OS 50SX-H

Troubleshooting and repair tips!

INTRODUCTION

The OS Max 50SX-H may be the sweetest running engine I've ever had, and the Hyper is more of the same. The Hyper differs in having a big anodized-aluminum head reminiscent to those used on the R/C car engines, and a carb throat, which is 1.5 mm larger in diameter. I've got two of each and find them to be extremely reliable and rock solid performers! I happen to like OS Engines for my helicopters, but as we say in the south; I don't have a dog in this fight (because I'm not in the business of selling these engines). Anyway, I have a some experience with glow engines that may help you so I'm sharing my 2¢ on what to do when your engine is running a little sickly.

FIELD TROUBLESHOOTING

If it's running bad, then while you're at the field the order in which I troubleshoot is like this.

1. Check the carb's feed and pressure lines.
2. Ensured there's no debris in the fuel system.
3. Ensure backplate, head, and carb bolts are tight.
4. Swap the glow plug for a new one.
5. Try fuel from a different batch.

These five steps are the first things I'll try because it's been my experience one of these will often resolve the problem of the engine not running like it should (versus immediately tweeking the needle valve, which is what rookies do first). Anyway, while this is the rough order of the steps I follow, the fact is because of my experience I may skip a step depending on symptoms. However, if none of these steps resolve the issue, then it's a pretty good bet you're going to either field strip the carb to look for debris, or work on your engine back at the workshop.

TOOLS AND EQUIPMENT

You'll need a few basic tools and equipment. For engine disassembly you'll need both a 2.0 mm and a 2.5mm Allen driver, an X-Acto knife with #11 blade, a soft hammer, both a 6" x 3/8" and a 3"x 1" dia. dowel, a small board, a drive washer puller like the OS #71510009 shown, an oven mitt or leather glove, and a 5/16" socket and driver for removing the glow plug. You'll also need access to an oven capable of reaching 350°, and a freezer capable of reaching 32°. A source of compressed air may be handy as well. You will definitely require eye protection!

SAFETY ISSUES

You'll be using compressed air, an oven, a freezer, and tools that may injure you. If the procedures described are beyond your experience, consider seeking more expert help. This white paper is not meant to be a complete and final instruction about engine repair. Use the information at your own risk!

REPLACEMENT PARTS

The scope of this white paper is limited to disassembly and replacing bearings, but you may also need gaskets, piston ring, rod, etc. depending on what you find.

TERMINOLOGY AND ORIENTATION

Before we begin, let's agree on terminology; top refers to the cylinder head side of the engine while front refers to the thread side of the crankshaft, OK? You're going to disassemble the engine because if none of the field checks resolved the problem, and if there's no debris in the carb, then I rather suspect you've got a bearing problem. The procedure will be to drop your engine out of the helicopter to work on it. Remove the engine while leaving the crankcase secured to the engine mount. Note: all screws on this engine are right-hand thread. Thus, CW (clockwise) tightens bolts (or closes the main needle valve).

REMOVE BACKPLATE

We'll begin by removing the engine's backplate. Remove the four screws which secure it to the engine – note which way is up as you remove it. By the way, did the screws "pop" when you loosened them? This indicates they were fully torqued. If not, you may have simply had an air leak at the backplate.

A 2-stroke engines require compression, i.e. a sealed crankcase, along with air and fuel, plus ignition to run. If the seal is compromised, the engine's ability to draw fuel is in trouble. As you ease the backplate off, be careful not to tear the paper gasket. Have an X-Acto with a new blade handy as it makes for a good tool to slip underneath a sticking gasket. If you tear it, buy a new one because how to make a new gasket is outside the scope of this paper. Note the flat spot on the backplate faces toward the top (cylinder head). This flat spot provides clearance for the piston as it rotates to BDC (bottom dead center).

DETERMINE BEARING CONDITION

Now let's examine the inside of the engine. Is it clean? How much rust is on the bearings? A little isn't a big deal, but a lot of rust is a problem – have you been running your engine dry and using after run oil? Some wise guys say that due to synthetic oils you don't need to oil your engines daily. In my opinion they're simply mistaken. I run my engine dry (by pinching the fuel supply shut at the end of flying) and oil it through the carb throat liberally with light machine oil, i.e. 3-in-1 or after-run oil. I do it every single day. Why? Because I really don't know how long it'll be before I fly the model again. Anyway, a little oil never hurt a thing and trust me, the blow-by past the ring of the combustion residue will corrode bearings. Of course, it's your engine so do as you please.

