WILLHOIT AUTO RESTORATION

4-Cam Engine Tests

We have dyno tested a number of 4 cam engines in the last several years, and below are listed four of those tests and some comparisons. None of these engines were built at WR and the dyno tests were only done to fine tune the engines. Some of the tuning issues are discussed.

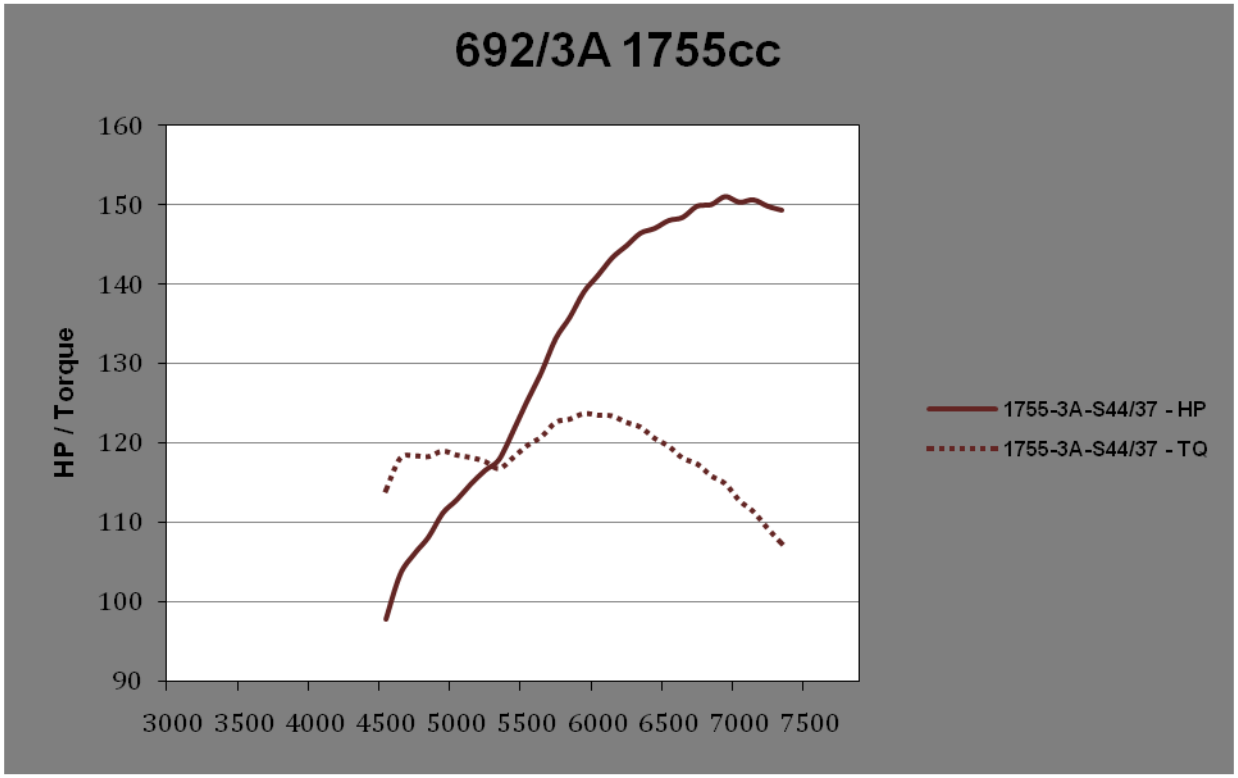
Following the four tests, is the testing done on an engine built at WR.

692/3A – 1755cc

151hp@6900 / 124ftlbs@5900

The 3A was the last evolution of the 1600cc engine. It used a higher compression ratio and higher lift intake cams. These new intake cams produced 12.5mm intake lift at the valve (almost .500”). The exhaust cams were the same as the earlier engines and had 10mm of lift at the valve. The carburetors were changed to larger 44P11 Solexes and venturi sizes varied according to exhaust and racing conditions.

This particular engine used the 92mm piston and cylinders from the 904, which increase the size to 1755cc. The stock Solex 44P11s had 37mm venturis, and the exhaust was a custom 4:1 header.

