Effects of Modifications To The Corvair

By Ned Madsen

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1 Introduction

Using some simple Physics and the geometry of the transmission, differential and tires can be used to evaluate the performance of the vehicle. For the purpose of this report the subject vehicle will be a 1966 Corvair coupe. This report will examine several potential modifications. The modifications are intended to increase the top speed and acceleration capability.

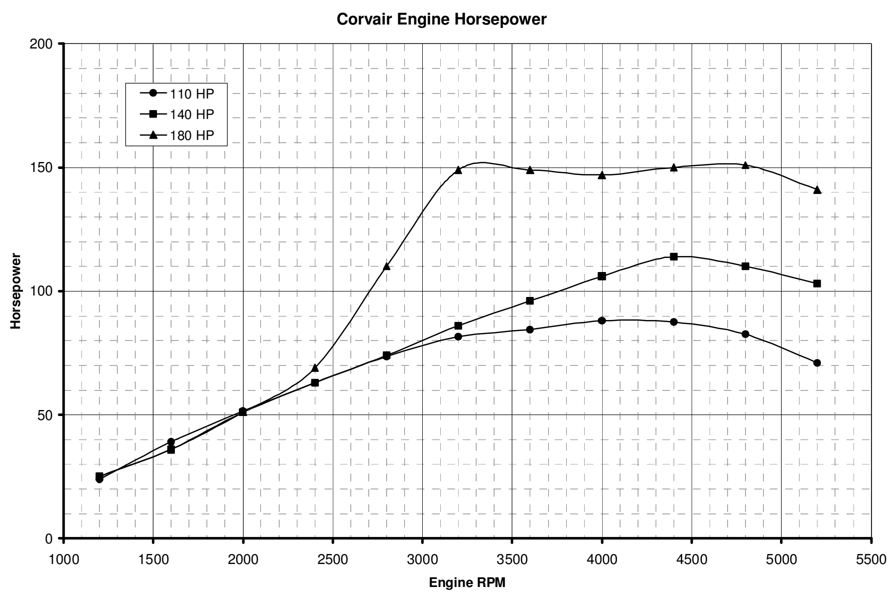
The data for engine modification are based on what has actually been accomplished. The author would like to thank Ray Sedman, Kent Sullivan, Bill Elliott and Ray Clayton for providing dynometer data.

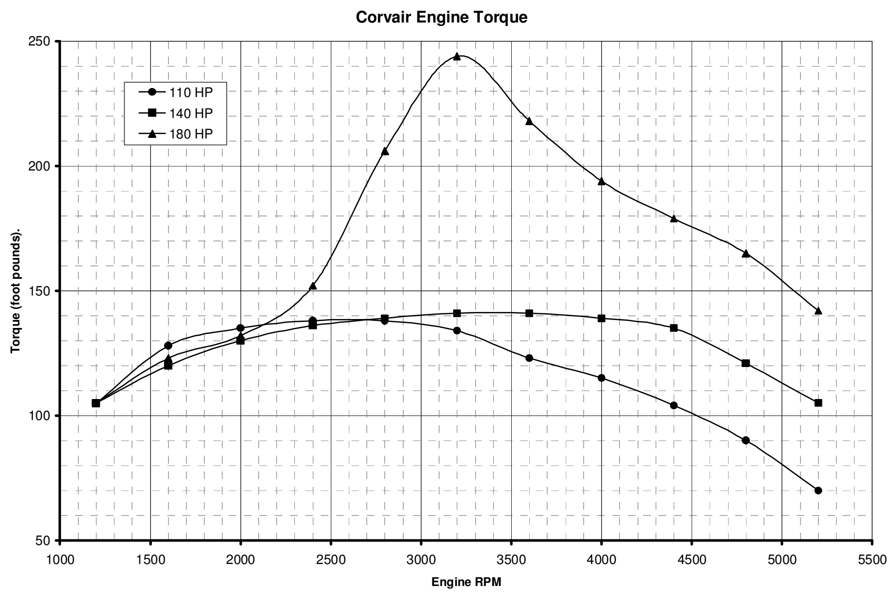
The aerodynamic drag will also be modified. The basic data was determined from GM wind tunnel data and verified through computer analysis. The aerodynamics was used in an acceleration simulation to calculate 0-60 MPH and quarter mile time. These results matched similar published test results.

2 Stock Performance

2.1 Engine Power

The 1966 Corvair had the choice of three engines. All three are air cooled, horizontally opposed six cylinder engines with 164 cubic inch displacements. The differences in the engines are due to the cylinder head design and the carburetion. The base engine has two single barrel carburetors and an advertised horsepower of 110 HP. The second engine has four single barrel carburetors. Two carburetors open directly with the throttle while the other two begin to open when the throttle is about 60% open. All four carburetors reach full open at the same time. This engine is rated at 140 HP. The final engine has a single carburetor and is turbocharged. This engine is rated at 180 HP. The following charts present the horsepower and torque at the flywheel for each of these engines as installed in the vehicle:





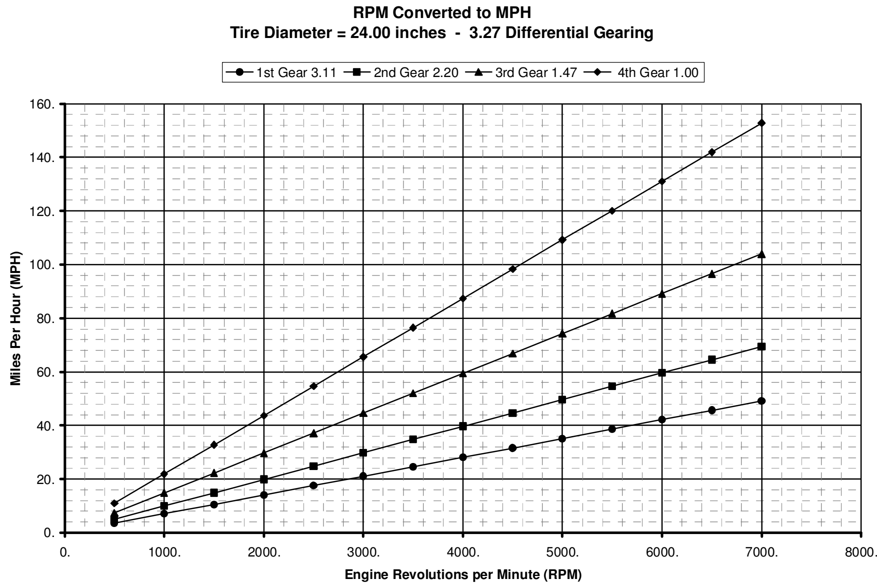
The maximum RPM for all three of these engines was set at 5200. As seen in the previous chart, the advertised horsepower claims were very optimistic. This was a somewhat common occurrence at that time. In the examples, the engines will be referred to by the advertised horsepower ratings.