Next, remove the glow plug. Rotate the engine through a few revolutions. I want you to develop a feel for nothingness. What I mean is that if you "feel" anything like a roughness of any kind whatsoever in the bearings as you rotate the engine, it's time to replace them. Period – this is not a subject for an argument, or discussion. If you feel can anything at all beyond "smooth as a baby's butt", then replace the bearings. Don't try to be cheap and replace just one bearing either, do them both!

My bet is the bearings are rough. I don't care which brand of engine you have, a rough bearing is a source of trouble, i.e. it doesn't really seem to matter if it's an OS Max, a Thunder Tiger, a Saito, an Enya, a YS, whatever. Rough bearings are trouble and it's time to replace them. Either purchase replacement bearings from the hobby shop, the engine manufacturer, or a reputable miniature bearing supplier like Boca Bearing.

REMOVE HEAD

Next, pull the 6 bolts securing the head. Again, do they "pop" when you loosen them? If not, then it's another good bet you have a leak here – remember, you need good compression (one of the requirements for a 2-stroke engine to run well). The orientation of the head doesn't really matter because the combustion chamber is symmetrical, but note the standard

SX cooling fins point fore and aft whilst the Hyper head has a narrow side, which faces for-aft as well – I keep track. Next, lift the thin brass gasket off the sleeve, or from inside the head if it's stuck there. Again, use that sharp X-Acto but be careful to not scratch it, or otherwise damage the gasket – the smooth surfaces are essential for sealing the combustion chamber. Next, examine the brass gasket carefully for witness marks of leaking. This will be visible as a discoloration. In my opinion,

if the engine's head has never been re-torqued following the first few runs, this may be a source of trouble. What I mean by this is that after the first few runs of the engine on the test stand, I re-torque all the bolts. I check them again following initial break-in, i.e. before I install the engine into a helicopter. Those who follow my aboutENGINES segment on *modelSPORT* video-magazine know my preference of never matching a new engine and a new model since when I fly it, I don't want to be worrying about the engine while I'm concentrating on the model. I only have one CPU (brain) so by nature; I am a single tasker, i.e. one-thing-at-a-time kind of guy.

REMOVE SLEEVE AND PISTON/ROD ASSEMBLY

Presuming the bearings were rough, let's replace them. In the OS 50SX, it's tricky to remove the piston and rod off the crankshaft. First you need to remove the sleeve. If it's stub-born, use a thin sliver of wood stuck in the exhaust port and then by rotating the piston upward it will usually lift it up off the crankcase to where you can grab it with your fingertips to finish removing it. DON'T USE METAL TOOLS FOR THIS!

Note: there's a tiny roll pin pressed into the very top of the crankcase. Its purpose is to align the sleeve so you can't install it incorrectly.

Wipe clean the top of the piston with acetone and use a Sharpie to make an arrow on the top facing forward so you can

reassemble the piston back as it was prior to your screwing around with things. Ditto for the face of the rod, but this time the mark will be on the back of the rod, i.e. the side that faces the backplate. Rotate the crank pin to TDC (top dead center) and holding your tongue just right, wiggle the piston and rod off the crank pin and remove them from the engine.

Now eyeball the oil holes in the big end of the rod and make sure they're clean and don't have swarf or anything blocking the flow of oil. Set the assembly aside on a clean surface; don't screw with the piston ring, just leave everything alone!

REMOVE CRANKSHAFT

Now use a lead or brass hammer and tap on the nose of the crankshaft to remove the crankshaft from the two bearings. The reason to use a soft hammer body is to not damage the threads. I'm experienced and will (in a pinch) put a nut on the end of the crankshaft (to protect the threads) and using my judgment (and an ordinary steel hammer) do the job – but I also know how much tapping is too hard. With regard to this last, remember what Will Rogers said, *"Good judgment comes from experience, and a lot of that comes from bad judgment."* You've been warned!