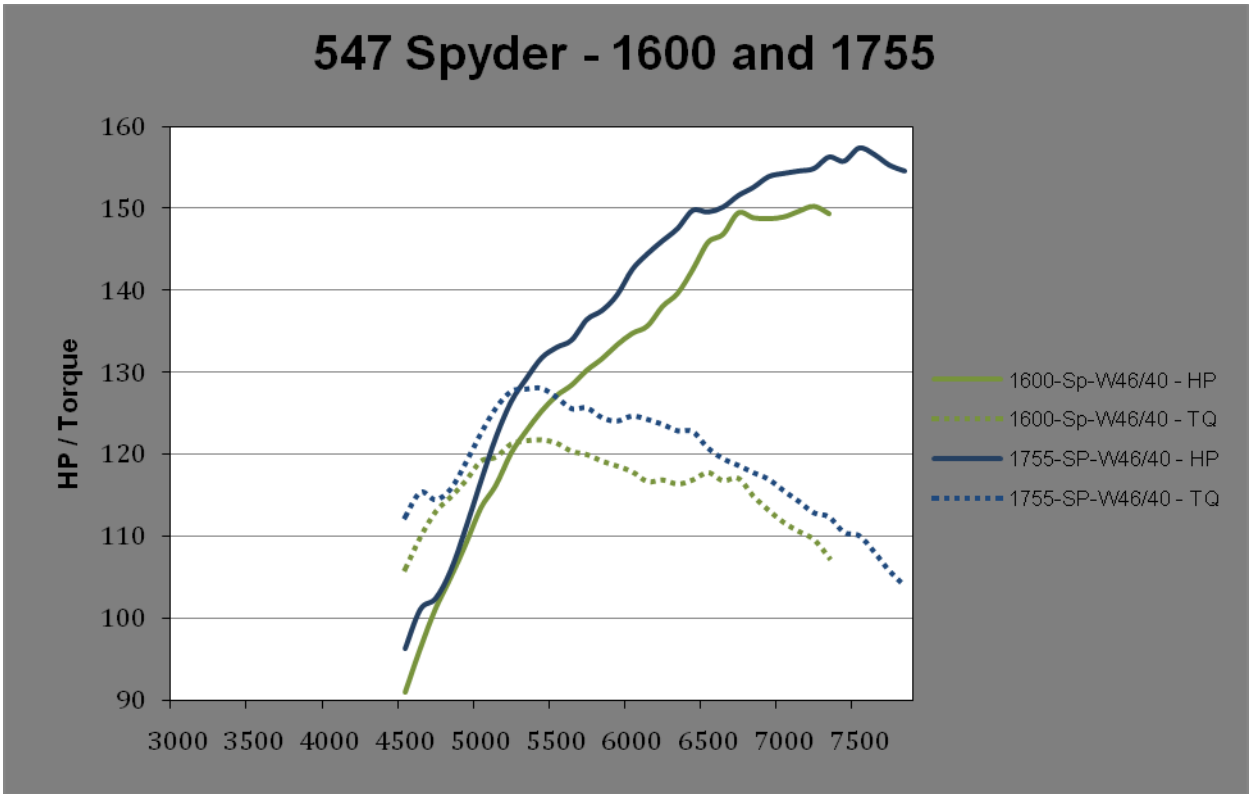


The 3A engines don't typically run well below 5K rpm, and this one was no exception. The primary pipes of the header were too large at 1.75" OD, and too short, which pushed the power up even more. In a race car with the right gears this would be a good engine…but not much fun as a street car. The added torque of the extra 155cc will definitely help.

