

The Mysteries behind the Torque Converter

There are daily questions asked to me about torque converters and how they work. There are many factors that come into play. But First you need to know that a certain amount of fluid pressure has to be met inside the torque converter. At this point that pressure that is met then looks for the resistance against its self before moving the vehicle. That resistance against the pressure is where stall or slip to an RPM comes into play. Once the fluid pressure over comes that resistance, the torque converter then locks up and begins to move the vehicle. The fluid pressure is controlled by manipulating the fins on the inside of the torque converter and more drastically by the diameter of the torque converter. Because we are taking a mechanical out-put through a liquid and back to mechanical again. This calculation then becomes a physics equation. Like standing on the outside of a Merry-go-round, the fluid inside a torque converter is pumped through out it using centrifugal force. The larger the diameter torque converters will be effected more so by the increase or decrease of resistance. So, lets say that you are standing on the out-side of the Merry-go-round and it is turning at a fixed RPM. The least amount of change will effect your ability to hold on to the Merry-go-round. However, when you take one step in towards the center of the Merry-go-round, the pressure pulling you outwards drastically drops. In order to reach the same pressure inside the smaller diameter torque converter you must spin the Merry-go-round faster to both meet the pressure needed and to over come the resistances against moving that vehicle.

Knowing the above allows you to figure out that stall range is variable and will directly depend on the entire set-up of the vehicle. All of the information about

the vehicle is needed in order to match the set-up. The torque converter is by far the most complicated component you can purchase for a vehicle. (**engines set-up Vs. Weight of the vehicle Vs. Rear gear with the run out of the tire**) This is a good starting point. for more information and videos on this subject please visit our web-site www.accperformance.com We have a method of matching up stalls that pinpoints stall range with an accuracy of 99.5%. Let us help you pick the correct stall for you application and most importantly for how you want to drive your vehicle.

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intake. The 1 inch open spacer plate will give you a couple hundred more RPM at the Red Line or the top of the RPM range. The intake we are using for this example is like an Edelbrock Performer RPM dual Plane. (the “dual plane” means that the intake will have a divider from left bank of cylinders to the right & Left bank of cylinders or passenger or driver side cylinders.) The intake is advertised from 1,500 to 6,500 operating RPM range. It is just over 4 inches tall. This is taller than most factory intakes. Like a cam or ignition systems, even an intake has a power band. This power band is what we are interested in. This intake also has taller and longer intake runners than factory. This is a key factor in the discussion.

If you were to take a circle and draw a V in it where to show a power band as if it was on a circular Tachometer. When you add the intakes power band and the 1 inch open spacer plate the air flow begins to flow good about 2,600 RPM. This set-up will go to a red line of 6,600 to 6,700 RPM. As the operating range of the intake shows us above it starts to die out at 6,400 RPM. The 1 inch spacer gives it that extra couple of RPM. Now move the V in the circle tachometer to match the new set-up with-out distorting the V. What you see is the lower Power Band moves up in the RPM range making the bottom end (from 600 to 1,100 RPM or idle RPM) becomes weaker. This produces less resistance against the fluid pressure in order to move the car at idle. In fact that means that it actually lowers the stall range in the converter. Now in part 1 of this explanation we also learned about the centrifugal force. So with that in mind we know that these small changes will effect a larger diameter torque converter more so than it would the smaller diameter torque converter. The drop in actual stall will be greater in the larger diameter converter due to its pressures are much greater.

NOTE: In some cases you may find that the converter is stalling low or you can feel the transmission engage once the transmission has been put in gear. If you let your foot off of the break and the car begins to move, then it is most likely you will have to upgrade the torque converter. (if the vehicle creeps forward after it has warmed up that is OK.) If you have to fight the breaks at a red light or stop sign you will need to upgrade the torque converter. If you have idling problems with the AC on or have to fight the breaks again this is a stall issue that comes from not matching the torque converter to the **(engines set-up Vs. Weight of the vehicle Vs. Rear gear with the run out of the tire)** All stall ranges set-up in the torque converter are variable (they are not fixed)

TIP: A lot of people will advance their ignition timing to help aim the strength of the fire or power band down at a lower RPM so they may launch harder or idle better and in some cases just to get the vehicle to idle. Without an aftermarket ignition box that drastically increases the power band you will make the top part of the RPM band range (at the Higher RPMs) weaker. With the correct torque converter you would need to retard or lower the ignition timing back between 4 to 6 degrees from where it is. This does depend on how far advance it is from where it originally started at.

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The Mysteries behind the Torque Converter Revealed: Part 3

If you have read our earlier posts, you are probably thinking that choosing a torque convertor is a lot more complicated than you once thought. If you missed the posts, take a few minutes to catch up. The next variable in this equation is air flow, specifically in the heads and the exhaust.