The crankshaft will come out pretty easy. I usually forego the hammer and just tap the nose of the crankshaft on a block of wood and this eases it out. Also, and this is very important, look for witness marks on the crankshaft. Witness mark is the term for scoring, or galling, on the a part which indicates something is wrong. In this case, a witness mark may indicate the crankshaft was spinning inside the inner race of the radial bearing. If all looks normal (like the picture), then as a dry run, take the new bearings and slide them onto the crankshaft. If the fit of the crankshaft within the inner race of the replacement bearings isn't nice and snug, consider using bearing & stud adhesive from Locktite, or similar . . . but be warned, the next time you go to disassemble the engine you'll need a plumber's torch for heating the area (to decompose the adhesive). It's been my experience adhesive usually isn't necessary.

SIZE REPLACEMENT BEARINGS

Put the new replacement bearings into the freezer. If you were awake in science class you'll remember the cold makes a material shrink, and hotter makes it bigger.

We're going to make this physical characteristic work for us by putting the new replacement bearings into the freezer to make them a little smaller.

REMOVE BEARINGS

To remove the bearings you need to heat up an oven to 350°.

Put the crankcase in the oven to heat for 10-15 minutes, or until the oven gets to 350°. I set the crankcase on the backside as often the rear bearing will fall out on its own. If I hear that then I proceed to getting the front bearing out!

Meanwhile, go look for a small piece of board. Also, get yourself either an oven mitt or a leather glove with which to grab the crankcase because it'll be hot as all get out and bad language is bad for your wife's ears. After the crankcase is hot,

and wearing the glove, grab the crankcase and tap the back of the engine on the board. The rear bearing will fall out (presuming it didn't fall out while the engine was sitting on it's back in the oven). Next, while the engine is still hot, flip it over and use a 6" long piece of 3/8" wood dowel rod and knock the front bearing out using the hammer. It too will practically fall out.

About now the guy who was sleeping in the back of science class the day everyone learned about coefficients of expansion is wondering why since the steel bearings and the aluminum crankcase are at the same elevated temperature this worked? Naturally, the guy with a pocket protector has his hand up but

I'm not going to call on him. Instead I'll leave it as an exercise for you to figure out why heating the assembly in the oven works to loosen the bearing from the aluminum crankcase (hint, aluminum expands more than steel). Anyway, trust me, this works!

REPLACE BEARINGS

If the crankcase is as clean as you want it, then it's time to install the new bearings. If not, then clean it by washing it with soap and water – yes, soap and water! If you've been running fuel with castor oil in the engine and want to remove the baked on brown crud, it's time for the antifreeze trick (*modelSPORT* back-issue MS0101 has the details).

Anyway, remove the bearings from the freezer. If the crankcase is still hot, I trust you'll remember to be wearing an oven mitt or leather glove when you hold the crankcase. If not, following your return from the emergency room it's time to place the cold rear bearing into place. It'll probably just drop in very nicely without your having to seat it by tapping it into place using the end of a wood dowel of suitable size and a hammer. Once the rear bearing bottoms out in the bearing seat, you're done. Now stick your forefinger into the back of the engine to hold the rear bearing in place and turn the engine over in your hand (to keep it from falling out) and install the cold front bearing. Maybe you have to tap the engine nose and bearing on the board to get it in, maybe not. It depends on how quickly you work. Now set the crankcase down gently (so as not to jar the bearings out of place) and let the assembly get back to room temperature. I don't get in a hurry; instead I go have a beer or a Coke.

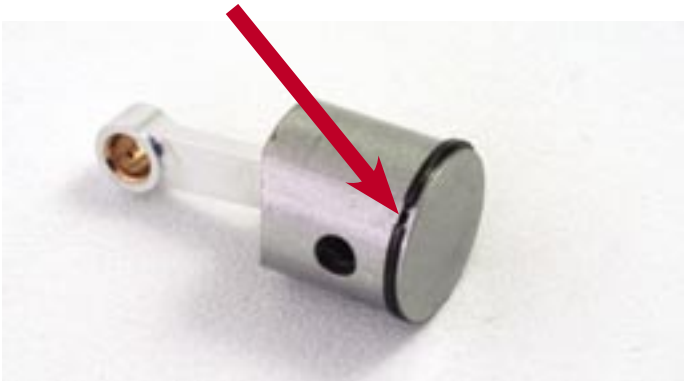
REINSTALL CRANKSHAFT

It's time to reinstall the crankshaft back into the engine. Insert the nose of the crankshaft in through the back of the engine. Guide it past the rear bearing and align it with the inner race of the front bearings. It should slide all the way in easily home.