TWO 547 Spyder Engines – 1600cc and 1755cc

1600cc – 150hp@7200 / 122ftlbs@5200

1755cc – 157hp@7500 / 128ftlbs@5400

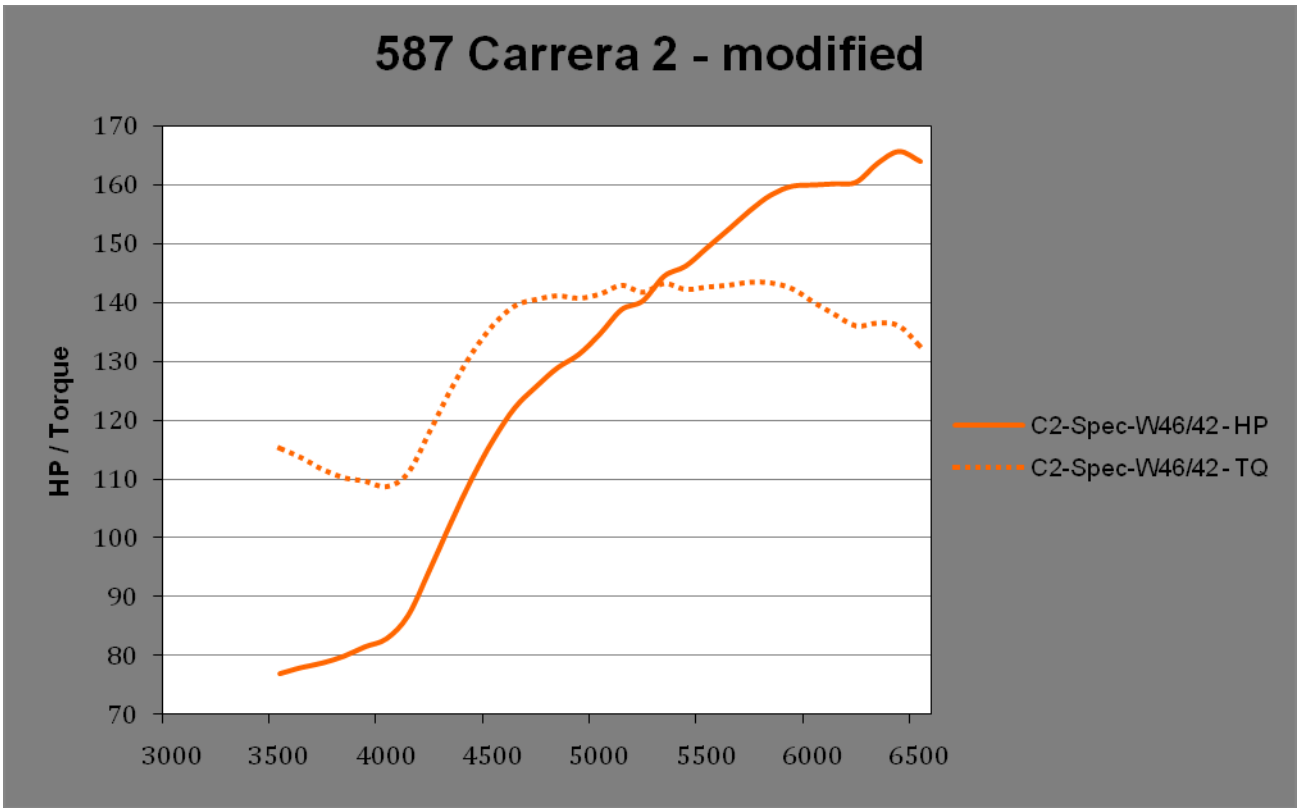


It's obvious that the larger 1755cc engine will have an advantage on the track. Both these engines are set up with Spyder cams on the intake and exhausts. These cams have 12.8mm lift at the valve on the intake and exhaust and push the power further up in the rpm range. Both these engines use Weber 46s with large 40mm venturis which was common on the RSK/RS60/RS61. Compared to the 692/3A engine, they have much longer primary exhaust pipes and get a boost at lower rpm that you can see in the torque curve. They are track only engines, not for the street.

587 Carrera 2

166hp@6400 / 143ftlbs@5700

This is a customers Carrera 2 engine that had been hotrodded with titanium valves, a 4:1 header exhaust and larger 46mm Weber carbs with 42mm venturis. The exhaust primaries were large at 1.75" OD and too short, which moved the torque curve up. The engine didn't produce the power that the engine builder expected but actually seemed very consistent with other 2L 4 cam engines that have been modified to 587/2 specs. Primaries of 1.625" OD and smaller venturis would have probably gained some of the power lost below 4500 rpm, maybe at the cost of some upper rpm power, but this would have made the engine more happy in a street car. There's always a tradeoff.



547/1-1792cc (originally early 1500GS)

This next engine was built for Speedster #81062. It was delivered to WR as a restoration project with the car. The engine was partially assembled, but had been sitting for many years. Upon disassembly, everything was checked and it was found to be in good condition and needed only a major rebuild. Fortunately, the camshafts, bevel gears and basic components had not suffered any destructive failures. Since the 1500 4 cam engine was not known for its stunning performance in a street car, the owner asked if any upgrades or changes could be made to make the car more user friendly during normal street driving. Below is a list of the changes made to the engine:

Special aluminum Nikasil coated cylinders were made to my specs by Charles at LN Engineering. By eliminating the 4cam head-gasket and sealing the cylinder tops directly to the head, I was able to easily increase the bore to 93mm, which when combined with the stock 66mm stroke, produced 1792cc. JE made custom pistons with domes that matched the 1500cc combustion chambers. The compression ratio was raised from 9.0 to 10.4:1. Lightweight 22mm floating wristpins replaced the super-heavy stock 24mm pins, and an ultra thin ring package was chosen that matched the Nikasil coated cylinders. The stock 4cams had copper plated steel head studs. In order to better match the expansion of the aluminum cylinders, I used factory 993 type Dilivar head studs. Dilivar is a proprietary stainless alloy similar to Inconel that expands at a rate similar to aluminum.

