Technical Notes — July '08' - Performance Parts II

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Last month I discussed considerations you might give to purchasing performance parts for your Corvette. This month I will look at one specific case: Bolt-on products to get the LS2 in your C6 to perform like an LS3 motor. With the exception of the early seventies when automobile gasoline went no lead, the Corvette owner has been plagued by one continual problem. You pay for your large horsepower 'Vette and within a year or two the newer Corvettes are more powerful. This "power" growth tends to make owners feel like they should have waited to buy their car and a bit like second-class citizens. Obviously, some owners refuse to be deterred. From the early years, they have attempted to keep up with the latest model by reworking their motors. In the 50s and 60s it was relatively easy: Get a bigger carburetor. Nowadays, with computer-controlled motors, things are a bit more complex.

Let's discuss the last two generations of Corvettes as an example of this issue. However, we'll stick to the base car since the Z06 option is a very large change and just boosting the horsepower does not address the total performance envelope. As an example, the C6 Z06 has a totally different frame, totally different tires, and not one interchangeable body panel compared to its base cousin. In the C5 era, cars built from 1997-2000 were 5.7L (346 cu in) LS1 engines with 345 HP and 350 ft-lbs torque. In 2001, Chevy boosted the same 5.7L block to 350 HP, 350 ft-lbs torque by designing a new composite intake manifold with increased plenum volume, smoother-flowing intake runners, and a slight cam modification. The C6 power growth was even more pronounced. The 2005-2007 cars' 6.0L (364 cu in) LS2 produced 400 HP and 400 ft-lbs torque. In 2008, Chevy increased the block size to 6.2L (376cu in), which boosted the performance to 430 HP and 424 ft-lb of torque. Worse yet for early C6 owners, there was even a loud mouth muffler option increasing the LS3 to 436 HP and 428 ft-lbs of torque. So, what is the early C5 or C6 owner to do?

Obviously, a myriad of methods can accomplish the same goal of boosting horsepower and torque to bring the early models up to late model power. Two basic solutions are available: (1) Spend lots of bucks to pull the engine and have it worked on internally such as installing different heads, cam, pistons, etc. or (2) Go the less expensive way and just bolt on a new intake, exhaust, headers, etc. I will discuss one situation and one solution, which in my opinion is the best bang for the buck. In keeping with last month's article, we are again discussing work done by ***Raabe Racing Enterprises*** in Daytona Beach. The objective was to bolt on a reasonable cost performance product and bring the LS2 in a C6 up to 2008 LS3 power and torque. Remember, torque gets you acceleration and horsepower keeps you at speed. For this "experiment," I was keenly interested in proving the increase and not doing analysis by "seat of the pants." So, the car performance was verified on a dynamometer. Since it was going on the dyno any way, I also had their technicians to squeeze every bit of power from the engine by tuning the engine's PCM. Obviously, with such a new car, you do not want to do anything that would void the manufacturer's warranty so nothing was done to remove any safeties used in the GM PCM computer program and all air into the engine was properly filtered.

The product chosen was a high performance cold air induction (CAI) system. Other options were discarded due to low power-to cost ratio. They included, exhaust modifications that cost $1500 to $2000 for the parts and gain about 5-7 HP and long tube header systems which claim gains of up to 20 HP gains by the manufacturer (remember last month's article, though) but can cost over $2000. Most cold air induction systems cost on the order of $400-$500 and claim roughly a 10-15 HP gain by the manufacturers. Now, please note that by just tuning the PCM, you can also achieve gains of 10-15 HP. I think I explained last month why tuning is almost a necessity when attempting moderately expensive bolt-on performance mods. Also, the rough prices quoted above are only for the parts. They do not include shipping, tax, parts installation, dynamometer time, tuning costs, etc.

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For this test, I chose the Vararam VR-SC1 cold air induction system. I picked this product because of two considerations: Favorable Internet reviews and the manufacturers' claim to increase horsepower and torque even more as the vehicle speed increase due to ram air effect. Vararam also produces a "sister product" to the cold air induction call VR-TBS1 throttle body spacer. Its function is to increase the plenum volume (remember the 2001 LS1 above). To verify gains, Raabe Racing installed and tested both products separately so that each claim could be examined.

