and has been tested up to 1000+ ft lbs with great success. The AOD/E planet is still reliable over 500HP, however needs some TLC and should be inspected for wear more frequently - much like a C4 planet. Planet choice should weigh on use of vehicle and power. Many drag cars chasing consistency prefer deeper rear gear with the AOD/E planet due to the even spacing of the ratio's.

You can upgrade the AOD/E with the 4R70W wide ratio planet. It is a common upgrade with performance builders. It is also widely confused and improperly assembled by those who are not familiar with the many changes and updates Ford has issued since the early 90's. The rule of thumb however is the newer the make of the trans/planet the better quality gear set you will find. I HIGHLY SUGGEST if this is a route you plan to take as a novice you purchase a 4R70W core to pull the gear train from. This way you will not be short any parts. The WIDE ratio swap for both the AOD and the AODE is detailed later in the WIDE RATIO GEAR SWAP section.

The mods listed above in the REAR ASSEMBLY LUBRICATION section are critical support measures for keeping the planet healthy. The lubrication improvements you make to your trans are directly proportional to the duty you require of the trans. Not only are you preventing failure due to frictional forces, but eliminating heat of these components as well.

FIG 12

Ford did an adequate job of designing the lubrication for regular duty. Additional lubrication improvements can be made by enlarging orifices and creating new. Lubrication is supplied to the direct drum snout where it is allowed to bleed through the ports and through holes placed on/near where bushings and bearings ride. Cast drums will have 2 orifices that supply the sun gear bushing and planet bushing. Later stamped steel drums have 4 holes. It is difficult with traditional short bits, but enlarging these orifices to 1/16" – 5/64" is a safe practice. (FIG 12)

Lubrication leaves the direct drum snout and into the center of the sun gear where it meets up with lube from the front assembly and lubricates the shell and planet. A popular mod to the GM 700R/4L60E is to machine grooves in the sun gears to help lubrication flow out toward the planet. This is a valid practice on the AOD/E/4R. Again you can do this with an angle grinder or dremel. In FIG 13 you can see I have machined grooves in the face of the gear.

FIG 13

INPUT SHAFT SELECTION

There is a variety of input shaft choices for the AOD/E/4R – more choices than nearly all other transmissions in production, so you can understand that there is often a lot of confusion regarding what you have versus what you need. We will start with the AOD input shaft as it is the most complicated and will help us understand how the AODE/4R is designed.

The AOD was equipped with a two piece (2pc) input shaft that consists of the 23 spline inner direct shaft (lockup shaft) and a hollow 35 spline outer shaft (intermediate shaft). The hallow shaft is driven by fluid coupling of the torque converter turbine and the inner shaft is splined to the front hub and damper of the torque converter (FIG 15). The direct shaft is spun 1:1 with engine rpm 100% of the time and is not fluid coupled inside the converter. This is why it is often referred to as "lock up" in high gears. Inside the transmission the intermediate shaft is machine fit to the forward drum and the direct shaft is splined to the direct drum. The direct shaft is removable much like the input shaft of a C4/C6. The direct shaft has always been a weak point of the AOD. Often referred to as the "fuse" – too much power or shift calibration usually results in breakage leaving you without 3rd and 4th gears. The stock shaft has been known to hold 500hp, however I have seen them snap at 350. Shift calibration is critical to preserve its reliability. No rock hard 2-3 or 4-3 shifts are suggested. It is very common to simply upgrade this shaft to an aftermarket specialty hardened unit. The

FIG 16

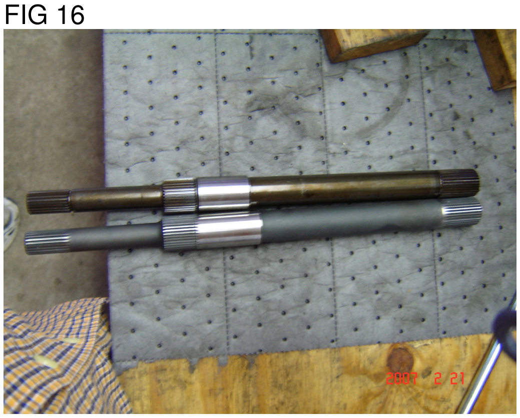


FIG 17

FIG 15

FIG 18

2pc input shaft design should not be considered reliable above 550hp due to the turbine shaft failing at that point anyway.