Custom Carrillo rods for the standard 80mm roller crank were ordered with 22 bronze wristpin bushings. The crank was sent to Bill Doyle for a complete rebuild. Fortunately, the case specs were all within standard tolerances, as were the countershaft and bevel gears. The stock 1500 flywheel was lightened to 14lbs and a 200mm VW bus diaphragm pressure plate and disc were chosen, since the pressure plate was compatible with the early throw-out bearing.

The heads were completely stock and still had the early bronze valve seats. These were changed to steel seats that were good for unleaded fuel. The stock intake valves are 48mm in diameter and have a 9mm stem; the stock exhaust are 40mm with large sodium filled 11mm stems. Ferrea custom made stainless valves for intake and exhaust with 8mm stems, and 3 groove locks like the 356C/912 and 911. Silicone-bronze guides were custom machined. Custom titanium retainers were fabricated, along with custom valve shims to match the 8mm valve tips. Standard 911 double valve springs replaced the stock 4cam springs. The flowbench tests showed a big improvement on both intake and exhaust, even with the 40mm carbs.

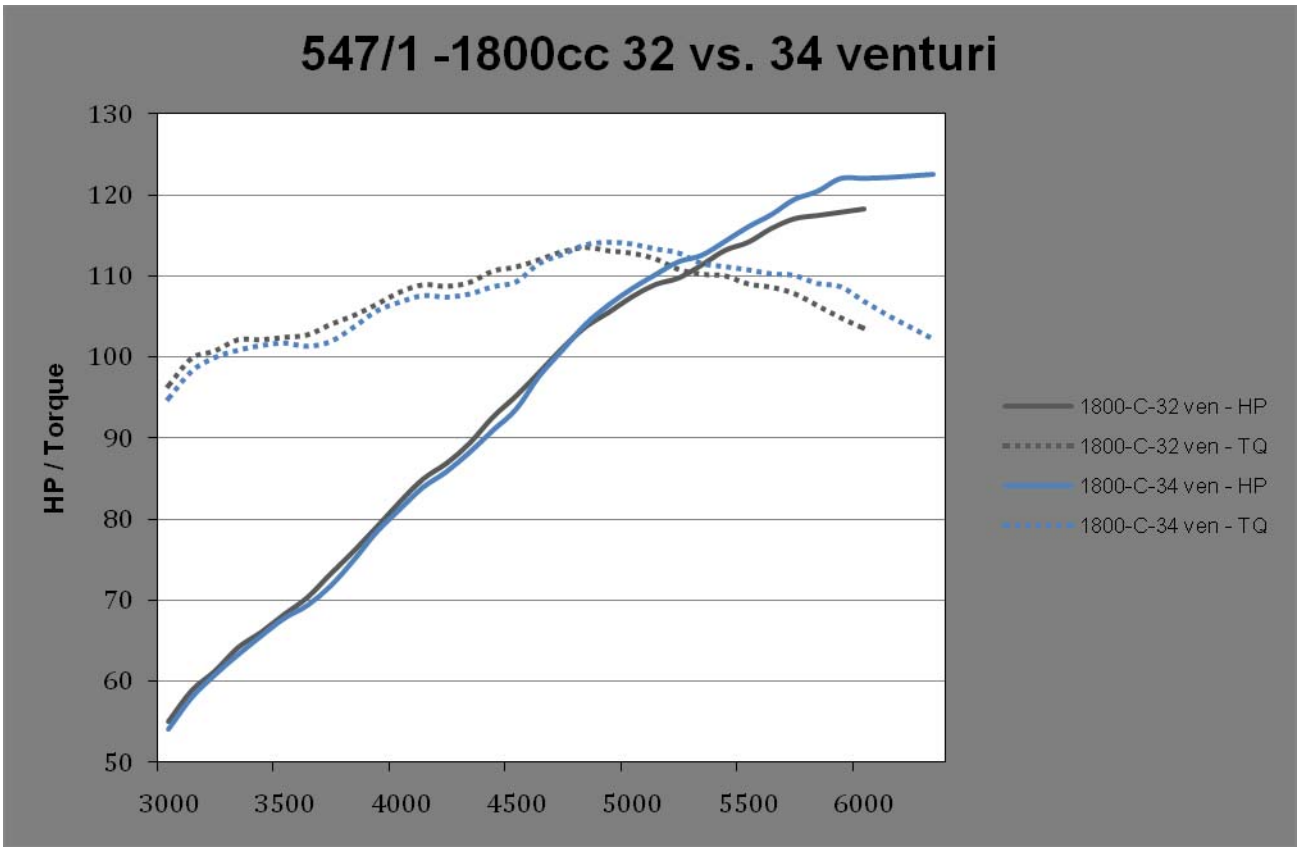
Two sets of venturis were made for the Solex 40P11 carbs: 32mm and 34mm. A set of the aluminum Solex 40P11 aircleaners with 2.25” internal air horns were chosen because they had been shown to produce extra mid range torque on pushrod engines. A simple twin pipe street exhaust was fabricated from stainless steel. A special 4:1 header was also tested. This header was designed for a similar engine in 1755cc and had stepped primary pipes of 1.625” into 1.75” OD.

