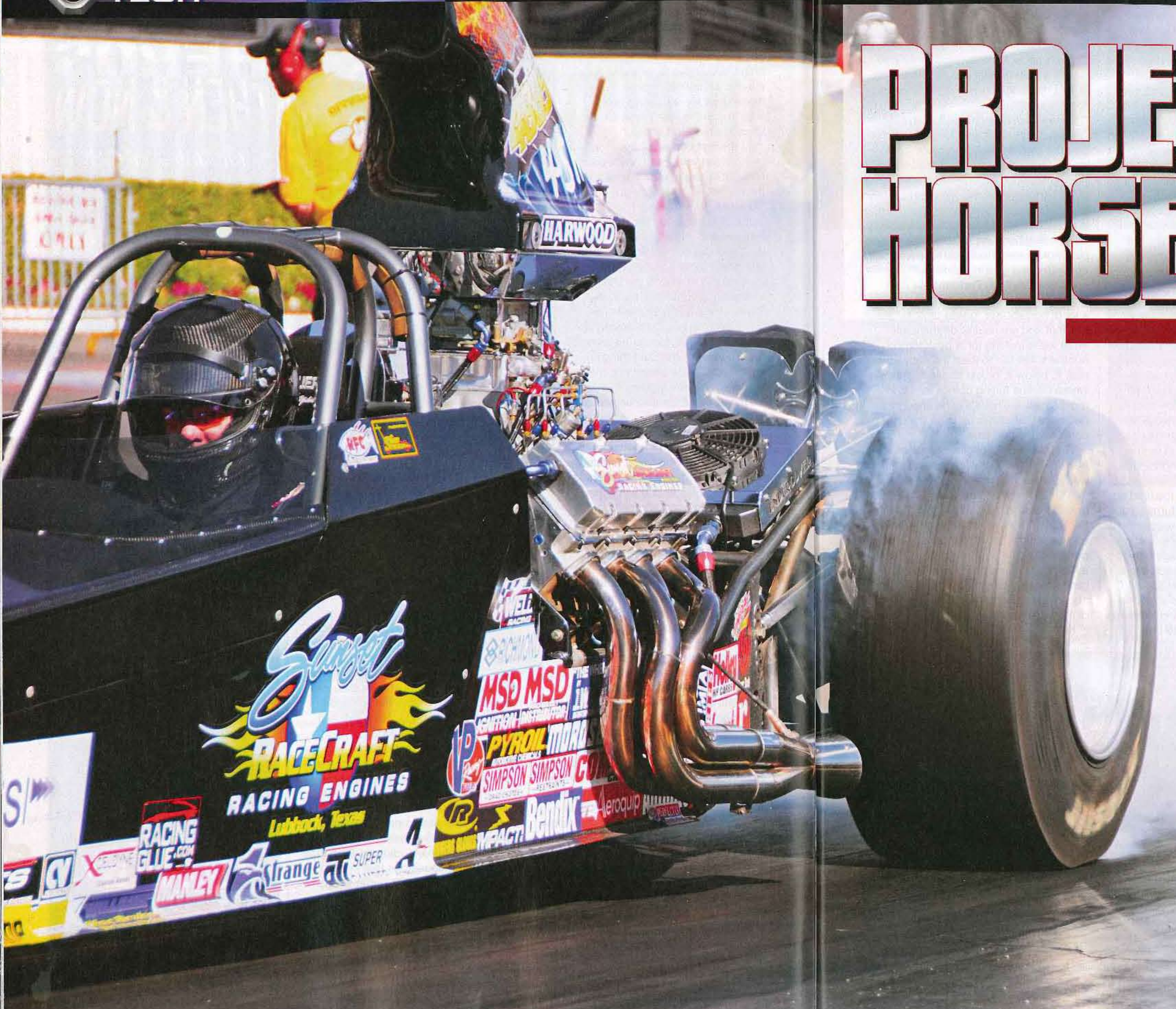



# PROJECT HORSEPOWER

## PART THREE—DYNO TESTING

BY JOHN DiBARTOLOMEO

In the past couple of issues (*DRA November 2010 and January 2011, Project Horsepower Parts 1 and 2*) we've been chronicling the efforts to build a 598-cubic-inch engine using the talents of Tracy Dennis and his Sunset Racecraft horsepower building facility.