REINSTALL PISTON/ROD ASSEMBLY

Now slip the piston and rod back into the engine and over the crank pin – remember the arrow points forward. If you're dumb and didn't make a mark on the top of the piston like I told you earlier, then look at the mark you made on the backside of the rod (you did make a mark on the rod, right?).

If you didn't then here's where it gets a little tricky. Look into the ring land on the piston (the groove) and you'll see a roll-pin. This pin is where the ring gap comes together. It's an alignment device. It's important to realize the ring gap shouldn't ride through an opening, or port, in the sleeve. The ring gap must be continuously supported, i.e. ride on the steel of the sleeve during the entire up and down stroke. Otherwise the end of the ring both doesn't maintain a good seal and risks catching on the edge of a port and break. If this happens you loose compression and the engine doesn't run – bad news!



To save time I'll just tell you to make sure that when you look down into the engine through the top of the crankcase, i.e. looking down into the hole where the sleeve fits into place, if you align the nose of the crankshaft so that it faces up at 12 'o'clock, the ring groove is roughly at 2 o'clock. Next time, make a mark like I told you!

Anyway, with the crankpin at TDC, make sure the ring gap aligns over the roll pin in the piston land and insert the rod down into the engine. Lift the big end of the rod into place onto the crankpin and press it home with your finger.

REINSTALL SLEEVE

It's time to re-install the sleeve over the piston and you don't want to break the piston ring while doing it. First, look for another roll pin, but this time it's installed into the top of the crankcase. You'll remember it serves to align the sleeve so that the ports in the sleeve align with the passages in the crankcase. Look for the notch in the sleeve and align everything.

Now you need to carefully slide the sleeve over the ring thereby compressing the ring into the piston's ring land. Look carefully at the bottom of the sleeve and you'll notice it has a taper machined into it. The purpose is to evenly compress the ring into the ring's land. You MUST make sure the ring gap aligns over the roll pin in the piston land or the ring will break. You've been warned.

Continue to slide the sleeve over the top of the piston and compress the ring. I use light machine oil (3-in-one) to make this easier. Frankly, at this stage of things it simply doesn't matter whether the ring gap is aligned (so as to not hit a port, or window, in the sleeve). The reason is because we're only worrying about compressing the ring evenly (without breaking the ring) and getting the sleeve down over the piston. Once this is well and truly started, we'll align the sleeve with the roll pin. Continue inserting the sleeve into the crankcase now ensuring there is close alignment of the roll pin and the notch, and slide the sleeve home (until if fully seats). By the way, the top of the sleeve is what the cylinder head and brass gasket will actually seal upon.

REINSTALL HEAD AND BACKPLATE

Ensure the brass head gasket and the paper backplate gasket are in good shape then re-install the head and backplate. Do the head first and tighten the bolts evenly using a crossing pattern. If you don't know how or why to do this, please refer to the RCB003 *aboutENGINES* DVD. When tight, rotate the engine a few times to make sure everything is moving smoothly like it should. Once I'm satisfied with this, I reinstall the backplate and tighten these bolts using a crossing pattern also.

GLOW PLUG

Install a new glow plug. I like 30% nitro and thus, use an OS #8 or an Enya #4 plug. Make sure there's no swarf in the threads in the head. With a new copper gasket on the plug, start the plug using a short piece of fuel tubing to ensure it's not cross-threaded. Tighten, and again don't be a gorilla!

REINSTALL CARBURETOR

Reinstall the carburetor onto the engine. Insert the nifty composite washer, which fits at the bottom of the crankcase where the carburetor bottoms. While there are some who will suggest leaving this off, I'm of the opinion that if it were a superfluous part OS Engines would have never installed it in the first place!

Next, after eyeballing to make sure the rubber o-ring is in satisfactory condition, install it onto the base of the carb. Make certain it didn't get rolled up as you did it because if it becomes deformed it may impede the seal. Finally, align the carb and press down on it with your thumb to ensure the o-ring makes a good seal with the crankcase and tighten the draw-screw.

