2012 Etec 800 w/ production Boyesen Rad Valves and Power Commander V fuel tuner Jim Czekala

Here's a 2012 Etec 800 with 680 miles on the odometer, loaned to us by Jim Cooper of Cooper Sales and Service in Waterport NY. Jim had updated this ECU with BRP's most recent (October 2012) reflash designed for better "punch".

DynoJet sent us a prototype Power Commander V Etec 800 fuel tuner, and we were anxious to see what fuel flow was available to compensate for airflow adding mods.

Also, Boyesen marketing guru Joe Nocentino brought production Etec 800 Rad Valve reed cages to assess before sending them to market. Previously, we had tested prototype Rad Valves that had some epoxying/ hand contouring of the aluminum reed cages, and Joe wanted to document that the as-cast production housings were similarly adding airflow and HP. The production Etec 800 Rad Valves worked well on Boyesen's own SuperFlow 902 dyno (with refrigerated intake air system) but Joe understandably wanted to have the production Rad Valves tested here.

We hired Jim Cooper to spend the day here with his BUDS computer to be able to tweak timing about and to monitor engine data during our dyno testing. With Etec engines (or any two-stroke for that matter) it's extremely critical to maintain constant coolant and exhaust temperature to ensure dyno test repeatability within a few tenths of a HP, and the BUDS system is perfect for that. Religious people often say that God "works in mysterious ways". It's apparent to some Etec riders/ tuners that God must have conspired with mad Austrian and/ or Canadian engineers to design the Etec ECU to enable it to create mysterious inconsistencies in HP depending on a wide variety of operating conditions. What operating conditions cause HP to occasionally drop? Is it some odd combination of muffler gas temperature, engine temperature, knock, and acceleration rate (yes, there are unfounded but plausible rumors of accelerometers buried inside the high powered fuel-cooled, and fuel-heating Etec ECU's) that creates the inconsistency that Etec 800 owners often complain about? Could the ECU decide that the crankcase and rotating and reciprocating parts may be getting too hot (there's no fuel vaporizing down there to absorb heat), and retard the ignition timing for a while (to put less heat into the piston domes), causing HP to drop?

Today, Jim Cooper would ensure that we would do each dyno test with consistent coolant and muffler temperature, exhaust valves open, and zero knock detected. The 93 octane gas I bought for testing had only 5% ethanol instead of the proper 10%. This means that the octane was probably substandard—mixing 10% ethanol at 102 octane only requires the other 90% of the mix to be about 91 octane to average out to 93 (guessing on octane math). If you get stiffed on ethanol you lose octane, and the wholesaler makes more $ because the cost of the gasoline is surely lower than ethanol.

Dyno Instrumentation

Besides torque, RPM and density altitude conditions it's important to measure fuel flow and intake air flow. The SuperFlow dyno measures the fuel flow from the pump to the ECU (fuel flowmeter A) then measures and subtracts the fuel that's bypassed back to the fuel tank (fuel flowmeter B) "FuelA_B" (the new SuperFlow software won't accept a + or – so the underscore must suffice as a minus). Airflow is measured by a mechanical flowmeter that has a bladed fan inside an aluminum venturi that counts turns as air passes through it, and converts fan RPM to Cubic Feet per Minute. Then the SuperFlow computer considers the density of the air and converts the CFM to pounds of air per HOUR. Then it does the math to give us A/F ratio (pounds of air per pound of fuel). 20 years ago, I rented my dyno facility to Ford Motor Company whose engineers wanted to assess patented technology by Suzuki on an oil-cooled motorcycle engine. 20 years ago, if you wanted to dyno test and tune motorcycles without pulling the engines from the frame my dyno facility was one of maybe three in the U.S. that could accomplish that. Being close to Detroit, I did dyno testing on motorcycles for Ford and G.M. But not being familiar with the SuperFlow meters, the Ford engineers brought a very high-buck Horiba flow measuring and recording system to compare test data from my SuperFlow dyno to equipment from their own engine dyno cels. They were surprised that the data from the SuperFlow airflowmeter was identical to the high buck hotwire Horiba airflowmeter. That made me feel good, knowing that the dyno system I spent $100,000 creating 27 years ago recorded that data as accurately as Ford's million dollar dyno cels.