Vararam claimed a gain up to 10-15 HP **static** rear wheel horsepower (RWHP) on a dyno, but said that their cold air system would add an additional 17 HP at 60 mph increasing to 20 HP at 100 mph due to ram air effect. Using ¼ mile drag strip times (around 12.5 seconds and 110 mph) they say the additional horsepower gain could be 22 HP. Unfortunately, you need a full-blown wind tunnel-dynamometer system to properly test their moving vehicle claims. Vararam testing for these claims use drag strip data. Thus, the test we ran could only verify static numbers. Vararam claims additional gains of up to 5 HP and 10 ft-lb of torque with the throttle body spacer.

So, here's what we did. Runs were accomplished primarily on days where the temperature remained within 2-3 degrees. Also, testing was done at times in the day when temperatures were increasing so that if the temperature did increase slightly, it would skew the results more conservatively. The car was run three times with the stock system; once cold and twice fully warmed up to establish a baseline condition. The Vararam cold air induction system was installed and run again twice to see the gain achieved. Throttle body spacer testing included one baseline run with the car warm. The spacer was installed and then we did the test run.

Yeah, I know… WHAT HAPPENED? These were the results and remember, these are rear wheel numbers. Although Chevrolet horsepower and torque numbers are SAE certified, they are measured at the flywheel without drive system losses. The table below lists the results for our nominal 400 HP/400 ft-lb LS2 motor. Due to parts availability the tests for the spacer were done on a different day with the same temperature. However, PCM system learning and some tuning tweaking probably accounted for the slight power growth from the last cold air induction system test. Here are the major observations:

1. A dramatic loss of horsepower and torque compared to a cold engine once the engine warmed to operating temperature.

2. The rather large drive train losses associated with modern Corvettes. Raabe Racing folks claim they see this all the time.

3. The ability of the Vararam products to broaden the power and torque curves in a large RPM band range.

4. The total gain of 26 horsepower and 34 ft-lbs of torque over the base engine.

5. Vararam's claimed gains for their products are essentially verifiable within the testing error.

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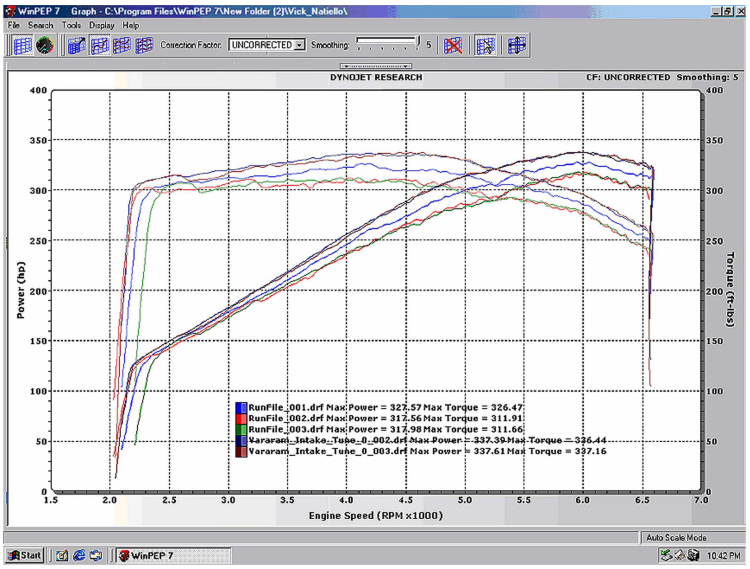
VARARAM COLD AIR INDUCTION (CAI) AND THROTTLE BODY SPACER (TBS) TESTING RESULTS