MUFFLER

A muffler to fit the OS Max 50SX isn't that hard to obtain. However, commonly available mufflers are usually 46-class units developed when the OS Max 46FX-H was the premier engine in the marketplace. Following the introduction of the 50SX-H they were relabled as being for 50-class engines. Of course, from a manufacturing point of view this was just smart business. However, from a performance point of view, this was

something of a compromises. Naturally, a significant economic benefit means some will opt to start with an inexpensive unit. This isn't unusual and in fact, is a perfectly valid point of view. We see this all the time when folks purchase a truck featuring a practical single-exhaust system perfect for the majority. High performance enthusiasts however, quickly opt for a set of dual exhausts because they breath better and make more power. The AUD0068 2-pc Muffler pictured above is a perfect example of an economical offering which fits the OS Max 50SX engine. It's reversable and thus, fits both port and starboard (depending on the requirement). The exhaust stinger points downward and thus, it's pretty quiet too. Plus, the stinger is has a reliefe cut so that an accessory exhast diverter fits easily.

However, while dual exhaust systems are a valid approach for high performance trucks, they're not so valid for our helis. Nonetheless, a high performance free flowing enhaust system optimized for power is attractive. Especially for those few for whom any compromise in performance is unacceptable!

Interestingly, creating a high performance enhaust suitable for the OS 50SX-H Hyper isn't the easiest thing in the world. We went through 12 iterations of the PDR0053 ProMuffler as we sought to optimize it prior to deciding on manufacture. "Why on Earth did you need to make 12 versions of a muffler?" The answer is simply this; we kept varying volume and chamber positions and working to make a little more power each time we did . . . until we went too far! Yes, occasionally we went too far so it became a matter of figuring out exactly where that was!

Anyway, when we tested the PDR0053 prototype (what we promptly christened PDR0053V1), I just wanted to offer a serviceable replacement for the Raptor 50 muffler I was using on my Tiger 50, ie. as an adjunct product offering. Little did I realize then the path down which this would lead!

You see, upon installing the V1 muffler I noticed I had to open the needle by 1-click (richer). I theorized this was because the V1 muffler was letting the engine make a tad more. Best of all, verifying there really was more power was a very repeatable process since switching them back reversed the optimal needle valve setting by 1-click. I remember thinking to myself, "Wow maybe we're on to something here!"

Curious about it, I began to explore the relationship between volume vs. length vs. chamber position. This soon led to me CCing (where I stopper one end and pour a measured amount of fluid (oil) in the other to learn the actual voulme of the units. I learned event though v1 was shorter than the Raptor 50 unit, because it was fatter, it actually had a little more volume. Then I hacked them both apart to see what else I could learn!

Interestingly we use an optical tachometer to actually "see" more power happening (via a change in main rotor RPM).

Pictured above is the protoype of the PDR0053 ProMuffler immediately below a Raptor 50 muffler.

The light bulb came on once I figured a helicopter can almost infinitely vary the load on the engine by the simple expedient of adding load via the pitch of the main blades. Thus, a helicopter can really be thought of as a flying dynamometer platform!

It's also worth noting that all this started prior to releasing the Tiger 50. Hence, I immediately reserved that particular Tiger 50 model for muffler testing only. We even referred to it internally as the Tiger 50MM (for Muffler Mule). The principal reason I saved it exclusively for testing mufflers was a simple matter of not wanting to vary any parameters if there was any chance I could maintain control of it. These included the model itself, the engine, the basic radio setup, the specific set of both main rotor baldes (V-Blades) and tail rotor blades (stock), as well as the fuel (Wildcat 30% standard heli mix), and even the glow plug!

Upon realizing the volume relationship, and figuring if some is good, more is better, I immediately had a larger version of the V1 muffler made (which we called the V2 - how original). But surprisingly, it promptly lost power! "Hmmm, I thought, what's with this?" I thus, decided to “sneak” up on the “right” muffler creating successive units a little bigger with varying chambers.

Long story short, more volume led to more power. I played around with the chamber volumes too. What, you think I never crash? Hah!

Variations on a theme . . . fater and longer! The V1 is at the top, then the Raptor 50 muffler, then other prototypes

By the time V9 rolled around (the one that’s not polished in the picture above), we were using the OS Max 50SX-H Hyper. We’ve figured that buggered up all the testing (by switching over to a Hyper from a standard SX engine). Thus, we went back and re-tested – which proved to be a monumental waste of time since the results were duplicated right down the line! By the way, for testing purposes, we calculate compensation tables to account for differences in temperature and humidity.

With v10 we are pretty close to what would ultimately be the final product - or so we thought! As it turns out, where the chambers are positioned, and how big the tube inside is can make a significant difference in power and “user friendliness”.

Heck, even the diameter vs. length affects things so V10 is slimmed down but a tad longer as compared to V9 - this was the right track!