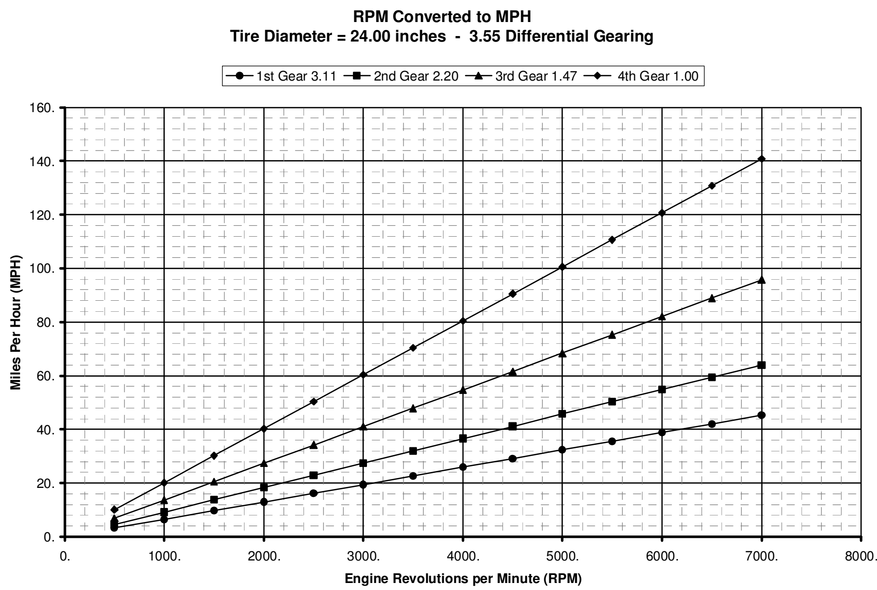
2.2 Differential and Transmission

Two different differentials and two manual transmissions were available for the Corvair in 1966. The differentials have different gear ratios, 3.55 and 3.27. The transmissions are a three speed and a four speed. The following table shows the gearing for each transmission:

Gear	First	Second	Third	Forth
3 Speed	3.11	1.84	1.00	--
4 Speed	3.11	2.20	1.47	1.00

Since the gearing differences between the transmissions are small, only the four speed will be used in the examples. The stock Corvair tire has an outside diameter of approximately 24 inches. The following charts present the relationship between engine RPM and MPH for the combinations of the two differentials and the four speed transmission.





2.3 Aerodynamic Drag

A sophisticated computer program was used model the Corvair body was used to determine the aerodynamic drag coefficient. This program is normally used by the aircraft industry as a virtual wind tunnel. With modification to the computer model, the program is capable of breaking the drag coefficient into different sources. The contribution to drag from the protruding parts was partially calculated with the computer model and partially calculated from a different method the individual parts. The other method involves comparison of the part geometry to a database of known parts. This method accounted for nearly 80% of the drag contribution from protruding parts. The total drag coefficient calculated here is expected to be within 10% of the actual drag coefficient.

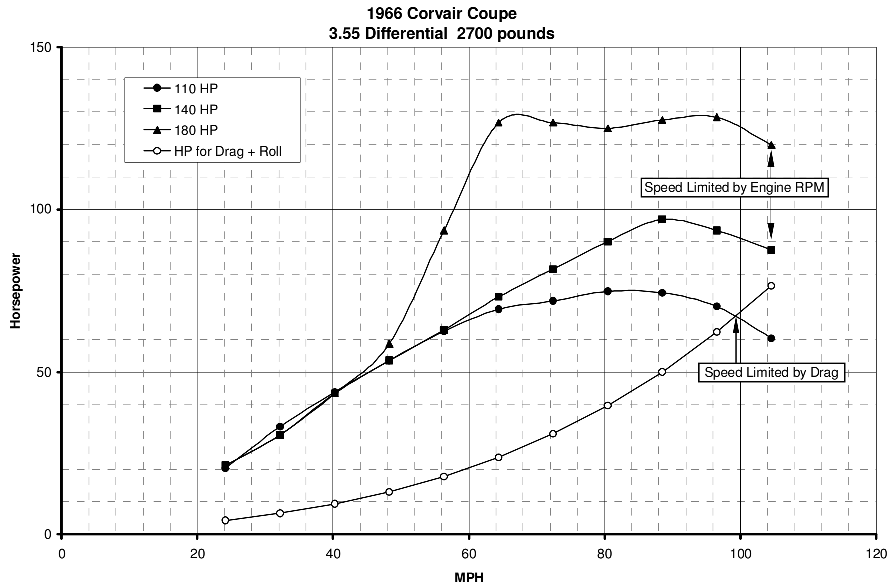
The following table lists the component drag coefficients that were calculated:

Component	ΔC_D	Actual % of Total C_D	Predicted % of Total C_D
Body Surface	0.014	3.89%	5%
Rear of Body	0.058	16.11%	15%
Windshield	0.036	10.00%	10%
Underside of Body	0.072	20.00%	15%
Airflow into Cabin	0.022	6.11%	10%
Wheel Openings	0.057	15.83%	10%
Ground Effect	0.014	3.89%	5%
Engine Cooling	0.029	8.06%	15%
Protruding Parts	0.058	16.11%	15%
Total	0.360	100%	100%

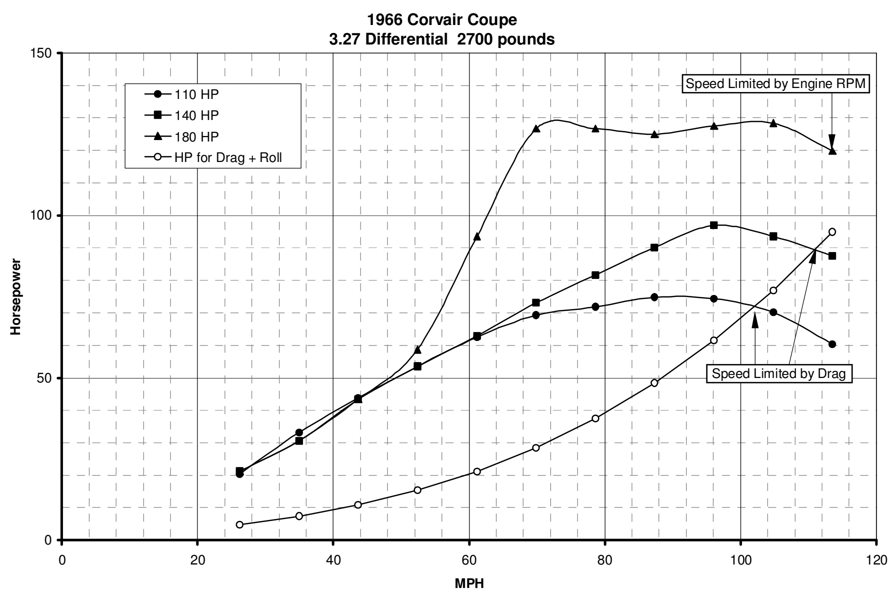
2.4 Maximum Speed

The first example will determine the maximum speed for our 1966 Corvair coupe. For this problem each engine and differential will be used. The power required to overcome the rolling friction and aerodynamic drag and the engine power available at the rear wheels are plotted against speed. This is accomplished by using the conversion of RPM to MPH for the highest transmission gear.