To reiterate slightly, today's aftermarket manufacturers have combined to build components that enable a person to build big-cubic-inch engines, but this still requires quite a bit of homework on the engine builder's part to assure everything fits together as planned. Both Parts 1 and 2 covered Sunset's choice of components and their work in fitting together everything in the name of horsepower.

After careful mock-up and assembly, the engine was finish assembled and ready for testing on Sunset's dyno.

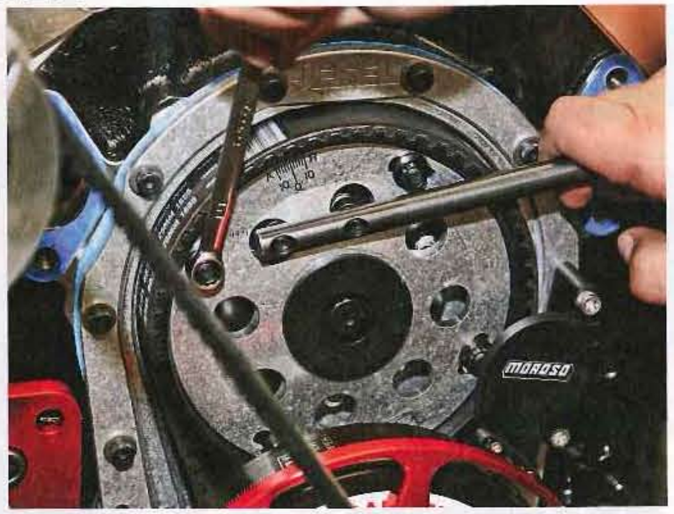
In the late '40s and early '50s, sharp racers began seeing the need for testing engines in a controlled environment in order to find more horsepower, speed and reliability. Enter the dynamometer.

The dynamometer was actually invented back in the 1800s even before the advent of the internal combustion engine, although it was used for measuring other types of power. The dynamometer for engine testing didn't become popularly used until the early to mid 1900s when Detroit's car industry used them as a test bench for the engines placed in new model year cars. The factories used the horsepower numbers derived from that testing to trump their competitors in much the same fashion racers were looking to beat one another.

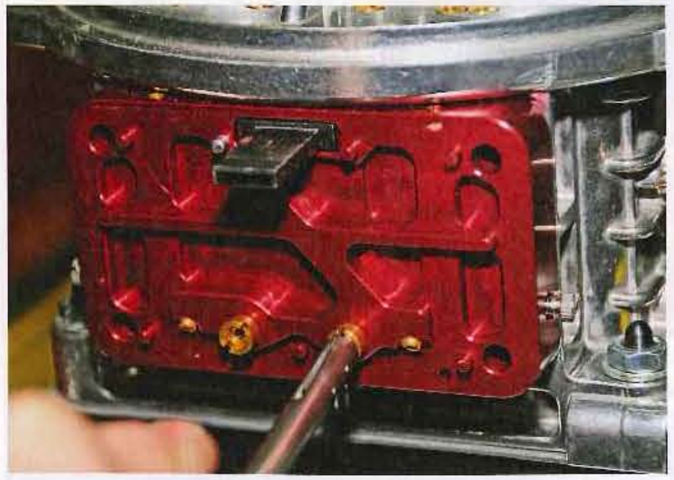
While much of the Indy car racers were using dynos to test their engines, the NASCAR boys in the early '50s were finding dynos to be helpful as they progressed from backwoods


Dyno testing of engines has become the norm not only in the search of horsepower and speed, but also for reliability and longevity. With our Project 598-inch engine complete, it was time to see just what the sum of all its components would add up to.

In the case of our engine, Dennis made several changes to the ignition timing to bring the power up to the levels it needed to be.




The beauty of running an engine on a dyno is that you eliminate any of the variables of on-track testing. Items such as camshaft timing can easily be changed and then evaluated without the worry of waiting in line for a run or changing track conditions.



Jetting changes on the dyno with our Quick Fuel carburetor brought our engine to within acceptable air/fuel ratios. However, jetting is one tuning detail that is probably more suited to track testing, as weather, hood scoops and other variables can have an effect on the final jet number.

the engine at a steady rpm. The operator would then read the torque reading from a gauge and manually calculate the horsepower and torque readings. This had to be repeated for each rpm the operator wanted to run the test for and often required two people—one to hold the rpm and the other to read the torque meter.