In case you haven’t figured it out, all along we were in pretty much unproven territory. You see, the computer flow simulation program had already said the mufflers were big enough as of V1, but because I’m just a dumb ass American who trusts empirical evidence more than a computer program, I kept having them make succeeding variations a little bigger. Hmmm, what’s empirical evidence? That simply means that every time I get a larger volume muffler back from them I kept having to open

the main needle valve a tad. Hence, if the theoretical computer results are that it has enough volume but empirically (i.e. by bolting it on and testing it) I keep having to richen the mixture and the main rotor RPM keep increasing, then I'm right and they're wrong because we're making more power – regardless of what the silly computer says! Anyway, "I" am the guy signing the check – so I'm right (because the customer is always right)!

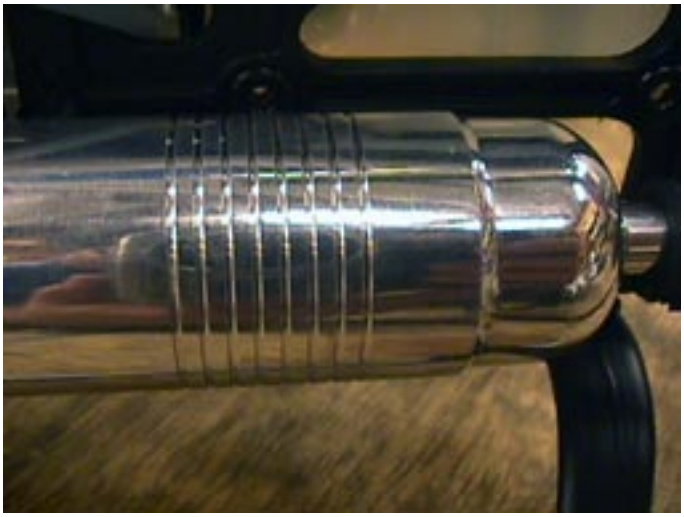
For what it's worth, 12 iterations doesn't mean there were only 12 mufflers made. *Au contraire*, there were actually several versions of each muffler. For example, between V9 and V10 there were the lost one called V9B (as well as 9C, 9D, and 9E) sacrificed to learn you indeed can have too much of a good thing! All in the 9-series except the one on the prior page got sliced and diced (yeah, like a Ronco Vegamatic) as we tried to figure out where we'd gone wrong.

Here's a comparison between V10 vs. V12, which is the one I finally pulled the trigger on for manufacture. Ain't she pretty!

Meanwhile, the PDR0053V11 was another failure. Again we went too far! Also, as with most of them in each series, these too were lost as we sliced and diced them apart. By the way, to get an idea of how similar some are, there is a mere 7cc variation between V11A, B, and C and V12. Variations between versions existed too. For example, there was a V11C1 and a V11C2!

The image above is of prototype V12B1. It's consistently exhibited the best combination of power, broadness of needle valve setting (yes, this is subjective), plus what I generally term user friendliness (again, a subjective measure).

Take a gander at this little sweetheart! That's some intricate aluminum welding going on folks! What's more, in an attempt to maximize the market for the unit, I've specified that it fit starboard (right-hand-side) exhaust helicopters as well (so there's where to place a pressure tap on both sides of it).



Here's a close up of the aft part of PDR0053v12.

An interesting discovery of the process was that varying the length of the exhaust stinger made a difference. A slightly longer exhaust stinger works better – look at pictures which have the Raptor 50 muffler in it to compare to the ProMuffler. This brought an additional benefit because it made it easier to secure the exhaust diverter. The fact is I simply "hate" losing a PDR0062 Exhaust Diverter, 35° in flight (regardless of the fact I have a warehouse full of them). I figured it probably bothers my customers too! Add to this I always trudge out and look for the silly thing when it falls off because I'm too stingy to simply leave it lying out there in the field without making "something" of an effort to find it. The means I'm happy to have a longer stinger.

Best of all, the ProMuffler is a friendlier piece of gear than a tuned pipe because the needle valve just isn't sensitive. It never "hangs on the pipe" during an autorotation thereby causing the clutch to drag. I'm a believer in mufflers and high nitro as the "best' way to make horsepower vs. the a finicky tuned pipe. If you don't agree, no sweat, that's why we have choices.

So there you have it, a behind the scenes peek at development of the PDR0053 ProMuffler. I hope you enjoyed it!