SuperFlow now uses a second measurement of A/F ratio by taking a voltage signal from a separate Innovate wide band A/F ratio meter and wideband O2 sensor inserted into the flow of exhaust gas. The voltage signal from the Innovate meter is recorded and displayed as "LamA/F1" (short for Lambda A/F).

That Innovate wideband A/F ratio reading is also used to compute airflow based upon mechanically measured fuel flow (FuelA_B) and the wideband reading to estimate how many CFM of air the engine is using. That's shown as "LM1air". Ideally, the wideband O2 sensor should be installed in the stinger pipe from rear cone to muffler and wideband A/F ratio readings are often identical to the mechanical A/F readings. But usually, as in the case of this Etec 800, we slide a ¼" tube up inside the muffler outlet as far as we can and feed exhaust gases to the Innovate O2 sensor. The downside of that sampling method is, at low revs, muffler reversion can contaminate engine exhaust with outside air at low and midrange WOT causing leaner-than-actual wideband A/F. But at high revs, there is very little reversion to skew readings and data is usually spot-on.

Having redundant airflow readings is often important in our attempts to assess what may be causing engine power to rise or fall. Do we believe our mechanical airflow meter? Is there an air leak between meter and engine? If it's backed up by similar airflow readings based on wideband A/F and mechanical fuel flow it makes us more comfortable. Today those redundant airflow readings would prove to be useful!

2012 Etec 800 with the latest reflashed ECU

As brought to the dyno, the timing was set at ".9" on the BUDS system. Here is the baseline test data, in dry winter-like air provided by our intake air refrigeration system. Note that the measured airflow CFM is lower than the CFM of the 2010.5 Etec 800. This could be the result of different cylinder design (they have different part numbers), exhaust difference, or difference in ignition timing. *Note in the following data how airflow CFM increased as Jim Cooper advanced the ignition timing.*

Etec 800 with timing set at .9

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	AirInT	LamAF1	Air_1s
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	degF	Ratio	SCFM
6300	96.1	80.1	0.774	72.6	11.78	33.1	14.37	186.8
6400	97.3	79.8	0.760	72.1	12.03	32.8	14.36	189.6
6500	99.7	80.6	0.761	74.1	11.91	32.6	14.28	192.7
6600	103.1	82.0	0.743	74.8	12.05	32.4	14.15	196.7
6700	108.5	85.0	0.710	75.2	12.32	32.2	13.86	202.3
6800	112.8	87.1	0.692	76.2	12.38	32.1	13.65	206.1
6900	117.5	89.4	0.671	77.0	12.42	31.9	13.49	208.9
7000	122.2	91.7	0.661	78.9	12.32	31.7	13.38	212.4
7100	126.3	93.4	0.654	80.7	12.19	31.6	13.28	214.9
7200	129.9	94.7	0.635	80.6	12.42	31.4	13.20	218.6
7300	132.7	95.5	0.627	81.4	12.48	31.3	13.20	221.9
7400	135.3	96.0	0.631	83.4	12.36	31.1	13.19	225.3
7500	138.1	96.7	0.636	85.9	12.24	31.0	13.18	229.6
7600	142.4	98.4	0.638	88.9	12.06	30.8	13.05	234.2
7700	146.2	99.7	0.634	90.7	12.00	30.7	12.92	237.8
7800	148.5	100.0	0.631	91.6	12.05	30.5	12.79	241.1
7900	150.4	100.0	0.608	89.5	12.49	30.4	12.78	244.2
8000	151.7	99.6	0.589	87.5	12.90	30.3	12.97	246.5
8100	151.3	98.1	0.592	87.8	12.94	30.1	13.24	248.0
8200	147.1	94.2	0.595	85.7	13.29	30.0	13.41	248.6
8300	136.7	86.5	0.624	83.5	13.53	29.9	13.58	246.7