Just as in our runs at the track, weather would also play a role in dyno testing. Again, back in the manual days, the operator would have to calculate a horsepower correction number that came into play when calculating actual horsepower. The purpose for this was to allow an engine to be tested and compared to another even if run on a totally different day.

So much for the manual days, though, as computer technology has now taken over dyno control. Today's dynamometer allows the operator to simply pull the throttle wide open, hit the test button and the load on the engine would automatically be set, taking readings at pre-set rpms as the engine accelerates. The operator initially sets his test parameters and the dyno does the rest of the work. No longer is it required to mathematically calculate readings as once the highest rpm set is reached, the engine idles back down and spits out a paper with horsepower, torque and other readings. This is essentially known as a sweep test.

Dennis pre-set his DTS dyno to start taking readings on our project engine at 6,000 rpm, with readings every 100 rpm, finally peaking out at 7,600. At 6,000, the engine made 990 horsepower, finally peaking at 1,165 at 7,600.

"Between the jetting and the ignition timing," Dennis said, "we try to remain fairly conservative until we get a feel for what the engine wants. I read air/fuel ratios from an oxygen sensor in the collector of our test headers. From what I saw on the first pull, the engine seemed a little lean with the air/fuel coming in at 7,600 at roughly 13.23:1. With all of the engines we run, we usually see the most power when the engine is at around 13.0."

Vacuum pumps allow for negative crankcase pressure but also have a tendency to pull oil away from engine components that rely on splash oiling like wrist pins, lifters, etc. During break-in or even warm-ups, we use a Jiffy-Tite quick-connect fitting with no internal valves to disconnect the pump. final dyno sheet on our 598-inch engine shows 1,224 horsepower and 909 ft.-lbs. of torque. Next step is on-track testing.

The gasoline 1,150-cfm Quick Fuel carburetor came through with 89 jets and a high speed air bleed of .031. "I like to just make a small change and see how it reacts," Dennis said, "so I increased the jet to a 90, which seemed to help power and also brought the engine horsepower up to 1,177 and the torque also peaked at 889 at 200 rpm lower."

In subsequent pulls, Dennis made slight changes to the ignition and camshaft timing. By test pull #6, our Project Horsepower engine had made 1,224 at 7,600 rpm and 910 ft. lbs. of torque at 6,200.

"Most of our 598 engines," Dennis said, "produce between 1,210 and 1,220, and we actually advertise our Pro Series 598 with a Dart block and cylinder heads at 1,208 at 7,400 rpm, so this one fell right into that area.

At this point we could have spent an endless amount of time trying different things, but it probably would have accomplished two things. One, the engine might not have made anymore power, and two, would probably just wear it out for no real reason. Under typical conditions, Sunset has seen these engines continue to make power for well over 300 runs without the need for a rebuild.

After the final dyno pull, a leak-down test is performed to assure the ring set is sealed and the valves are once again adjusted as well as the valve spring pressure checked. Given a clean bill of health, the engine was deemed ready to run and the next step is in the car testing. Stay tuned. DRA


Once dyno testing is complete, Sunset has the confidence the engine will run as planned without any problems. Before the engine is crated up for shipping, Dennis rechecks valve adjustment and performs a leak-down test on each cylinder. The oil is drained and the engine crated for shipment.