The next upgraded shaft option is the “one piece.” This shaft is one machined part that has one set of splines for the converter (commonly Ford 31 spline – C6 style) and machined to fit the forward drum with a 23 spline portion machined on the back end (FIG 16). The forward drum must be removed from its stock shaft and pressed onto the one piece shaft. This shaft is as good as you can get for the AOD. It should be capable of supporting well over 700hp in the correct application. This upgrade does require a knowledgeable transmission builder to assemble and a custom built converter.

The AODE/4R has a different input shaft design than the AOD. It is considered a one piece design, but in truth it is still made up by two pieces (FIG 17). The center input shaft is commonly referred to as the “stub shaft.” Like its daddy, the AOD, the AODE/4R is also prone to input shaft failure. The early AODE stub shaft had an undercut at the base of the direct drum splines (FIG 18) that created a weak point. FIG 18 also shows the progression from 1996-1998 shafts to the best current 1999+ hardened shaft where the undercut is absent. The 99+ shaft is sufficient for use up to 500hp quite easily.

Lastly, on the AODE/4R, all the Ford production stub shafts fits loose into the forward drum splines and are allowed to fall out/down slightly until they seat themselves against the output shaft lube orifice (OH NO! not again) or bump up against the splines of the direct drum. This means the stub shaft is never fully seated into the forward drum and is a major point of concern with stripping the forward drum splines. For performance use or extreme valve body calibrations it is critical that you stake the shaft firmly into the forward drum. You can do this by pinging a few spots around the splines so that the shaft is held in place and not allowed to fall out. This does create a headache installing the front assembly.

The most common building materials for aftermarket shafts are 4340 or 300M. I personally only choose 300M due its ability to flex slightly, where 4340 is so brittle it will snap – I have seen it many times!

OUTPUT SHAFT SELECTION

Last time I tallied up the count there was 14 output shafts to choose from of which I only regard 5 worth using. We can break them down into three varieties: short 15”, long 16”, and 4x4. Of these varieties there are 7 or 8 tooth machined speedometer splines. Then you can break it down into: 2, 3, or 4 governor feed holes. Two holes usually means 96+ 4R, Three means non lubed AOD, and Four is your choice of lubed AOD or very early AODE (before they changed to 2 holes). The AOD uses a governor to command shift points where the AODE/4R does not require these provisions. When using a true manual valve body in the AOD, you can us the 4R two governor feed hole shaft – otherwise do not. Once again another break down would be if it is full spline or short spline.

So which do you need?? Once again to reference the REAR ASSEMBLY LUBRICATION section above, this is the first important trait. I consider them all to be at least 600ft/lb capable. Later 4R70W /4R75W full spline shafts with special hardening I would rate 750ft/lbs easy. I choose to use full splined 4R70W output shafts in anything looking to achieve over 700hp/700ft/lbs. FIG19 shows a small selection of shafts. From left to right, 15”/AOD/3GOV/SS, 15”/AODE/4GOV/FS, and 15”/4R/2GOV/FS. The 4GOV/FS shaft was only available in 93 MarkVIII and some Crown Vics and useful for “auto function” AODs exceeding 700hp.

Output shaft lengths on the 2wd units are only separated by 1 inch (FIG 20). It is often hard to spot at first, so double check the length you need or plan on using. The 16” versions were used (some still are) in Lincolns and trucks and rumored to be in some police vehicals. However those rules are not absolute. When snooping a core, a 10.5” extension housing usually means it is 15” shaft, and 11.5” a 16”.