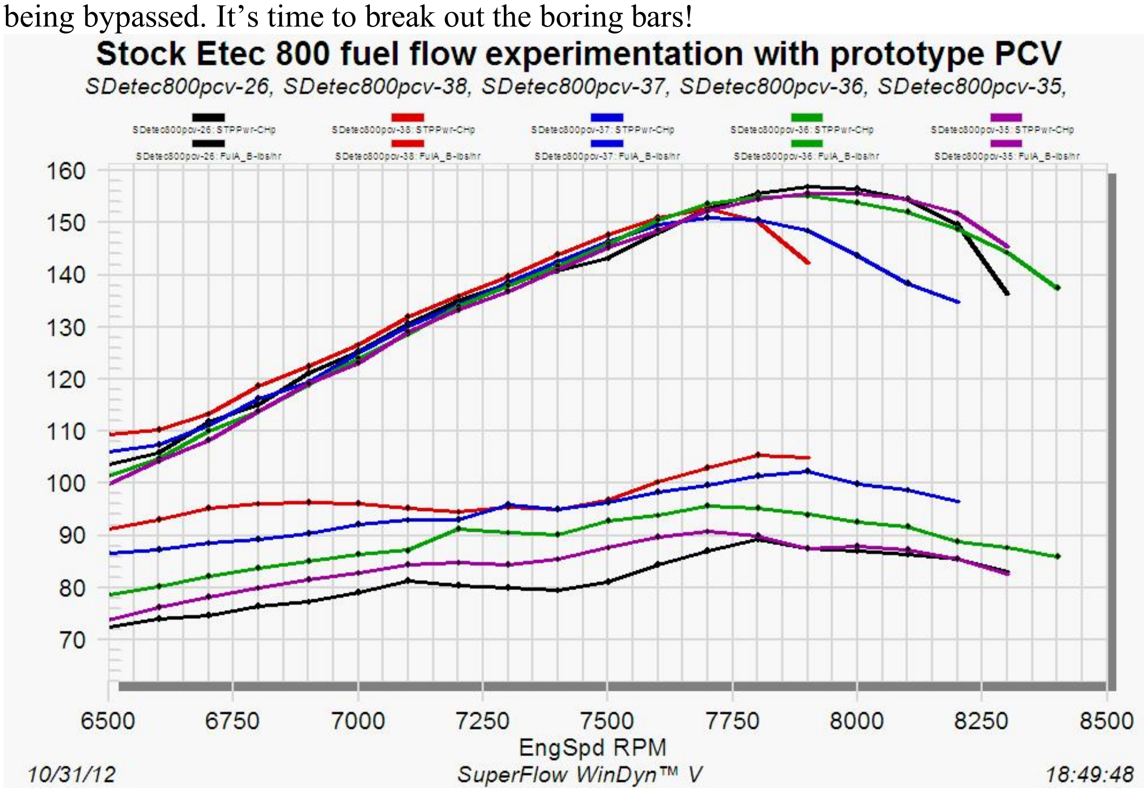
Next, Jim Cooper maxed the timing out to "4.9" with his BUDS system, and torque and HP climbed substantially. All of the following test data was with timing at 4.9, though we took time to go back and forth with each combo that follows. In each case 4.9 made the best torque and HP so that's what we presented.