Run	Condition (**B** = Baseline and **T** = Test)	Rear Wheel HP	Rear Wheel Torque
1	Stock Engine Induction	327	326
2	Stock Engine Induction engine coolant warm (operating temperature) (**B**)	318	312
3	Stock Engine Induction engine coolant warm (operating temperature) (**B**)	318	312
4	Vararam CAI system engine coolant warm (operating temperature) (**T**)	337	336
5	Vararam CAI system engine coolant warm (operating temperature) (**T**)	338	227
6	Vararam CAI system engine coolant warm (operating temperature) (**B**)	340	341
7	Vararam CAI system and TBS engine coolant warm (operating temperature) (**T**)	344	346

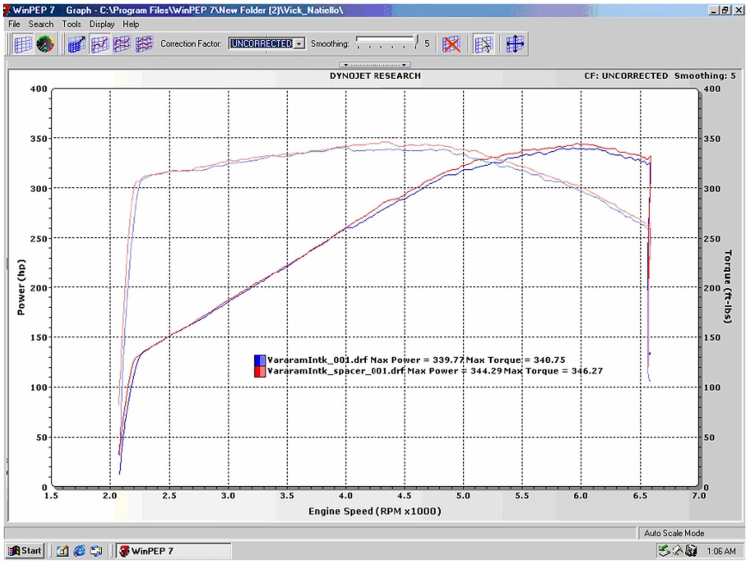
The dyno sheet for the testing the Vararam VR-SC1 Cold Air Induction System (CAI).

The top two lines are the test runs and the bottom two are the baseline runs with the engine warm. The middle blue line is a baseline run with the engine cold. Notice how much difference a cold engine can make. Also notice that above 3000 rpm the entire engine power curve is widened and the torque curve is widened throughout the entire engine rpm range.



The dyno sheet for the testing the Vararam VR-TBS1Throttle Body Spacer (TBS).

The effect of increase plenum volume is evident using the throttle body spacer and for a street price around $50, is a relatively high power to cost item.



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The testing has a few other issues I must address. First, is gasoline octane rating. 91-octane fuel was used throughout the testing. I intentionally did not use 93-octane in the test because this is not the stated fuel octane recommended by GM for the base C6. Also, speculation abounds about whether a customer actually receives 93-octane gas of some low-price retailers. Thus, where you buy your fuel could become an issue with a 93-octane tune. Raabe Racing technicians claimed that a tune for 93-octane would have boosted results on the order of 3-4 more horsepower and that if 93 octane fuel was exclusively in the car the PCM timing curves would adjust for it in the long run and provide the additional power. The Vararam technician also recommended giving up and down latitude to the PCM by using 91-octane fuel.

The second item is fuel economy enhancement. Last month's article mentioned Mr. Raabe's statement that his C6 Z06 gets better fuel economy after the PCM tune and Vararam installation. Unfortunately before this upgrade, I was unable to do accurate gas mileage tests for this article. Even if I did have pre-install fuel economy figures, most gasolines nowadays contains up to 10% ethanol, which in itself can account for a loss of nearly 1 mpg in highway conditions. However, I did do one test of sorts. Prior to the purchase of the cold air induction system, I had driven the car several dozen times on a flat highway in no-wind conditions using cruise control set speeds of 60, 65, 70 and 75 mph. In most cases, the maximum DIC instantaneous fuel economy achieved was about 31-32. After the installation and PCM tune, these maximum numbers increased to 33-34. There seems to be some rough empirical evidence that increased fuel economy is achievable by using the better flowing filter arrangement.