Air flow, both in and out of the engine, has a direct effect on choosing the size and stall speed for our application. To dial this part in, we need to know how the engine breaths and how much back pressure is generated by the exhaust system configuration. The first thing we need to determine is which type of metal that the heads are made of, whether cast iron or aluminum. Cast iron heads, which are common on older vehicles, are very dense and hold in a great deal of heat. Aluminum heads, on the other hand, will dissipate heat at a much faster rate. The aluminum heads will generate more power due to having a lower temperature, which translates into more power. Now that we have determined our head material, it's time to get into the details. Starting off, you will need to know the combustion chamber size (Ex:64cc chamber) of the head in order to find out how fast the fuel is burning. Next, the valve size has a lot to do with how a 4-stroke engine works as well. A larger intake valve will allow for more fuel and air intake leading to a greater response to combustion. With a larger intake valve, you also need a larger exhaust valve in order to exhaust the spent gases. Smaller valves, by contrast, may increase resistance in how the engine breaths. If there is more resistance, then a higher stall is required. Less resistance lowers the stall. Large diameter torque converters will be effected by this more than the smaller diameter torque converters.

Knowing these factors, we then follow the air flow path to the exhaust system, starting with the manifold/headers. Depending on the air flow volume, we now turn our attention to the type and size of the exhaust system. These two factors contribute to back pressure within the exhaust system. All of these factors interact with the stall in the torque converter. Remember the torque converter works off of **Fluid Pressure Vs. Resistance**. Ultimately, we are

trying to find the resistance that is preventing the vehicle from moving. With less resistance, the torque converter will lock up at a lower RPM, because it will overcome the resistance against it more quickly.

Case Study

To put this into practice, we will use the following example. Our set up will include aluminum heads with 2.02 intake valves and 1.60 exhaust valves. This head will have a 64cc combustion chamber that burns fuel quickly. We will bolt on a set of 1 5/8" headers with a 2.50" collector pipe. From here we continue with 2.50" exhaust pipes, dual chamber mufflers and a cross-over pipe, also known as an 'H-pipe' exhaust system. This exhaust system will go all the way back to the rear bumper. With these parameters, there is less back pressure on the motor at low RPM and it will need to increase RPM to apply the back pressure needed to help overcome that resistance.

To understand the complexity of this calculation, consider that there are numerous types of exhaust systems that can affect the ultimate outcome:

1. Factory manifolds, Y pipe to a single pipe, single muffler, back to duals & out the back of the vehicle. This will have the most back pressure.
2. Factory manifolds, True dual exhaust, two mufflers, out the back. This is the second most restrictive system.
3. Headers, true dual exhaust, two mufflers, X-pipe configuration, then out the back is the 3rd most restrictive system.
4. Headers, true dual exhaust, two mufflers, H-pipe or cross-over pipe, then out the back is the 4th most restrictive system.
5. Headers, true dual exhaust, two mufflers, then out the back is the 5th most restrictive exhaust system.
6. Headers, no pipe or open headers is the least restrictive of these systems.

Special Note: With a 2.50" collector and a .500" lift cam that peaks at 6500 RPM, it will take nearly 5,000 RPM to get the proper back pressure with open headers. This means that if you put an exhaust system on this application you could see more low-end torque and be faster.

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If you have read our earlier posts, you are probably thinking that choosing a torque converter is a lot more complicated than you once thought. If you missed the posts, take a few minutes to catch up. The next variable in this equation is the weight of the vehicle and the true run out of the gear ratio and the height of the tire.

The curb weight or as the vehicle sits is what we will be using. Many times people will mistake curb weight for gross vehicle weight rating. The gross vehicle weight is the weight of that vehicle plus the additional weight that it is designed to carry, such as passengers, luggage and fuel. These all combine with the weight of the car to equal the gross vehicle weight. We must also remember that the torque converters' output comes from **Fluid Pressure Vs. Resistance**. The heavier the vehicle weighs, the more resistance that there is in moving it. Conversely, a lighter vehicle takes less resistance to move. This brings us to the resistance against the pressure that tries to move the vehicle. The more resistance (weight) against the torque converter, the higher the stall speed to move that weight. The less resistance against moving the vehicle, the lower the stall will be in the torque converter. To understand this principal, we will use a vehicle with a curb weight of 3550 lbs. that will tie all of these posts together.

There are many different choices when it comes to gear ratios. As the ratio gets larger, the engine has to turn more RPM to make the axle rotate the same number of revolutions. A 3.08:1 rear gear ratio would be considered a road gear for cruising or top end speed, as the engine turns the driveshaft 3.08 revolutions for every one revolution of the axle. Therefore, a 4.11:1 would be

considered a pulling gear for 4x4 vehicles to gain low-end torque. It is also a usable gear ratio to compensate for tall tires, commonly used for drag racing.