Etec 800 stocker with timing set at 4.9:

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	AirInT	LamAF1	Air_1s
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	degF	Ratio	SCFM
6400	100.3	82.3	0.748	73.3	11.96	31.8	14.50	191.5
6500	101.4	81.9	0.724	71.7	12.45	31.5	14.51	195.0
6600	103.8	82.6	0.718	72.8	12.55	31.4	14.42	199.5
6700	109.8	86.1	0.697	74.8	12.40	31.2	14.04	202.8
6800	113.2	87.5	0.687	76.0	12.42	31.1	13.90	206.2
6900	118.4	90.1	0.681	78.8	12.19	31.0	13.78	209.7
7000	122.2	91.7	0.674	80.6	12.14	30.9	13.63	213.8

7100	127.8	94.5	0.657	82.1	12.13	30.7	13.51	217.5
7200	132.4	96.5	0.630	81.5	12.45	30.6	13.44	221.9
7300	136.7	98.4	0.610	81.6	12.64	30.4	13.44	225.2
7400	140.4	99.7	0.615	84.6	12.45	30.3	13.51	230.0
7500	145.2	101.7	0.613	87.1	12.32	30.1	13.54	234.6
7600	149.7	103.4	0.608	89.1	12.26	30.0	13.48	238.6
7700	153.3	104.5	0.606	90.9	12.19	29.9	13.27	242.1
7800	155.3	104.6	0.595	90.5	12.41	29.8	13.06	245.3
7900	156.4	104.0	0.581	89.0	12.73	29.6	13.07	247.4
8000	156.4	102.7	0.564	86.4	13.19	29.5	13.34	249.1
8100	156.0	101.2	0.554	84.7	13.53	29.4	13.64	250.3
8200	152.5	97.7	0.564	84.3	13.65	29.2	13.82	251.4

Next we installed a prototype Power Commander V fuel tuner just to demonstrate what changes we could create in fuel flow lb/hr. The other PCV's used on EFI sleds add or subtract fuel on a **%** basis—that is if you put a +20 in a particular throttle position and RPM, you get precisely 20% more fuel flow at that point. On the Etec 800 PCV, the numbers added are different. Here we just adjusted our full throttle column at every RPM. Test 26 = 0 (stock), test 35 = 20, test 36 = 40, test 37 = 60, test 38 = 80, which maxed our Etec fuel flow at a peak of just over 105 lb/hr. The 105 lb/hr (red line) test ended early because the excessively rich mixture kept the pipe cool and it quit making power at 7900. This would surely be plenty of fuel for a 180hp engine running in the winter at sea level. At 105 lb/hr there is plenty of fuel pump capacity, with lots of fuel being bypassed. It's time to break out the boring bars!