## SOURCES

**ATI PERFORMANCE**
410-298-4343
www.atiracing.com

**CALLIES**
419-435-2711
www.callies.com

**COMETIC**
440-354-0777
www.cometic.com

**COMP CAMS**
901-795-2400
www.compcams.com

**DART MACHINERY**
248-362-1188
www.dartheads.com

**DIAMOND PISTONS**
877-552-2112
www.diamondracing.net

**JESEL**
732-901-1800
www.jesel.com

**MANLEY**
732-905-3366
www.manleyperformance.com

**MOROSO**
203-453-6571
www.moroso.com

**MSD IGNITION**
915-857-5200
www.msdignition.com

**PAC**
248-799-5400
www.racingsprings.com

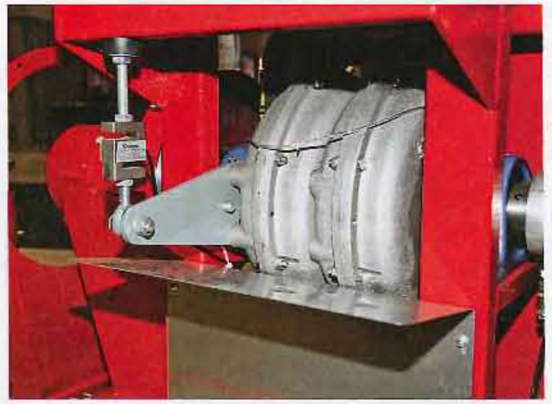
**SUNSET RACECRAFT**
806-747-2700
www.sunsetracecraft.com

**TOTAL SEAL**
623-587-7400
www.totalseal.com

**TREND**
586-447-0400
www.trendperform.com

**VP RACING FUELS**
210-635-7744
www.vpracingfuels.com


Different from today's computerized dynos, a dyno of old utilized a manually operated water valve which controlled flow to an absorption unit that held an engine to a certain rpm. Oftentimes, it took two people to run the unit.



While different brand dynos vary, this is a photo of an absorption unit. Inside the housing resides a rotor. Water flows against the vanes of the rotor to control engine rpm when the carburetor is wide open. The load cell on the left measures resistance to the housing and provides the info to the computer to calculate torque and horsepower.

moonshine runners to the then-fast oval tracks of the day. It's unsure which drag racer actually started the evolution of dyno use for straight line racing, but when it comes to finding any one of those three aforementioned principles (horsepower, speed and reliability), the dyno is king.

There are many different types of dynamometers used today, but in our case as racers, only two dyno types are used, that being an engine or chassis dyno. While a chassis dyno uses electrical current as the means for measurement, an engine dyno consists of an absorption unit which is nothing more than a rotor inside a housing. The rotor is coupled to the engine, while water flows through the housing to provide a load on the rotor's vanes. The housing is attached to an electronic load cell that measures the load on the housing and returns torque readings back to the operator which are used to calculate horsepower. The engine dyno tests the engine only, while a chassis dyno allows the car and drivetrain to be strapped to its mechanism and tested as one whole complete unit.

The use of a chassis dyno for testing the complete drivetrain might very well be beneficial, but in many cases, it doesn't allow for knowing just exactly where a gain or loss can be measured. In this case, the engine dyno becomes the necessity.

Jason Dennis is charged as the dyno operator at Sunset, and he said, "We've had our own engine dyno since 1994 and it allows us to not only assure our customers and ourselves that the engine we put together runs as planned but also that it makes the horsepower and torque it's intended to make. Once we have gotten the numbers, we also use the torque readings to assist our customers in their converter and gearing choices."

JC Beattie of ATI Performance said, "We always like to see a dyno sheet since a lot of horsepower 'guess-timates' are just that and are usually off the mark. What we're looking for is peak torque numbers. We like to flash the converter near it, below it, or just above it. That's where the fine tuning comes in but, in most cases, we have a large enough database that allows us to hit the right converter the first time."

With our project engine complete, it was time to see just what the end result was in terms of horsepower and torque.

With any new engine, there is a certain break-in period. Not only is that the time to make sure there are no leaks and the engine has the correct amount of oil pressure and, in our case, with the use of a Moroso vacuum pump, that the crankcase holds a vacuum. The Total Seal piston rings also require a certain amount of mating to the cylinder walls.

Keith Jones of Total Seal said, "The

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Date : 09-20-2010 Time : 16:00:44
INF-1 Mode : A-Sweep

T16:00 D09-20
Timing:32
JETTING PRI:89 SEC:89

Engine Type:598 dart 11deg.
CARB: apd 1150
CUSTOMER: drag race mag.
Note:lash 24int 24ex.