FIG 19

FIG 20

TAILSHAFT LUBRICATION MOD

When using numerically higher gear ratios it is common for the tail housing bushing to become galled due to the absence of lube and build up of heat. The tail housing of the AOD/E/4R does have fluid in it, however it is not vigorously pumped into the area to support lubrication. To prevent bushing wear, a remote lubrication tube can be added that pumps fluid directly to the bushing. I have added this mod successfully to the C4 and C6/E4/r100 as well. The modification has been documented on TCCOA.com for years. Some companies also sell kits that simply take the labor out of the modification. FIG 21 shows the progression. On the AOD you will need 20" of 3/16 brake line and (2) 90* compression fittings (3/16 comp to 1/8 PT). After you remove the old bushing, you drill (11/32" drill FIG 21) in the location of the bushing on the drivers side in the thickest area you can find. Tap the hole (1/8 NPT). Inspect the depth which you will thread the fitting. Install the new bushing and in the newly tapped hole you need to drill a .05" hole for lube to reach the bushing/yoke area. Assemble the fitting with thread sealant and install the second fitting in the LINE test port. Do not attempt to use any other test port. Attach the 3/16 line with it traveling the backbone of the trans so not to interfere with vehicle install.

FIG 21

CLUTCHES and STEELS

Clutch choice is always on the mind of any performance builder – and these days with popular advertising consumers know about specific clutch brands as well. COLOR IS NOT ALAWAYS AN INDICATION OF PERFORMACE. Popular belief is RED or BLUE are the best…forget that nonsense. That is a marketing tool. Factory paper tans will hold a significant amount of power. Consider a Ford C6 will handle near 1000hp on a stock rebuild with Borg Warner tans. Black material such as Dynax and Raybestos High Energy is also a great choice and is becoming popular due to its high reliability with slip and low cost. The newest generation of clutches materials are porous and absorbent and able to handle the heat of slip. Reds are often promoted as being the performance clutch for everything. I like the Raybestos Stage 1 performance clutches a lot for mid range power applications. They have a nice firm grip. Be careful not to overpower them however, they burn like tans – quickly. Alto USA has a line of red clutches they promote combined with thin koleen steels (heat treated anodized steel plates). The clutches are a good factory replacement; however I am disappointed at the designs lack of waffling. Blues (made my Raybestos) are considered the "racing" clutch. They are hard as a rock and have super reliability. In trans with high line pressure and performance enhanced valve bodies they are great. The use in lazy street applications or stock systems can possibly produce ill effects of slide bump and some slippage and are not cost effective.

The design of the clutch in terms of friction face is also a concern. I prefer waffling on almost all applications of any clutch. The waffling aids in apply and release timing with the added space for fluid to move. Smooth clutches also have advantages. They hold the tightest and are great for clutches that maintain clamping pressure such as the Fwd clutch in a C4 or C6. They do however produce a slightly slower apply time. It is okay to lose a clutch in a stack when moving up into performance friction materials. For instance, what a 6 clutch tan assembly will hold, a thick steeled 5 clutch Blue assembly should hold as well. In FIG 22 you can see a wide variety of dir clutches showing what I have mentioned.

Choice of steels can be critical as well. Generally speaking, the thicker the better. They act as heat sinks for the clutch – we don't want the heat to build up in the friction plates. If the steel is to thin they will warp at the first sign of heat and then trash the clutch pack quickly.

BANDS

Much like paper frictions, paper bands have a real grip to them, however when slipped they quickly turn to ash. The new trend is leaning toward high energy materials that are high in carbon and often black in color. Kevlar is another popular choice but it should be noted that Kevlar is very hard material and will often slip MORE than paper, however it will survive the slipping more reliably aiding in its service life. I strictly use high carbon content bands, some are even custom made. Though I don't know of any "rigid bands" for the AODE/E/4R, I tend to lean on flex bands for all my applications due to their reliability at high apply speeds where rigid bands tend to be brittle. In any instance, the pressure and apply time of the servo is always the first line of defense against burnt bands. If you are not looking for grandma smooth shifts, get a bigger servo. Even saying that, proper VB calibration can make any servo or band apply shift feel comfortable.