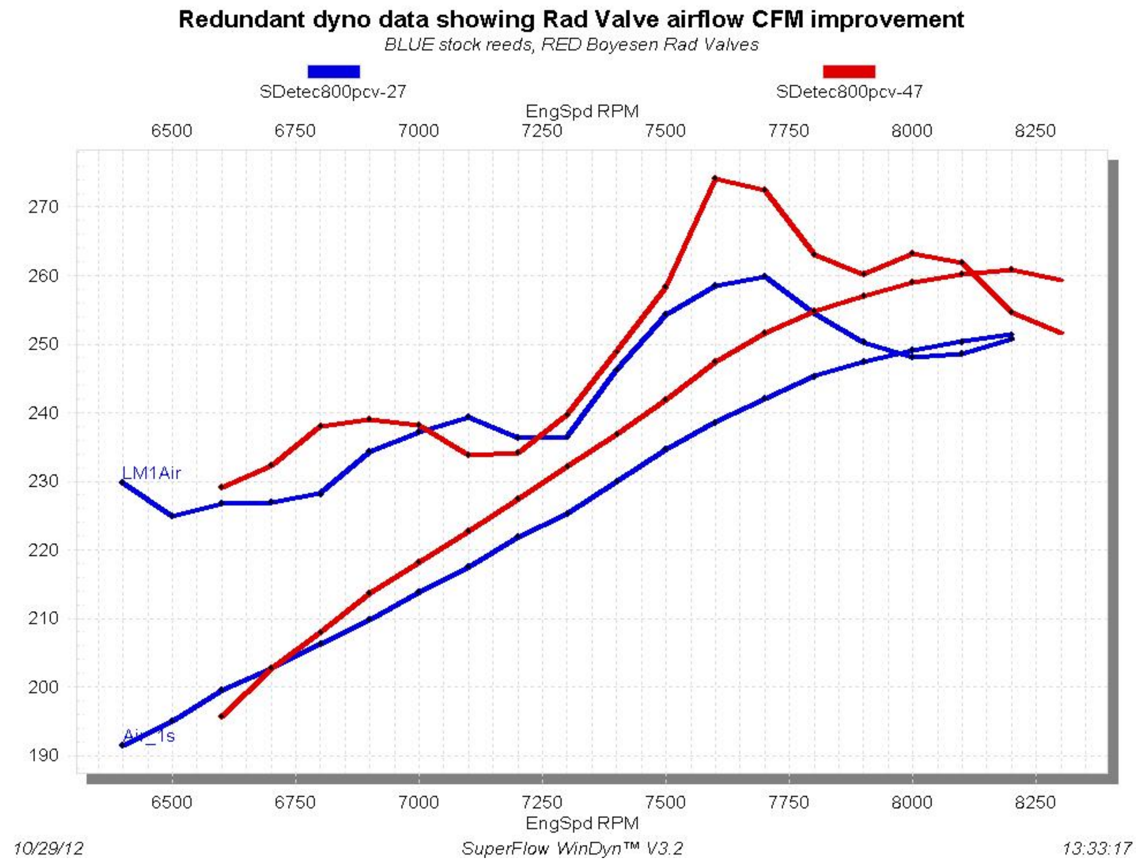


Boyesen's Joe Nocentino had Jim Cooper install the production Boyesen Rad Valve reed cages. Here's where the redundant SuperFlow dyno airflow data would prove useful. We measured an incredible mechanical 4% airflow increase combined with a lower, but still meaningful 1% HP increase! OK, perhaps there was an air leak between the mechanical airflowmeter and the engine while we were testing stock reeds, skewing CFM readings. But wait! The LM1air reading was similarly 4% higher at peak revs compared to LM1air with stock reeds! If those two independent readings were accurate, where did the missing 3% added airflow go? Perhaps short-circuited—could the extra indicated airflow just be pumped up through the transfer ports and out the exhaust ports but not packed back into the combustion chamber due to less than optimal exhaust tuning with the stock pipe? We tried adding fuel with the PCV, but it didn't add any HP. Here's the Etec 800—this time with production Boyesen Rad Valves.

Etec 800 with production Boyesen Rad Valves

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	LM1Air	LamAF1	Air_1s
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	Ratio	SCFM
6600	102.9	81.9	0.729	72.5	12.36	229	14.38	195.7
6700	108.2	84.8	0.712	74.3	12.49	232	14.22	202.8
6800	111.8	86.3	0.710	76.7	12.42	238	14.14	208.0
6900	118.1	89.9	0.682	77.9	12.56	239	13.98	213.7
7000	122.7	92.1	0.661	78.4	12.74	238	13.84	218.2
7100	127.9	94.6	0.628	77.6	13.14	234	13.73	222.7
7200	132.3	96.5	0.608	77.8	13.38	234	13.71	227.4
7300	136.7	98.4	0.599	79.2	13.42	240	13.80	232.1
7400	140.6	99.8	0.597	81.2	13.35	249	13.97	236.9
7500	144.8	101.4	0.598	83.7	13.23	258	14.08	241.9
7600	149.8	103.5	0.617	89.5	12.66	274	13.98	247.4
7700	154.4	105.3	0.606	90.6	12.72	272	13.73	251.6
7800	156.7	105.5	0.587	89.1	13.09	263	13.48	254.8
7900	157.9	105.0	0.579	88.4	13.31	260	13.44	257.0
8000	157.7	103.6	0.576	88.0	13.48	263	13.66	259.0
8100	156.0	101.1	0.571	86.2	13.81	262	13.87	260.1
8200	152.8	97.8	0.562	83.1	14.37	255	14.01	260.8
8300	142.2	90.0	0.590	81.2	14.63	252	14.17	259.4