The following charts present this data:



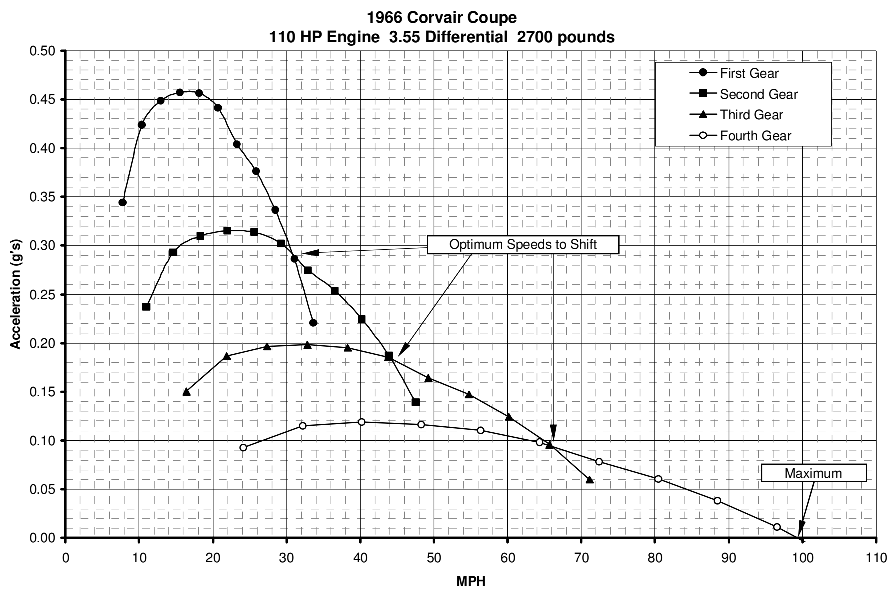
Notice that the power required curve crosses the power available curve for the 110 HP engine. The point where these lines cross is the maximum speed which is drag limited. The vehicles with the other engines have a maximum speed that is limited by the maximum engine RPM. If the differential gear is changed to the 3.27, the maximum speed plot changes to the following:

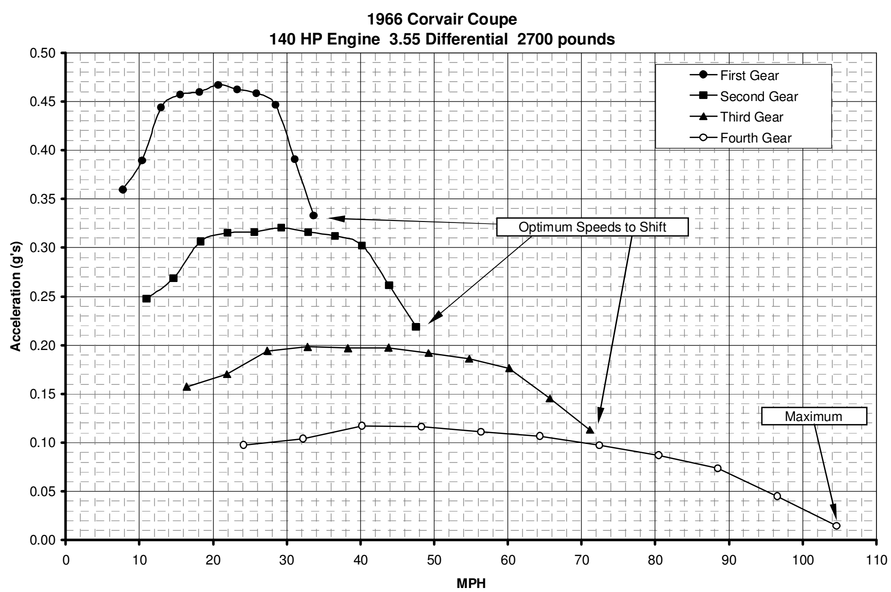


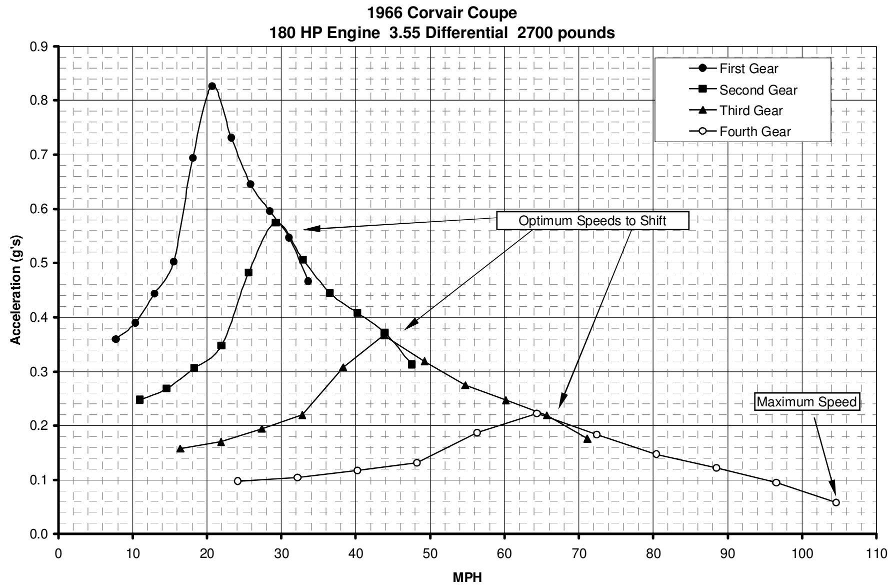
This plot shows, that while the differential change allows the engine to have the capability to reach a higher speed, the 140 HP powered vehicle is now also limited by aerodynamic drag.

2.5 Acceleration and Shift Speeds

To find the maximum speed of the vehicle, the power available from the engine and the power required for aerodynamic drag and rolling friction were calculated for the transmission top gear. The difference between these two lines is the power available for acceleration. The acceleration can be calculated for all gears and plotted versus speed. The following plots show the resulting plots for the three Corvair engines:





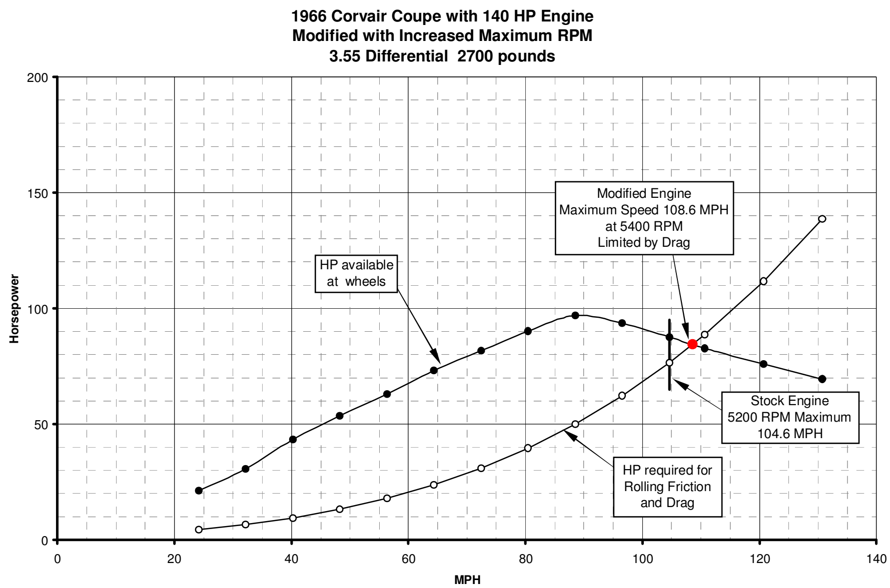


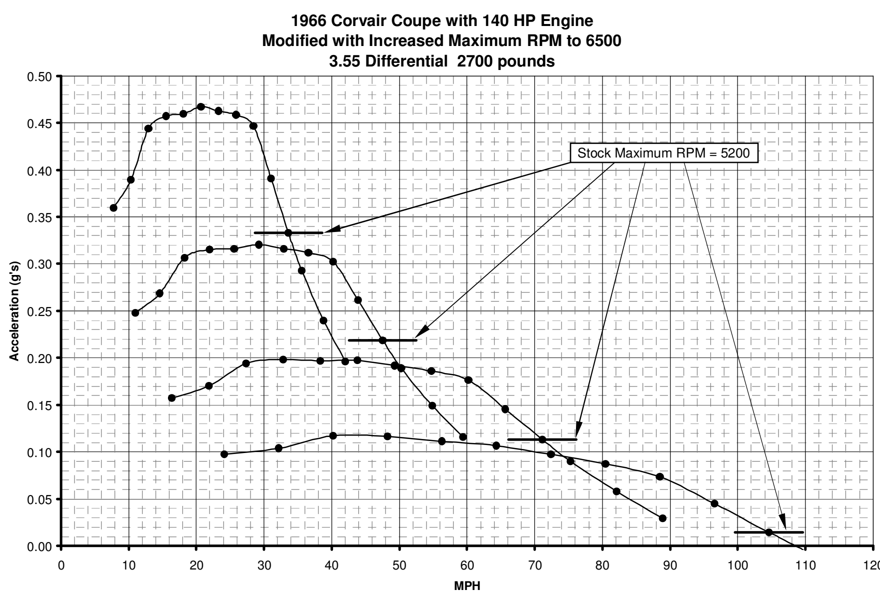
From these plots, the speed to shift to a higher gear can be determined. Many times the driver will shift to a higher gear when the acceleration feels like it is starting to drop off. Also, the shift should not always be delayed until the maximum RPM is reached. The shift should be made when the acceleration of the next gear is higher than the current gear. This speed is where the curves cross. If the curves do not cross, the shift should be made at the maximum RPM. The 180 HP chart has some interesting aspects that should be pointed out. First, the peak acceleration in first gear 0.826 g's almost double the maximum acceleration of the 140 HP in first gear, 0.467. The second point is that the backside of the curve, speeds above the peak acceleration, is very smooth. This is can be felt by the driver of the car as a smooth acceleration when shifting through the gears.

It should be noted, that modifications to the engine to increase the maximum RPM might not always result in a faster vehicle. If the vehicle has the maximum speed limited by aerodynamic drag, increased RPM will not give a higher speed. Similarly, if the optimum shift speed is below the maximum RPM, extending maximum RPM will not give greater acceleration.

3 Increase Maximum RPM

The first modification considered will be an increase in the maximum RPM of the engine from 5200 RPM to 6500 RPM. This is a fairly simple modification and assumes the horsepower and torque curves are extended from stock. This modification can be accomplished by several methods. Stiffer valve springs help to prevent valve float and ignition changes prevent ignition breakdown. The following chart presents the effects of this modification.

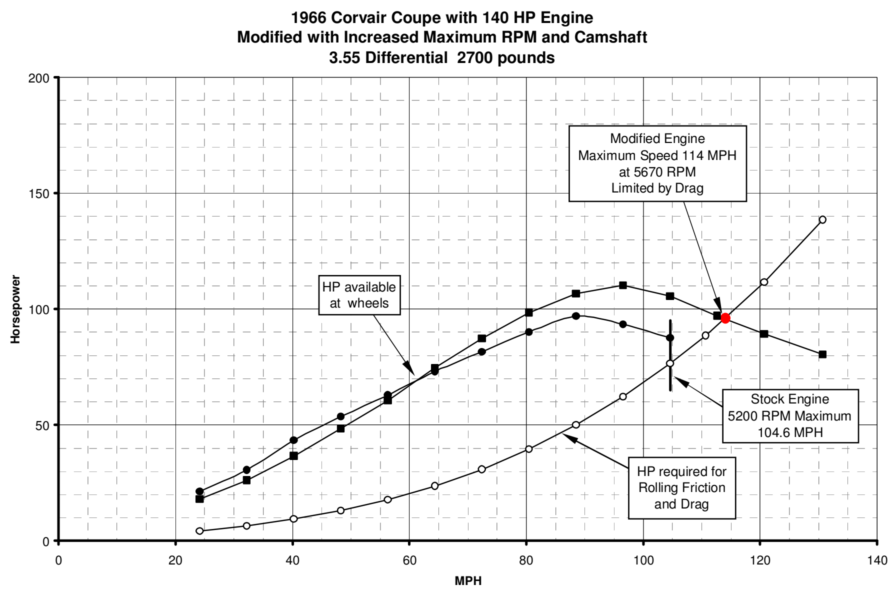


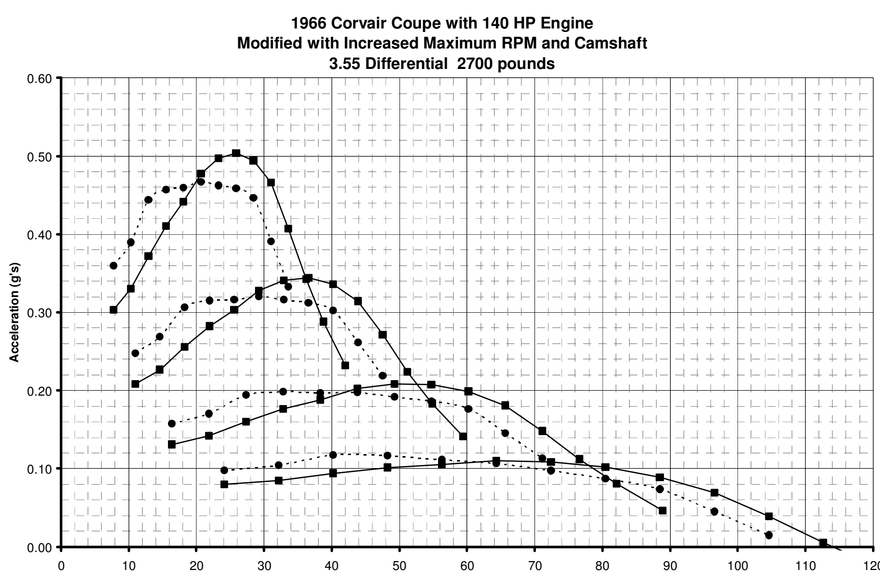


These charts show that the maximum speed increased by 10 MPH and the vehicle is now limited by the power required by rolling friction and aerodynamic drag. In fact, the maximum speed occurs at 5400 RPM, 200 RPM over the stock maximum of 5200 RPM. Similarly, the change in the shift speed is not significant. This indicates that this modification did not improve the performance a great deal.

4 Modified Camshaft

A common engine improvement is the replacement of the stock camshaft with a modified camshaft. The replacement camshaft increases the amount the valves open as well as the time they are open. Typically this type of modification increases the horsepower at high RPM while reducing the horsepower at lower RPM. The increased maximum RPM from the previous example is retained. The charts also contain the performance of the stock 140 HP engine for reference.