FIG 23

CLUTCH DRUMS

The AOD was originally built with cast steel drums (FIG 23 RIGHT) and in the early 90's Ford began equipping the AOD and new AODE with stamped steel drums (FIG 23 LEFT). Cast drums are very tough, however they are heavier than stamped and brittle. In any instance stamped steel drums are the choice of performance builders when upgrading an AOD. The stock 92+ AODE/4R is equipped with them. Cast direct drums are still considered usable up to 450 HP. Cast and Stamped drums DO NOT use the same spline pattern on the clutch steels or the same pistons. You must be careful when ordering steel plates for the 90+ AOD, it might have a mix of cast and stamped drums.

FORWARD DRUM: (FIG 23-1) The cast forward drum does not necessarily have any weak points outside its weight but should still be upgraded in high torque applications to prevent stripping the input shaft splines much like the C4. When switching to an AOD ONE PEICE input shaft I always use the late model 4R70W fwd drum. Torrington bearings are not subject to change with drum choice. It should be noted that there is SEVERAL different snap ring heights that were machined into the Fwd drum. Piston thicknesses vary as well through the years and the cast drum piston can only be use on the cast drum. The Fwd drum has a wave/cushion spring at the bottom. The Stamped steel version has 3 or 4 different thicknesses to choose from. This wave is critical to keeping the Park-to-Drive clunk minimal and the 4-3 downshift from being too abrupt. There is no accumulator on the Fwd clutch, much like the OD servo, the spring or wave act as the only thing to soften the apply. Some builders eliminate its use in lou of a 6th friction. A

FIG 24

very pronounced 4-3 shift is noticeable with this setup, especially on the coasting downshift. 5 clutches are standard in this drum and are sufficient up to 500 hp easily.

REVERSE DRUM: (Please read the Intermediate One Way Clutch section above) The cast reverse drum utilizes the 1.5" AOD band and does not have the surface area to support the use of a 2" AODE/4R band. The cast reverse drum was only produced in the 7 element roller design and very early units came with a bronze washer design indicated by 3 dimples in the bearing face. Later stamped steel reverse drums had the 7 and 14 element and most recently the "mechanical diode" option (FIG 23-2). Each drum is machined different to utilize these OWC's. The stamped reverse drum has a slightly larger diameter so the design of the sun gear shell was updated as well to a "dimpled" design (FIG 24). The 4R uses the dimpled shell as well, however with a 38 tooth sun gear due to wide ratio. You must use the AODE 36T shell to retrofit a stamped drum into the AOD. Cast drums have a snapring groove machined for 3 or 4 clutches and use the same pressure plate. Stamped drums have the same snapring groove and two different thickness pressure plates to build a 3 or 4 clutch setup. Three clutch reverse is sufficient for all car applications and has the least amount of drag. The 4 clutches setup is ideal for towing and transbrake use

DIRECT DRUM: (FIG 23-3) The cast direct drum is the most common failure in performance applications. The cast material of the snout (where the direct input shaft inserts) is prone to stripping or breaking cleanly if shift settings are to harsh with the direct drive feature in tact. Loss of 3rd and 4th is the result. Later stamped steel direct drums are not prone to breaking or stripping and have better lube port design and splines. With significant torque the direct drum is prone to twisting – a new snout/tower is in production now that made of Chromalloy 4340 to prevent this in applications with over 700 flt lbs.! All drums should have at least 6 clutches. Clutch choice is critical here as 7 is the max you can fit without machine work. Upgraded clutches can hold more power reliably as mentioned in the CLUTHES AND STEELS section.