Valve timing was set to stock specs, and the camshafts were the standard “one dot” GS version with 10mm lift at the valve. The results of three tests are shown. One with 32mm venturis plotted with the same engine with 34mm venturis, the other with the 34mm venturis and the 4:1 header. The header was run straight into the dyno exhaust. Typically a reverse cone megaphone would have produced higher top end numbers.

The ignition was also changed, although, no outward signs would be visible. The PS distributor was equipped with a standard 4 cylinder Pertronix ignition unit that was mounted on a custom aluminum plate. The signal from this distributor was sent to a new MSD CDI box that fires both sets of spark plugs and has a programmable timing curve. Both distributors were locked (the DS is in slave mode) and the timing curve was set using a laptop for programming. With the programmable MSD it’s possible to bring the timing in faster after idle to improve throttle response, and the system is super reliable. It’s also possible to set an rpm limit, a good option with the rev happy 4 cam.

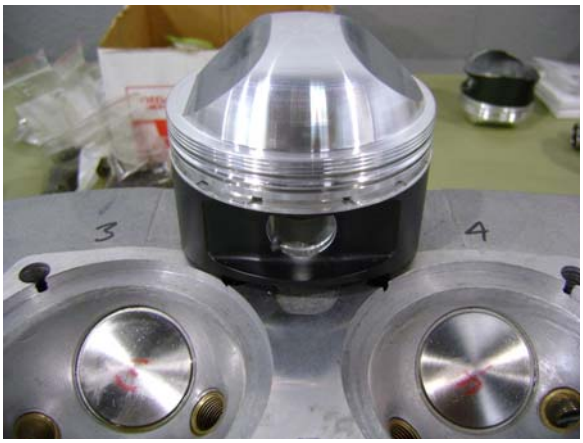
Street exhaust w/32 venturis – 118hp@6000 / 113ftlbs@5000

Street exhaust w/34 venturis – 122hp@6300 / 114ftlbs@5000



The engine made great torque in the lower rpm range, and had terrific throttle response. The torque was actually very flat in the 3K to 6K test range. The 34mm venturis provided additional top end and only lost slightly below the torque peak of 5K. Considering the peak torque on a stock 1500GS was only 90ftlbs, I was more than please with the results. The exhaust was quiet and with the flat torque curve the car was much easier to drive than a normal 1500GS.

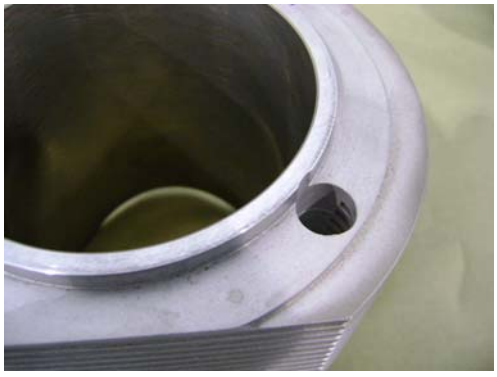
After testing was completed with the street exhaust, I couldn't wait to test the engine with the 4:1 header mentioned above. The results were astounding! The giant valves and ports of the Carrera engine were made for a free flowing exhaust and bigger carbs.