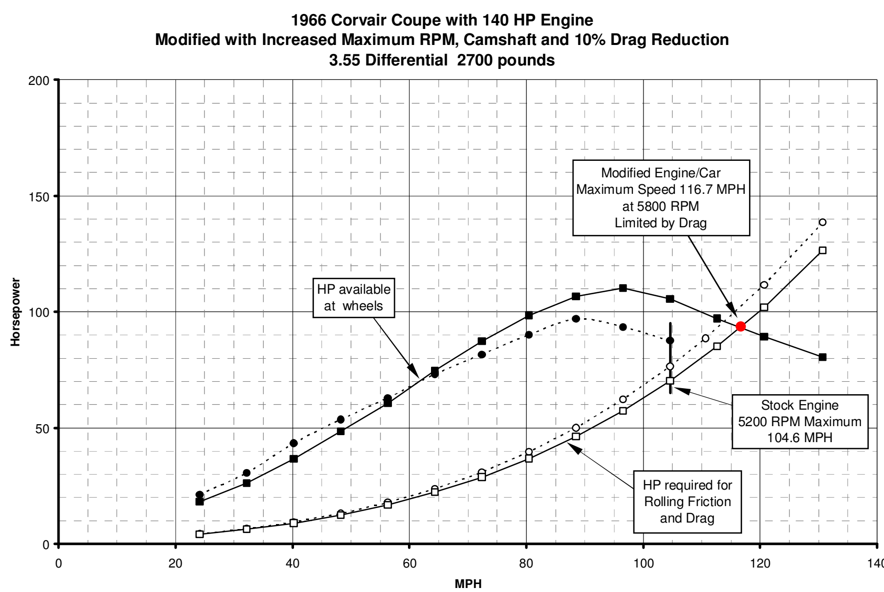


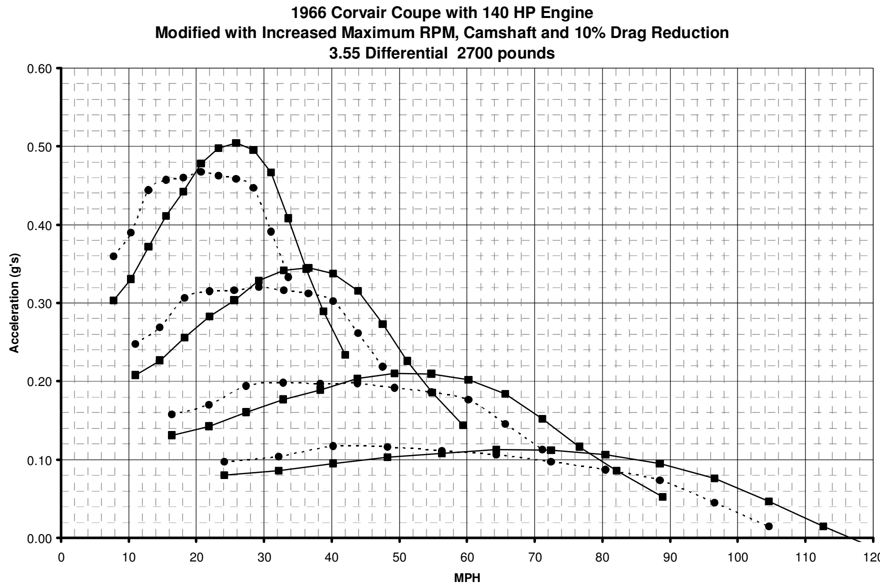


The results of this modification show an increase in the maximum speed. The acceleration also increased over the stock engine for the higher RPMs. However, acceleration at lower RPMs did decrease, but this only affects the performance in first gear. The acceleration increase overcomes the decrease in 0-60 MPH and quarter mile runs.

5 Simple Drag Reduction

Since the maximum speed continues to be limited by the aerodynamic drag, the next modification will be to reduce this loss of power. The goal of this modification will be reversible and not visible changes to the basic car body. This is desired so that the car can be easily restored to the original condition. The modifications include cleaning up the front of the car by removing the bumper and headlight assemblies. The resulting holes are filled in a method that results in a smooth contour. Air flow under the car is restricted with a front spoiler that extends just a few inches from the ground. The final part of the drag reduction modification is the removal of the windshield wipers and side view mirrors. It is estimated that these modification will reduce the aerodynamic drag by 10%. The following charts present the resulting performance.

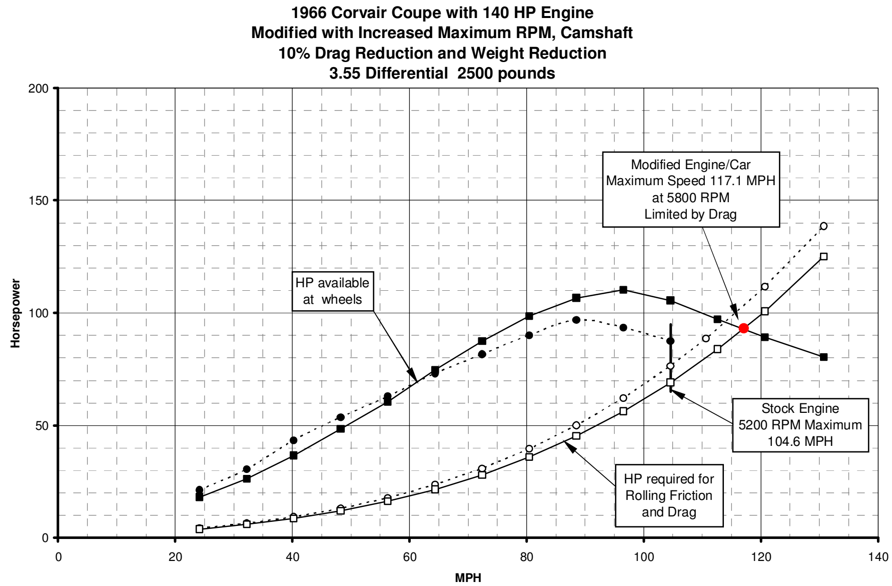


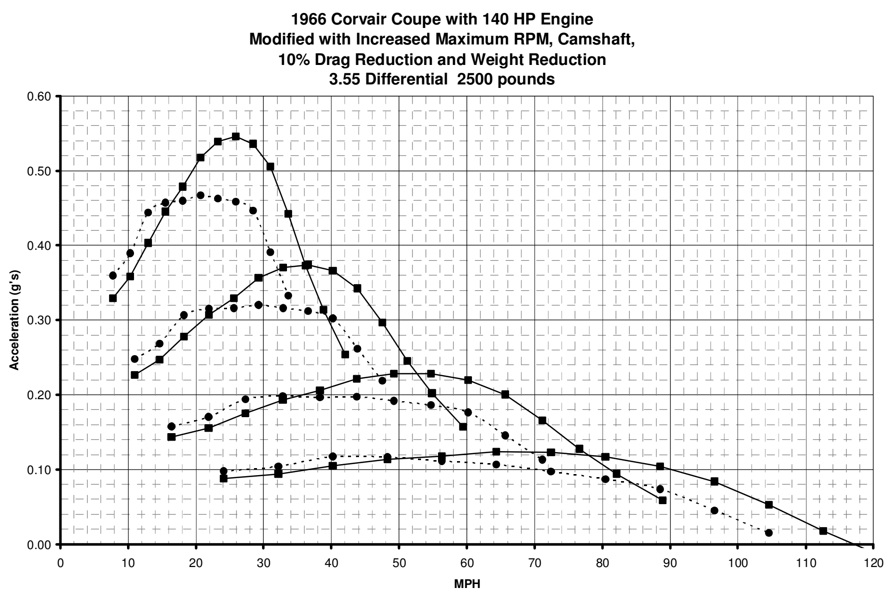


The drag reduction did result in an increase in maximum speed of almost 3 MPH; however the car remains limited by aerodynamic drag. The acceleration also improved somewhat. This indicates a possible area for further modification.