FileName : DRAG-MAG.D01

| Speed rpm | CPower C_HP | C_TQ lbft | Oil psi | Water° °F | VAC "hg | A/F Left | fuel2 psi | Fuel1 psi |
|---|---|---|---|---|---|---|---|---|
| *6000 | 990.1 | 866.6 | 83.6 | 149 | 18.08 | 12.38 | 7.9 | 7.9 |
| *6100 | 1012 | 871.4 | 83.6 | 149 | 18.19 | 12.39 | 7.8 | 7.6 |
| *6200 | 1030 | 872.5 | 83.6 | 149 | 18.29 | 12.39 | 7.7 | 7.5 |
| *6300 | 1046 | 871.9 | 83.7 | 150 | 18.47 | 12.28 | 7.7 | 7.6 |
| *6400 | 1065 | 874.3 | 83.7 | 151 | 18.57 | 12.17 | 7.8 | 7.4 |
| *6500 | 1081 | 873.3 | 83.5 | 151 | 18.69 | 12.02 | 7.9 | 7.5 |
| *6600 | 1096 | 872.1 | 83 | 151 | 18.84 | 12.13 | 7.8 | 7.4 |
| *6700 | 1108 | 868.4 | 82.8 | 151 | 18.9 | 12.31 | 7.9 | 7.3 |
| *6800 | 1122 | 866.9 | 82.1 | 151 | 19 | 12.53 | 7.7 | 7.4 |
| *6900 | 1132 | 861.6 | 81.6 | 153 | 19.09 | 12.71 | 7.6 | 7.3 |
| *7000 | 1141 | 856.2 | 81.5 | 153 | 19.19 | 12.8 | 7.6 | 7.1 |
| *7100 | 1146 | 847.8 | 81.4 | 153 | 19.28 | 12.92 | 7.7 | 7.3 |
| *7200 | 1154 | 841.7 | 81.2 | 153 | 19.3 | 12.95 | 7.6 | 7.2 |
| *7300 | 1157 | 832.5 | 80.9 | 153 | 19.4 | 12.99 | 7.7 | 7.1 |
| *7400 | 1160 | 823.1 | 80.4 | 153 | 19.4 | 13.16 | 7.5 | 7.1 |
| *7500 | 1161 | 813 | 79.8 | 153 | 19.5 | 13.25 | 7.5 | 7.1 |
| *7600 | 1165 | 805.2 | 78.7 | 153 | 19.5 | 13.23 | 7.6 | 7.1 |

Average data in * band

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6084 | 987.78 | 764.18 | 73.43 | 135.58 | 16.93 | 11.3 | 6.89 | 6.57 |

Today's computerized versions of a dyno allow the operator to program a sweep test enabling the dyno to run the engine through an rpm cycle and automatically calculate horsepower and torque along with several other data points. The first pull on our Project 598 showed meager results with more to come.

The proper break-in procedure of a new engine is mandatory if you expect good results. Sunset Racecraft's Jason Dennis said, "We run a new engine at 1,800 rpm with just a slight load from the dyno for two 10-minute periods. We then pull the valve covers, run the valves and take apart the System 1 oil filter to inspect for any debris."



With the engine properly broken in and the oil and water temperature up, the valve adjustment is easily reset with the Jesel shaft rocker system.

break-in procedure is real important to the overall health of the engine. We recommend using a good break-in oil, not some really slick synthetic or race blend. Bear in mind that what we're trying to do is allow the piston rings to match themselves to the cylinder bores. A good break-in procedure will have them sealing up in no time and staying that way."

Dennis' routine for break-in involves running the engine on the dyno for two 10-minute cycles at 1,800 rpm with just a slight amount of load on the engine from the dyno. After both sets, the valve covers are pulled and the valve adjustment is checked. "We also pull the oil filter and check for any particles which might indicate a potential problem," Dennis said. "We use a System 1 oil filter that can be easily disassembled, cleaned and checked."

The Moroso vacuum pump is also disconnected during the break-in procedure. The vacuum pump has a tendency to pull oil away from the engine components which rely on splash oiling on initial start up like wrist pins, lifters, etc.

Jones said, "Under normal circumstances the vacuum pump is a great benefit to ring seal, but during break-in periods you want to have as much oil as possible in between critical clearances."

As an addendum to this, we choose to use a Jiffy-Tite quick-disconnect fitting with no internal check valve on the vacuum line from the vacuum pump. This allows the ability to quickly disconnect the pump even during warm-up at the track.

With break-in complete and all the lines connected as such, Dennis set the dyno up to make the first pull.

When racers first started using dynos, they essentially were manual machines that operated in a steady state. That is, the operator controlled the amount of water that flowed through the absorption unit which, while the throttle was held wide open, the water controlled