WIDE RATIO AOD

The AOD and AODE share the same gear set with (Ratio 1=2.40, 2=1.47, 3=1.00, 4=0.67) which is considered "even spaced" where the AODE-W/4R70W has "wide ratio" gearing (Ratio 1=2.84, 2=1.55, 3= 1.00 4=.70). Wide ratio gearing has many advantages, mostly Helping to accelerate heavy or underpowered vehicles, It is also a strong gearset both in design and function with a deeper 1st gear more torque is transferred to the output shaft.

Table 1

DOUBLE RACED REAR CASE BEARING	F3LY-7F242-A
4R70W OUTPUT HUB	5.16" OD
4R70W RING GEAR 88 TEETH	F3AZ-7A153-A
DOUBLE RACED DIRECT DRUM TO HUB BEARING	F1AZ-FF240-AA
STAMPED DIRECT DRUM	F2AZ-7F283-B
4R70W PLANET	F2AZ-7A398-A
4R70W SUN GEAR 31 TEETH	F3LY-7F242-A
4R70W SUN TO SHELL BEARING	1.457" OD
4R70W SUN GEAR SHELL 38 TEETH	
STAMPED STEEL REVERSE DRUM	

A popular swap is to install the wide ratio gearing from the 4R70W into the AOD. This task can be simple or painstaking both in assembly and valve body calibration. As mentioned, the easiest way to perform the swap is to find a decent 4R70w core and swap everything needed into the AOD – bearings and all. I have detail the items needed in Table 1.

Before performing the swap you should also consider your VB choice. The AOD valve body is HYDROLICALY DESIGNED to shift the even spaced gear set does a terrible of shifting the wide ratio gear set. Uncalibrated vb's will have a LONG first gear (due to rpm needed to tell gov to shift) and the 2-3 shift will hold just a tad longer than before at part throttle, however the 2-3 becomes to short due to the RPM you had to gain just to get the 1-2 shift. A manual vb or custom calibrated vb is the best suggestion to control this gear set in a more controlled manner. If you are determined to tinker with it yourself, start with the lowest rpm governor and epoxy mod (mentioned later in this article) and work up from there. You can identify this governor valve by the solid head with nipple on the valve vs. the high rpm having a hole drilled in the middle.

FIG 25

Make a note of rear gearing. If you are geared to high (above 4.30) with the AOD/E 2.40 ratio, the wide ratio 2.84 will make 1st significantly shorter. The most popular rear gear with the wide ratio planet is 3.73, while 4.10 seem to reign as king with the even spaced AOD. In any regards, don't fear the gear!

CASES and CORES

Not all cases are created equal. When snooping the yards, case ID is the first give away as to what you are looking at. As the AOD/E/4R matured there were many case upgrades. The part number is casted into the case above the shift lever. The AOD starts with RF-E0 meaning 1980, then progresses RF-E9

(1989). The E9 case is the most preferred case to start with. Not only will it have better late model internals and valve body, but it has extra reinforcement at the bell housing ears and backbone (FIG 25). This is not a critical upgrade however. The Super Coupe did have a special case with the casting SC on the bell – very rare. The only other outward ID that can help with core selection of the AOD is length (4x4 or 2wd - 30.5" or 31.5"). There is often a tag on the tail housing, but good luck reading it.

The AODE/4R also progressed with RF-F4 (1994), RF-F7 (1997), and finally the 05+ case with an additional sensor for the input shaft. The RF-F7 case is the standard for performance use and early cases are not suggested due to poor casting for fluid control of lockup. Also the earlier castings for sure will not have upgraded internals like the 1998+ units do. 1998+ units are easy to ID with the RF-F7 casting and a ratcheting sound when the input shaft is turned…you are sure to have a mechanical diode if you hear this. Early units will just squeak. Also to quick ID the core, the case bulkhead connector come in WHITE or BLACK…black being 1998+.