6 Simple Weight Reduction

Up to this point, all of the performance has been based on the measured weight of a stock Corvair of 2700 pounds. The weight of the car has a direct bearing on the acceleration of the car and a smaller contribution on the maximum speed. This affect is examined in this modification. The weight reduction will be limited to removing or changing items that, once again, can be reversed to return the car back to stock appearance. The weight of the car is reduced by removing the interior items including the seats. The driver’s seat is replaced with a lighter aftermarket seat. The items used to provide heat are also removed. The total weight saving is estimated to be 200 pounds. The following charts show the resulting performance:

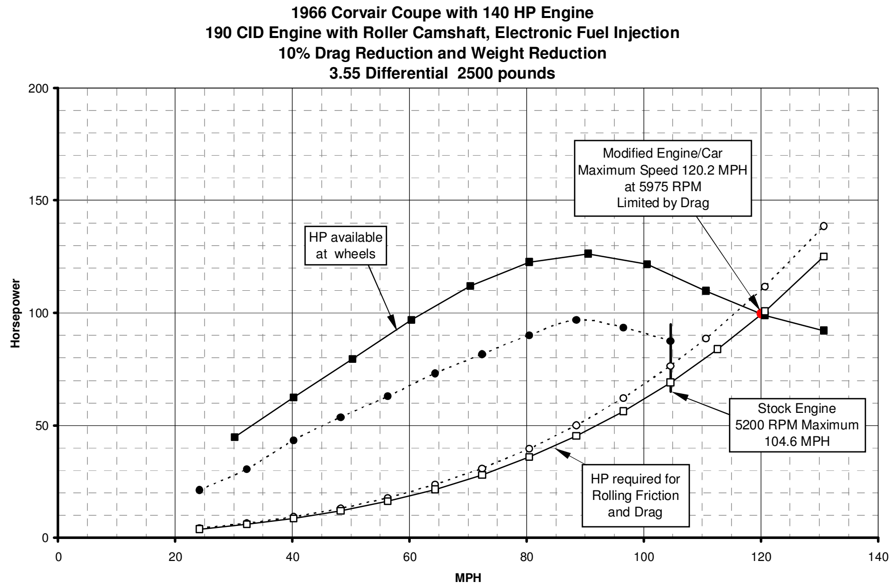


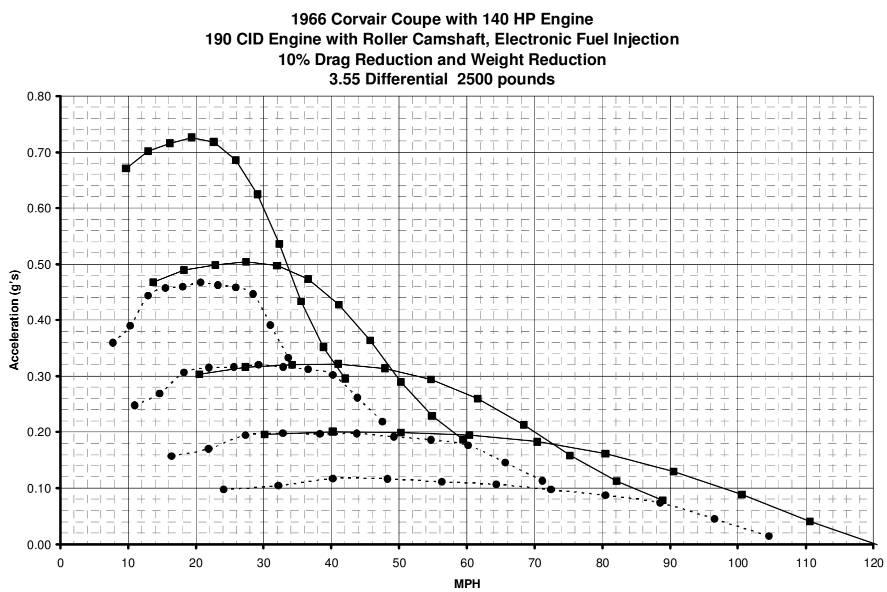


As expected, this modification improved the top speed by only 1 MPH. However, the acceleration improved greatly.

7 "Big Bore" Engine

It has been said, "There's no substitute for cubic inches." This modification will examine the affect of increasing the engine displacement. To accomplish this modification the cylinders, pistons and other internal engine parts are replaced. The displacement increases from 164 cubic inches to 190 cubic inches. This modification is known as a "big bore" engine in the Corvair community. The example engine for the performance also has roller lifters and electronic fuel injection. The following charts present the performance of this engine.