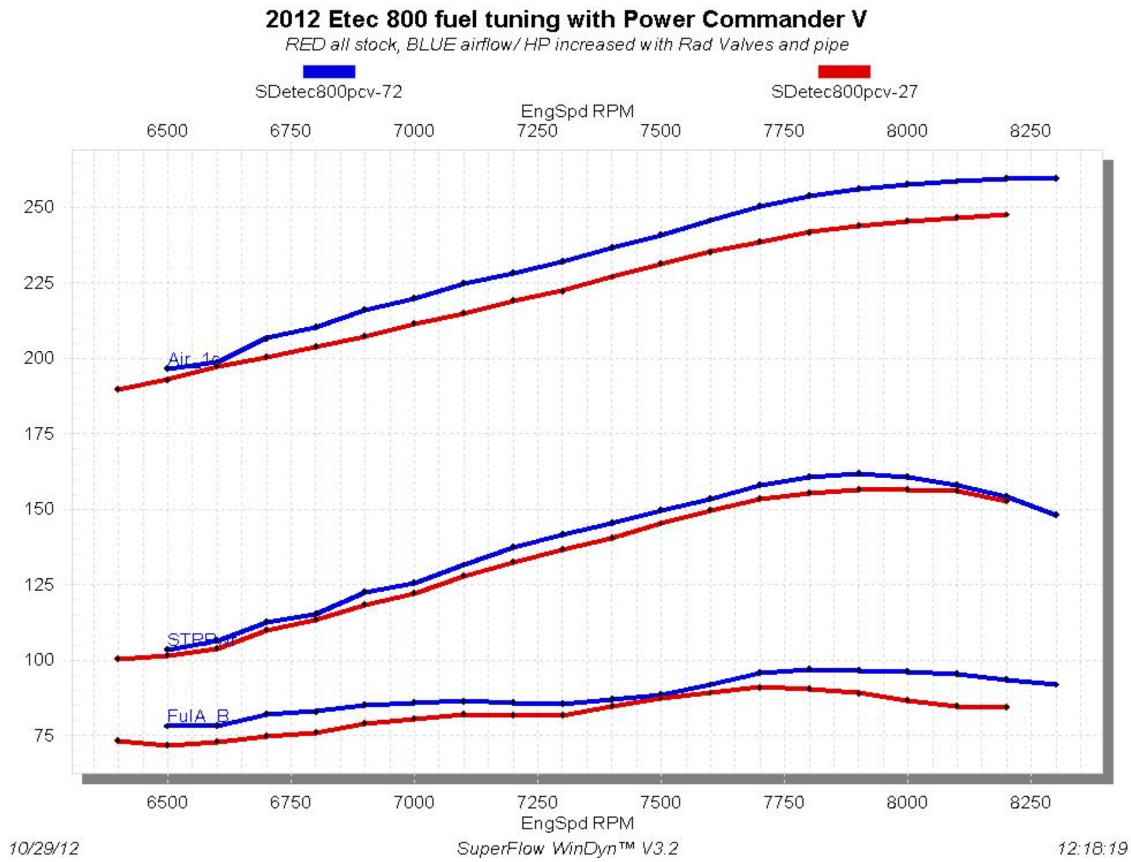
Here's a graphic comparison of stock reeds vs Boyesen Rad Valves with totally independent mechanical airflow readings and computed airflow readings based upon wideband A/F ratio—remember that at lower revs inversion often creates lower-than-actual A/F wideband readings hence the too-high airflow CFM in midrange. But this is good evidence that the Rad Valves were indeed creating 4% more airflow at peak revs:



Now here's the advantage of having dozens of test pipes hanging on the dyno room wall racks. Remember the Aaen single pipe that we tested with mediocre results on the carbureted stock SkiDoo 800R (scroll down and you will find the exact pipe tested)? Since it was still hanging on my pipe rack, Jim Cooper grabbed it and installed it on the Etec 800. Voila—airflow CFM was nearly identical to the stock pipe but torque and HP mysteriously increased! Then, adding extra fuel with the PCV, HP increased even more! Does the Aaen 800R pipe do a better job of packing the EXTRA short-circuited air back into the combustion chamber as the exhaust port closes? Now, perhaps we needed more Etec fuel to compensate for the fact that maybe some of the extra air was being packed back into the combustion chamber instead of blowing out of the muffler, and engine performance improved. Now we're having fun!

Etec 800 with Boyesen Rad Valves and Aaen 800R single pipe, fuel added with PCV

EngSpd RPM	STPPwr CHp	STPTrq Clb-ft	BSFA_B lb/hph	FulA_B lbs/hr	AFRA_B Ratio	AirInT degF	FulPrA psig	Air_1s SCFM
6500	103.3	83.5	0.78	78.0	11.55	33.5	58.4	196.8
6600	106.4	84.7	0.758	78.0	11.67	33.3	58.5	198.9
6700	112.6	88.3	0.751	81.9	11.57	33.0	58.0	207.0
6800	115.2	88.9	0.743	82.9	11.64	33.0	58.0	210.8
6900	122.4	93.2	0.715	84.9	11.68	32.7	57.9	216.6
7000	125.7	94.3	0.705	85.8	11.75	32.6	57.9	220.3
7100	131.5	97.3	0.678	86.4	11.96	32.4	57.8	225.6
7200	137.2	100.1	0.644	85.8	12.22	32.3	57.8	229.0
7300	141.4	101.8	0.621	85.3	12.50	32.1	58.0	232.8
7400	145.3	103.1	0.618	87.1	12.48	32.0	57.8	237.5
7500	149.5	104.7	0.611	88.6	12.50	31.8	57.6	242.0
7600	153.5	106.0	0.616	91.8	12.31	31.7	57.4	246.7
7700	157.9	107.7	0.624	95.6	12.04	31.6	57.7	251.5
7800	160.8	108.3	0.620	96.8	12.06	31.4	57.6	255.1
7900	161.6	107.5	0.615	96.5	12.22	31.3	57.6	257.5
8000	160.7	105.5	0.617	96.3	12.33	31.2	57.6	259.2
8100	158.0	102.4	0.622	95.4	12.48	31.1	57.7	260.1
8200	154.3	98.8	0.624	93.4	12.78	31.1	57.8	260.9
8300	147.9	93.6	0.639	91.7	13.03	31.0	57.8	261.2



Billy Howard is planning a major DTR thrash with his 2012 Etec 800 after he gets breakin complete………

Now that we can precisely put extra fuel where it's needed, we can try increasing airflow even more with Ypipes, different tuned pipes, maybe ported cylinders. Now thanks to DynoJet the sky (or 180hp at sea level) is the limit. And it's possible that even a bone stock Etec 800 could be happier with just a bit more top end fuel. Note that on the HP/ Fuel flow graph, the engine made nearly the same HP with 20s dialed into the PCV at full throttle. Could this make the engine and exhaust run cooler and keep the ECU happy? And since we didn't try the Aaen 800R single on this Etec 800 with stock reeds, we don't really know if it needs the Rad Valves to make extra HP. We can try that on Billy's sled when it gets here! And what about airflow and HP difference between 2010.5 and later Etec 800 engines? Could it be just retarded ignition timing—even with BUDS maxing both out? Billy is planning to install an offset flywheel key ahead of time so we can be sure we can optimize the timing on his 2013. Stay tuned for more!