VALVE BODIES

The AOD VB has 3 different castings starting with the RF-E0 (1980), then RF-E4 (1984), and lastly the RF-E9 (1989+). Each casting improved upon the last with the E9 as the final destination and best unit. There were countless separator plate revisions. However only the plates designed for the castings will work with that casting. You can not mix/match them – unless you are experience to ID and modify them. The most notable AOD vb is the E9 which eliminated the use of the 3-4 accumulator. The 3-4 accum was a leaky POS that often bound up and lead to many dead OD bands. This VB simply blocked it's use via the separator plate. All AOD vbs will fit any case and control the trans as intended.

The AOD vb is regarded as the most complex hydraulic maze of channels and valves ever. I have years of experience experimenting with them. The single most important item any AOD build (stock or otherwise) is a modified vb. Like all kits or custom vb options they attempt to cure common shift annoyances and increase reliability by reducing shift overlap and speed up apply and release of clutch/bad components.

There is a market full of vb components and "shift improvers" for the AOD vb. Most common vb components are: Boost valves, some offer increased pressure which is a great option combined with a shift improvement kit. The constant cycling of the valve over many years wears out the bore and life supporting boost pressure can decrease. TV valve, much like the boost valve the bore is worn and the tiny plunger inside will bleed pressure or bind the valve. There are many other valves and vb components available however they are not all critical items and aftermarket options should be researched before attempting to solve a vb/shift issue.

There are many Shift improver kits available as well. Transgo, Superior/Fairbanks, Baumann, TCI, B&M, Art Carr, Performance Automatic, to name a few. May of these brands have multiple kits to help cure or modify different aspects of vb performance. Not all kits are
"performance" related and very useful for all types of driving. Regardless, they all require YOU to perform modifications to the stock vb. These alterations include drilling holes, plugging holes, and replacing valves or springs per the instructions. You can not un-drill a hole so some modifications are permanent obviously. Another option is custom/aftermarket valve body offerings. These modified stock vb offerings include everything from slightly modified no better than a simple kit to wildly modified manual valve bodies. The most important things to note about custom options are they do not require you to do any detailed modifications and simply bolt in for the most part. The next big thing is the modified shift pattern options that allow manual 2nd gear or the ability to lock out overdrive via solenoid.

The most critical items on the AOD vb that need attention are eliminating 2-3 cutback, increasing the holding rpm of 2nd gear, and the ability to increase the RPM of all shift points after a numerically higher rear gear ration has been installed. The last critical item that has yet to really be addressed by anyone other than me, is calibrating the vb for wide ratio gearing install.

With the AODE/4R vb came a whole new evolution toward electronic transmissions. This new vb still controls the same basic functions of the AOD, just in a different case. It is much less complicated and solenoids take the place of what valves and hydraulic pressures accomplished in the AOD vb. Much like the AOD, there were many castings starting with the F2 (1992), F6 (1996), then around 2002 it changed slightly again with the deletion of the orifice valve and mod valve. There are tons of separator plate choices and in some instances check ball use. Like the AOD the plates should not be swapped around unless you know what you are looking at and swapping new/older vbs into some applications is not always acceptable due to the electronics

There is a significant amount of info I could expand on to continue this section however most of it would be redundant to the www.tccoa.com articles. I will leave it with the most handy upgrades for the 4R vb is to retrofit newer vbs into older applications with the proper respect to electronics and a good PCM tune.

ACCUMULATORS

TORQUE CONVERTER – LOCKUP VS NON LOCKUP

This is a subject that always seems to be a matter of debate. Unfortunately many folks concerned with choosing lockup or non lockup with the AOD and AODE/4R don't understand the basics. Firstly the term lockup can mean many things. A converter builders use to say, "it will lockup around 3000 RPM." This means the fluid coupling of the turbine in the converter has reached it peak efficiency and doing about all the work it can do to turn that input shaft. Since the development of true lockup type transmissions and converters the term has taken on a new meaning. Today we refer to lockup as a mechanical component of the converter that is commanded by an electronic solenoid to apply a friction surface that is splined to the input shaft or turbine. This essentially "locks up" the input shaft at a 1:1 ratio with engine RPM – just like a manual transmission.