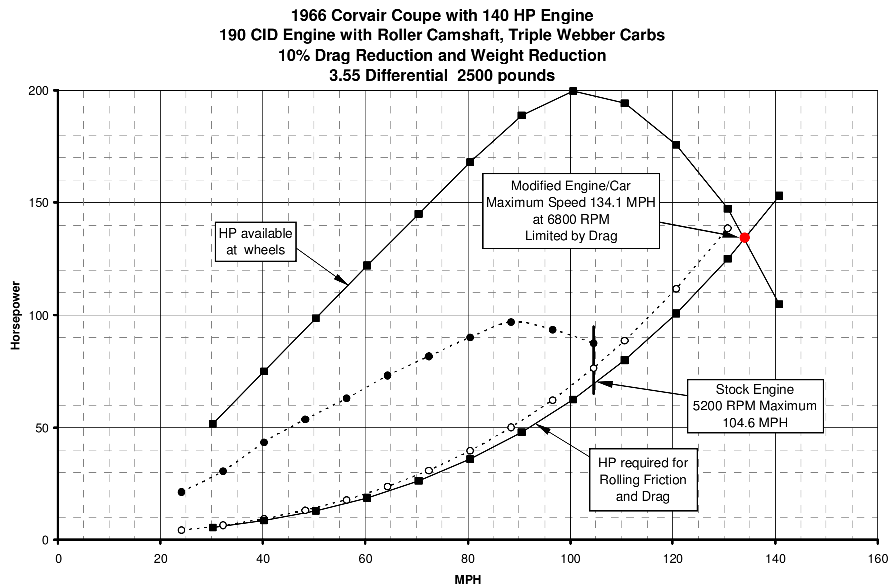


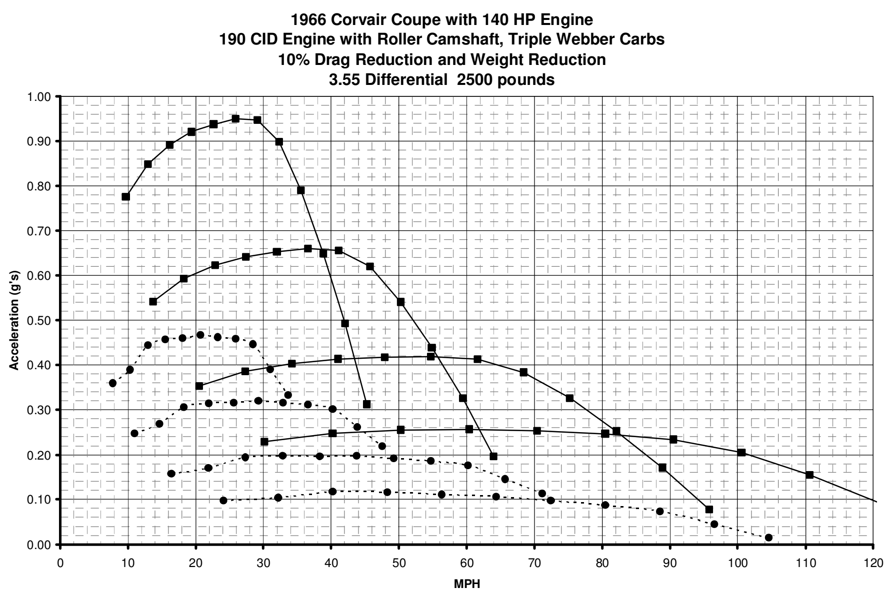


These charts illustrate the just how strong the effect of increasing the engine displacement is. A 15% increase in displacement resulted in nearly 30% increase in the horsepower delivered to the rear wheels. The acceleration also increased greatly. This modification is very effective in improving the car's performance.

8 Triple Webber Engine

A common modification to the Corvair engine used in racecars is the addition of triple Webber carburetors. This modification requires the removal of the stock intake manifolds from the heads. The Webber carburetors improve the intake of the air fuel mixture. Other modifications to this engine include improving the exhausting of the combustion gases. This is typically done by smoothing the passages in the head and slanting the exhaust tubes. The resulting engine has great potential for greater horsepower. As with the previous examples, this modification will build on the last. The following charts show the performance of one example of this engine.

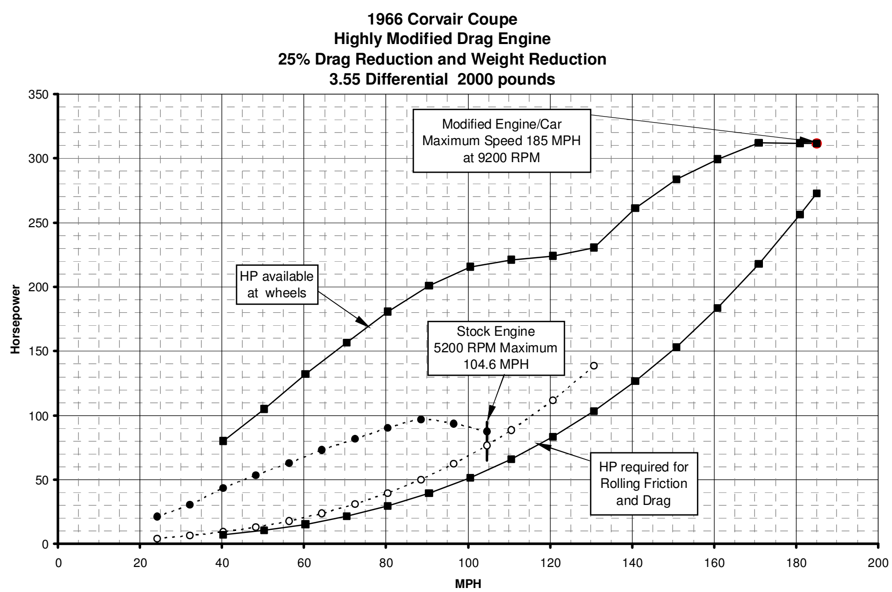


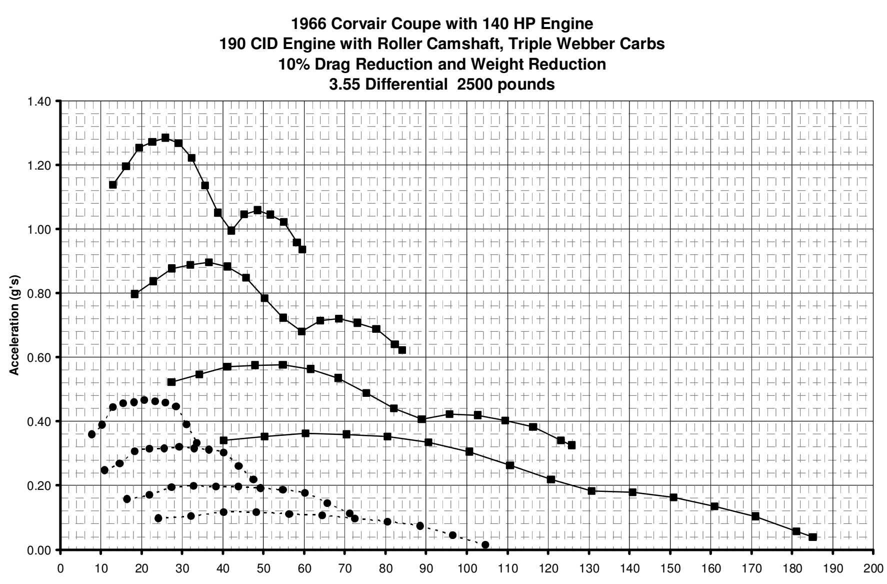


The maximum speed has increased 14 MPH and the maximum acceleration is nearly 1 g. This is testament to the capability of the engine with these modifications.

9 Corvair Dragster

As already discussed, the triple Webber engine has great potential. A version of this engine has already been presented with 200 HP at the rear wheels. The engine in this example is the extreme version of that engine. This engine was displayed at the 2005 Performance Workshop. The engine has had many modifications to enable it to provide 370 HP at 8700 RPM. This modification also includes a drag reduction of 25% and a weight reduction of 700 pounds. These figures represent the performance of this combination:

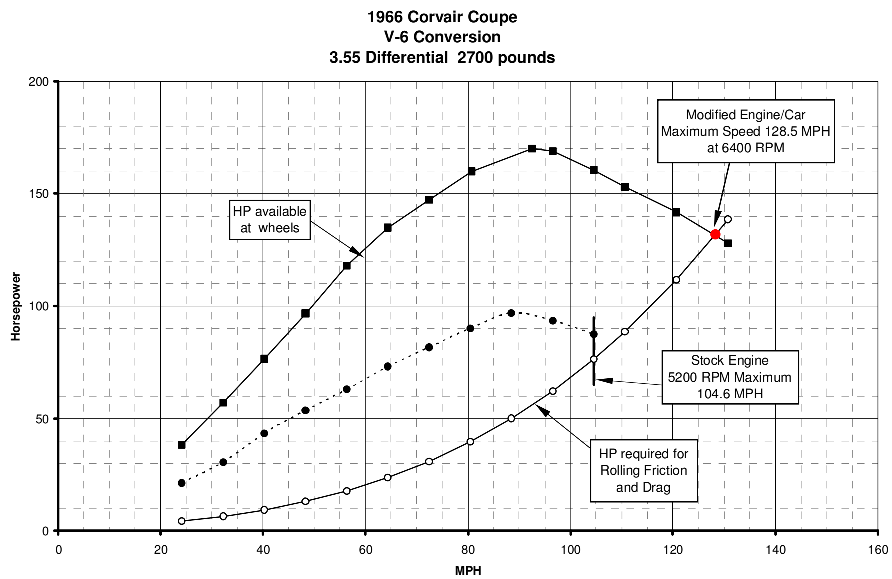


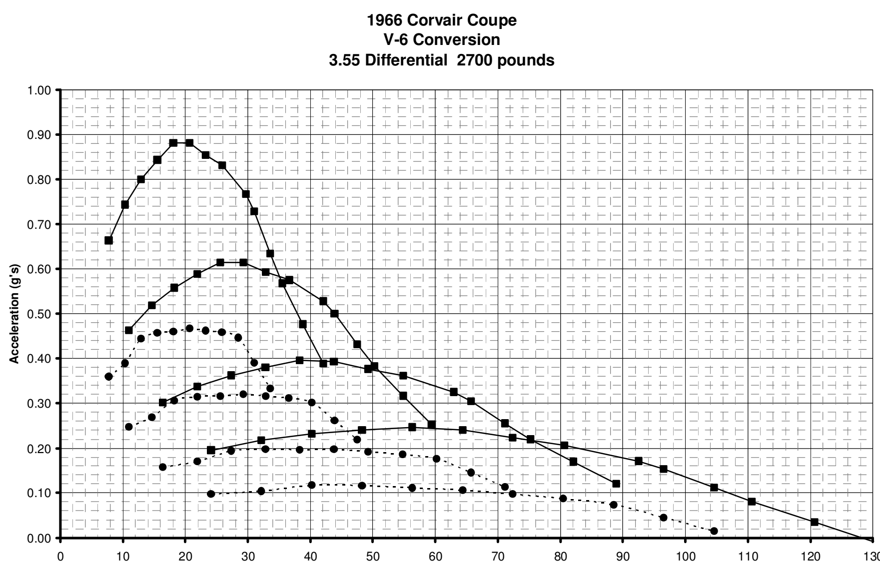


This engine has plenty of horsepower to overcome the losses due to aerodynamic drag. Using this data in an acceleration simulation resulted in a quarter mile time of 10.8 seconds at 128.3 MPH and a 0-60 MPH time of 2.8 seconds, enough said.

10 V-6 Engine Conversion

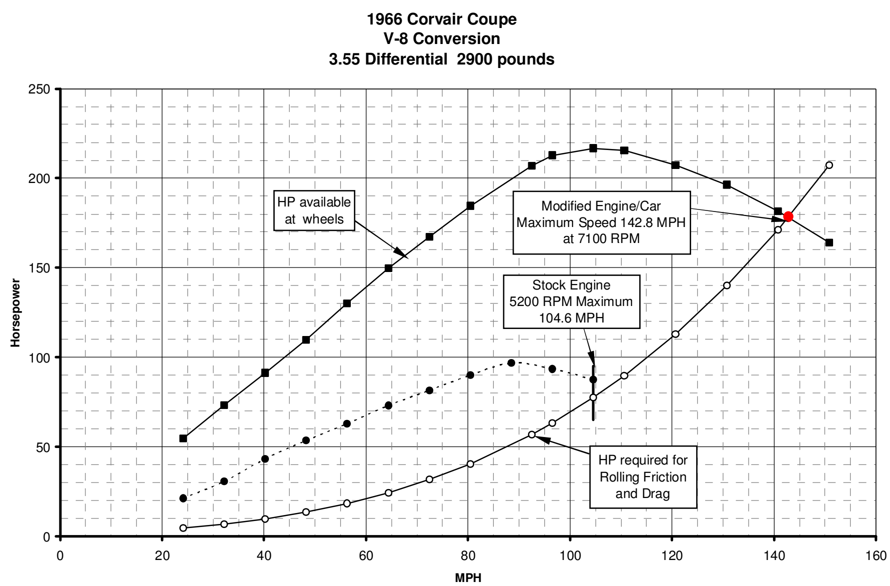
A few Corvairs have been modified by replacing the stock engine with a water cooled V-6. This modification is difficult as it requires the addition of a radiator and the related accessories. These engine replacements have been placed both behind and in front of the rear axle. These modifications also may use different transmissions and differentials. This modification is by no means easy. The following charts show the performance of a mildly prepared V-6 in an otherwise stock Corvair:

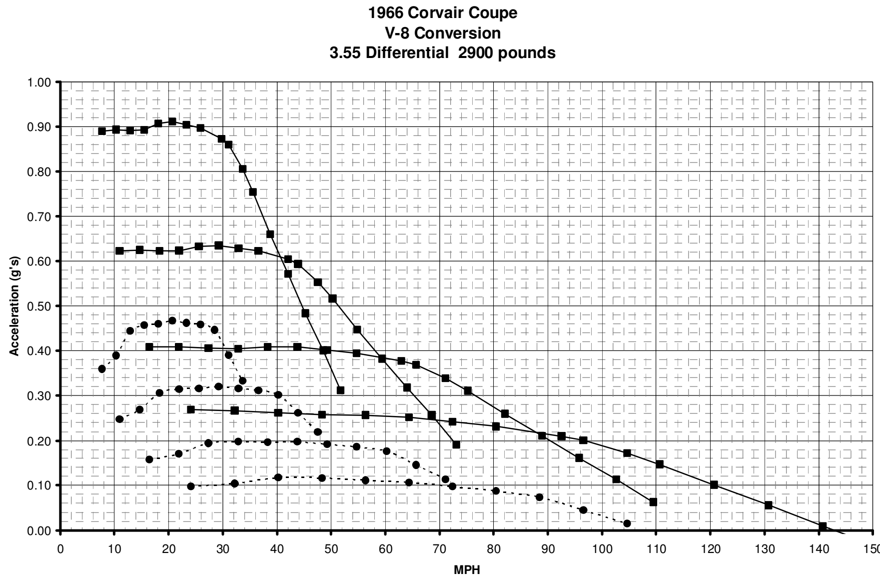




11 V-8 Engine Conversion

A similar engine swap to the V-6 conversion is one utilizing a V-8. As with the V-6, there are many different engine/drivetrain combinations and locations for the engine. Most conversions locate the engine in the rear seat area. Although, there are some that locate the engine in the front and in the stock engine location. Yet other conversions have used the Oldsmobile Tornado or even a Jaguar V-12. The goal is the same, more horsepower. The vehicle weight will most likely increase. However depending on the location of the engine, the weight distribution front to rear can be nearly 50/50. This modification has the same difficulties of properly installing a coolant system in a stock air cooled car. The rewards of this modification are great. The selection and availability of high performance parts for common V-8 are seemingly endless. The following charts present the performance of this conversion:




1966 Corvair Coupe
V-8 Conversion
3.55 Differential 2900 pounds
Acceleration (g's)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
MPH