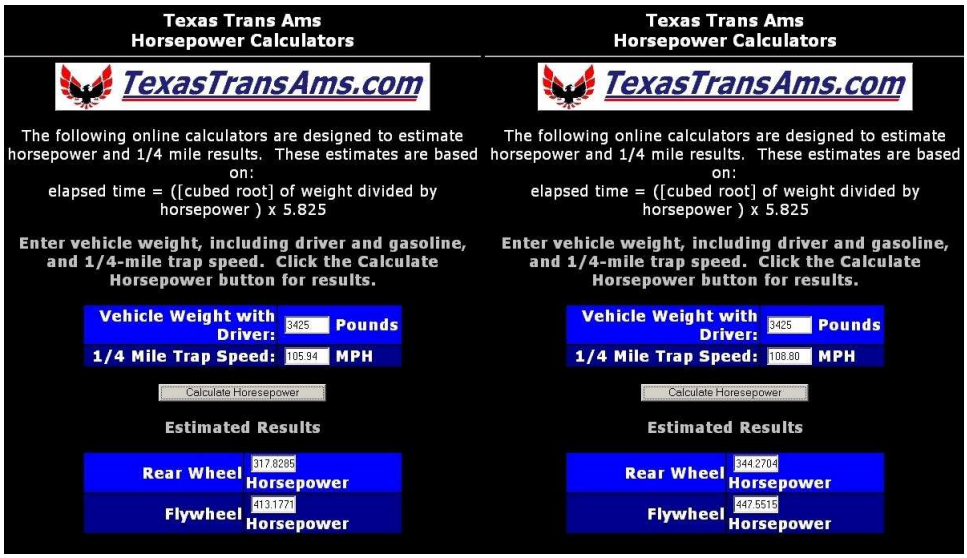
Finally, I have seen drag strip results by Vararam and Internet accounts by their customers seem to support their contention that even more horsepower and torque are available when the car's motion rams the air into the intake. Although we did not have the ability to verified any ram air effect on the dynamometer, Vararam's claim of approximately doubling horsepower over just their static cold air system seems possible given the drag racing results and known horsepower to low ET/high top-end speed formulas. I know Mr. Raabe is convinced his performance noticeably improves when his Z06 is at speed.

So, was our bolt-on successful in accomplishing what we wanted to do? Well, first you must contend with the dispute associated with flywheel versus rear wheel horsepower. After all, Chevy does not list RWHP. Historically, speed shops have had a tendency to use percentages to determine the loss; roughly 15% for manual transmissions and 20% for automatics with all-wheel drive even higher. Recent articles tend to dispute those calculation methods and contend that the drive train losses are essentially constant regardless of increases in power and torque.

If you use the percentage loss methodology, the bolt-on performance enhancement was a huge success. The LS2 has a great deal more flywheel power and torque after the modifications than its 2008 cousin. See it for yourself using the link shown above the image to the right.

Inserting a typical 3,425 pound C6 including gas and driver, you can play with the trap speeds until you get close to the before and after rear wheel horsepower numbers from the before and after dyno sheets (average 317.77 before and 344.29 after).

http://www.texastransams.com/articles/horsepower_calculators.htm



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Nevertheless, even using the constant drive train loss theory, this performance enhancement was still pretty good. As far as torque goes, the LS3 gets either 424 or 428 ft-lbs of torque at the flywheel depending on the muffler system. The LS2 is rated at 400. If you take the 34 ft-lb torque improvement we achieved, on paper our LS2 will out-accelerate its '08 brother with its higher rear wheel torque assuming similar drive train losses. The horsepower increase was not as dramatic, but if you factor in the Vararam ram air effect as speed increases, our LS2 could easily rate higher than 430 or 436 HP at speed.

One must also consider cost in the comparison. Early model year 2007 C6 base cars run $2,800 less than the equivalent base '08 Corvette. The difference for earlier C6s is even larger. The base 2008 car gives you On-Star and the improved Tremec transmission over the'07. Nevertheless, you're still doing well in the performance match up despite the costs associated with the performance upgrade. Even though it is hard to exactly mimic ongoing GM improvements to the Corvette, at least with this bolt-on, performance enhancement, you no longer have to consider yourself a second-class citizen.