The AOD DOES NOT HAVE LOCKUP in the true sense of the word. It is technically called direct drive but for all explanation purposes and to stick with popular terminology we will call it lockup. The AOD enters into lockup for 3rd and 4th gears. Third gear is not completely in lockup as it is still using the intermediate input shaft that is in fluid coupling. There is no way to turn off lockup on an AOD without eliminating the damper from the converter (déjà-vu FIG 15). Though 1:1 or lockup gets the most power to the rear wheels possible, it is often eliminated in the AOD converter in favor of torque multiplication and reliability. As mentioned in the INPUT SHAFT SELECTION section, the direct drive function of the AOD is weak and prone to failure. There is a lot of stress happening to the direct drive shaft during the 2-3, 3-4, and 4-3 shifts. A custom built converter that eliminates the damper welds a similar component to the turbine which now powers the direct shaft with fluid coupling along with it's best friend the hallow intermediate shaft. The conversion is accomplished with the sole modification of the converter and no input shaft alteration or valve body change is required. Removing the stress of lockup increases reliability and produces an enjoyable "seat-of-the-pants" change in performance by eliminating that 2-3 "bog" feeling.

The next step in preventing input shaft breakage and gain some performance is to eliminate direct drive (lockup) inside the converter. This is a custom converter where the builder welds the direct shaft splinted component to the turbine so that it is mated with the intermediate shaft and functions identically with fluid coupling. This eliminates the bogging feeling of the 2-3 shift on the AOD and you gain torque multiplication in 3rd and 4th gears. This switch in converter can be done using stock input shafts and will preserve the direct shaft up to the same performance level as the hallow intermediate shaft. This means you don't really need to invest in a special hardened direct shaft if you plan on using a "nonlock" converter for 2pc input.

The ONE PIECE AOD input shaft is non lock no matter what as the converter can not function lockup without the 2pc design.

The AODE/4R has a modern "lockup" converter where a large diameter clutch (FIG XX) is engaged inside the converter via hydraulic pressure often commanded via solenoid on the valve body. The design is used in almost every modern converter today. Lockup is usually commanded by the PCM in 3rd and 4th in most applications and is subject to throttle position or resistance. Performance converters often have duel or triple disk designs that increase the surface area the converter can utilize for clamping. It should be noted that a 9.5" converter with triple disk lockup should not be considered "better" in design over a 12" converter. The circumference of the lockup clutch has just as much to do with design as the amount of clutches. Performance converter builders can utilize many different makes/models of converters to build from, and use custom machined parts, covers, and hubs.

ASSEMBLY NOTES

Assembly of the AOD/E/4R for performance applications is pretty straight forward. Always use the best gaskets and seals your supplier has to offer. Always air test your assemblies to get them seated and check for leaks and use plenty of assembly lube. Use GM 325-4L solid teflon turbine shaft seals for the direct drum ring seals – they fit very tight. A general rule of thumb is 0.005-0.01 clearance per clutch after they have been soaked for at least 30 mins. A typical performance AOD/E/4R up to 450hp can use the standard 3 or 4 clutch Intermediate, 5 clutch forward, and 6 clutch direct. Clutch choice is a matter of reliability, cost, and shift feel at this HP level – tans will suffice and are perfectly good choice. Be sure to lube every single bushing and clean/dip every bearing in fresh ATF. It is critical to lubricate the pump, pump bushing, and sprags before you button up the trans - this area will see stress immediately after startup especially if you are gravity filling the trans. Always use new sprag or roller assemblies. Inspection and the words "clean and smooth" should always be repeated in your head. Pay attention to drums where the steels spline and the friction spline to the hubs - damage or burrs here will result in unruly release and generate heat warping.