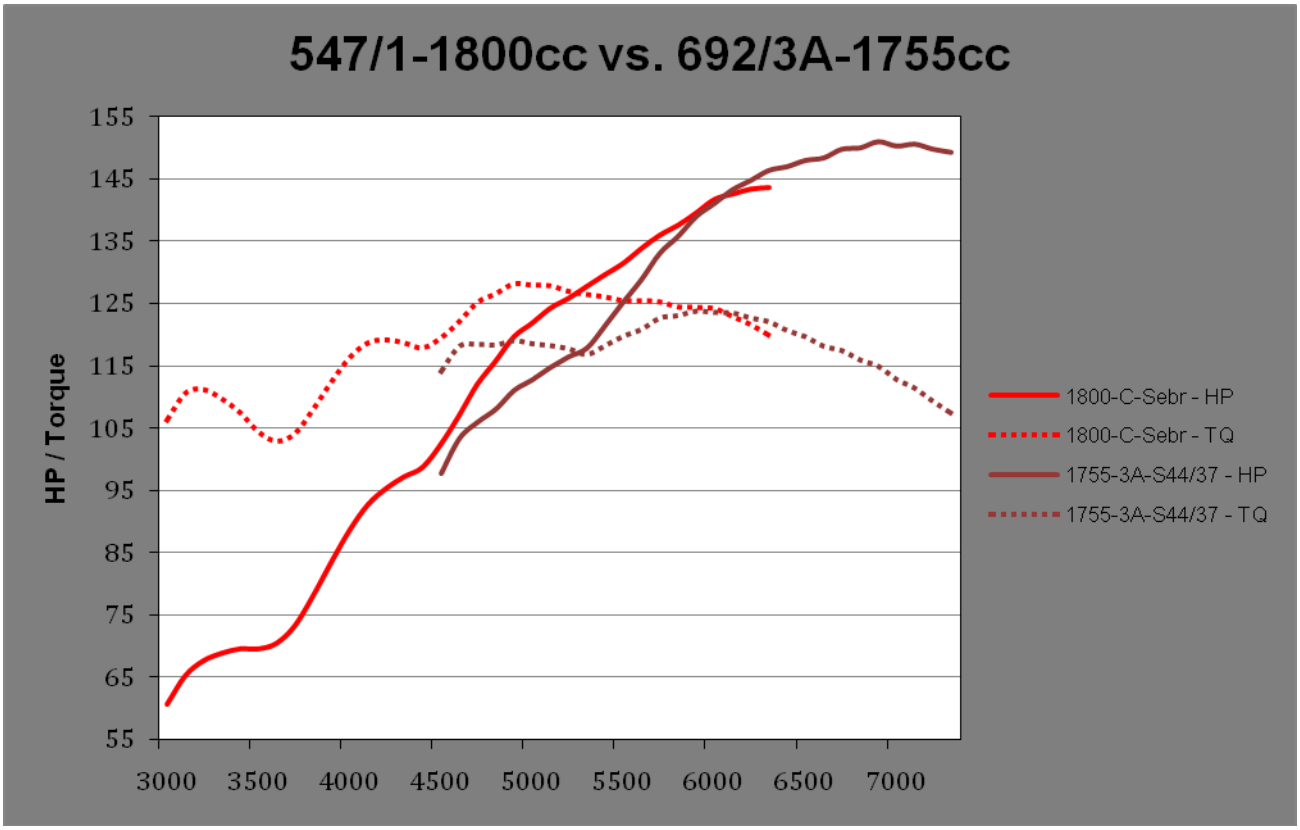
Street exhaust w/34 venturis – 122hp@6300 / 114ftlbs@5000

WR 4:1 header (1.625”-1.75”OD) – 144hp@6300 / 128ftlbs@4900

Since the car wasn’t going to be driven with the race exhaust, no further testing was done. It would be interesting to see how much more power is possible with this engine with larger carbs and a reverse cone megaphone attached to the header. I’m sure that around-town driving would suffer, but it would be a fun compromise.



Below is a comparison to the 1755cc 692/3A race engine:



It's obvious that the 1800cc, milder intake cams, and smaller carbs have an advantage below 6K. The 3A engine is definitely not happy driving around town, but in a race car with the right gears it would have an edge on the track. As mentioned before, it would be interesting to explore the possibilities of the 1800cc 547/1 with larger carbs and a higher rpm limit.