The height of the tire makes a big difference on actual output & the performance of the vehicle. Most ring and pinion gears are designed for a 26" overall diameter (OD) tire. That means for every 1.48xxx inches over 26" OD, you can take 1 whole gear set out (less) in order to get the final drive ratio. For our calculations and easier math, we round it up and use 1.5 inches over the 26" OD tire. As you can see in the picture below, the taller tire will travel further than the smaller tire with only one revolution.



If our test vehicle has a 3.73 rear gear ratio with a 26" OD tire, then the gear ratio will run true because of the tire height.

1. If we had changed the 3.73 gear to a 4.56 gear ratio, the torque converter would in fact stall less due to the lower resistance needed to move the vehicle.
2. With the 3.73 ratio, if we went from a 26inch tall tire to a 27.5" OD tire, the roll out of the tire will give us 3.55 rear gear output & performance. (that is 1 whole gear ratio less) **Note: NOS and Superchargers/turbos like the longer or lower gears to give them the time needed to load up.**
3. The same is true for the opposite, if you went to a 24.5" OD tire from the 26" OD tire, then your ratio will increase (that is 1 whole gear set more) to 3.90 output & Performance.

When considering gears & tire combinations, there is another factor that comes into play. That factor is **Rolling Resistance**. You can have too much

tire. An oversized tire or even tires with not enough air in them can hinder the performance and speed of the vehicle, not to mention that the actual weight of the oversized tire is higher. This is known as “unsprung” weight, which also includes the weight of the wheel, rotors and other rotating parts. This increased rotating mass robs horsepower. With the gear ratio and the rollout of the tire, you can better see how much resistance there is against moving the vehicle. That resistance & the diameter of the torque converter directly dictates how the torque converter stalls.

Using the combined knowledge of all of these posts will help you to understand that actual stall range is variable and will directly depend on the entire setup of the vehicle. We are getting closer to the set-up. All of the information about the vehicle is needed in order to match the set-up. The torque converter is by far the most complicated component you can purchase for a vehicle (**Engine set-up Vs. Weight of the vehicle Vs. Rear gear with the rollout of the tire**). For more information and videos on this subject, please visit our website www.accperformance.com. We have a method of matching up stalls that will pinpoint the stall range of your application with an accuracy of 99.5%. Let us help you pick the correct stall for your application and most importantly for how you want to drive your vehicle.

The Mysteries behind the Torque Converter Revealed: Part 5

Now we have covered the engines set up in part 1 In part 2 we have started on how the engine breaths and how that can affect the torque converter. Then in Post number 3 we checked out the heads and exhaust to finish up how the engine breaths. In post number 4 we talked about actual gear ratio Vs run out of the tire and how that affects the torque converter. If you missed the earlier posts, take a few minutes to catch up. We will be putting all of this information together.

Now we are moving into a complicated part that ties the engine torque curves and horse power together. Unlike most things you can't just turn it on and off. You have to match the cam with the rest of the vehicles setup and how you want to use it. An engine is a machine that has fixed parameters and is controlled by its components with the amount of fuel you give it. In order to have the best output all of the components must match or complement each other. All of the parts power bands or operating ranges must match each

other. Just one thing can throw the entire setup out of whack. This can cause a ruff idle, the car bogging down, not enough vacuum to operate the vehicle.

First you have to understand that a cam tells the valves in the heads when to open and when to close via the lobes.



The cam has several lobes all the way down the shaft. These lobes raise and lower the intake & exhaust valves. The 4 cycle engine works as follows;

1. The intake valve opens as the piston moves down and sucks the air & fuel into the cylinder.
2. The intake valve closes then piston begins to move up, it then squishes or compresses the air & fuel mixture.
3. As the piston rounds the top again, the spark plug fires and combusts the fuel / air mixture forcing the piston down.
4. The piston then rounds the bottom again as the exhaust valve begins to open to release the combusted fuel out the exhaust valve.

Each cam comes with an ID card call a “cam card”. This will have all of the cam specifications on it. The specs will show the distance or how far into the cylinder will push into the cylinder. Like .520 thousandths of one inch. There is also something called split lift where the intake is .520 the exhaust valve could be .528. There is also 2 different kinds of “duration” on a cam card. The first is advertised duration and the second is the duration at .050 thousandths of one inch.(also known as “at 50”) They are both informative, however the at 50 measurement is more descriptive on when the cam is going to begin its power band range. Then you come to the “Lobe Separation” & “Center Line” of the cam. This will tell you how choppy the cam is and its ability to idle. The lower the numbers go, it will diminish the vacuum and the engines ability to idle. The need for a higher stall increases as those numbers decrease. This just

shows some cams are designed with the same lift and exhaust depths into the cylinder. (Like .509 lift on the intake valve and .488 on the exhaust lift.) The greater the lift on these profiles or lobes will increase the distance the valve travels into the cylinder. This will allow a larger volume of air & fuel mixture in the cylinder for more power. The duration of the cam is dealing with how long the valves stay open and defines the power band. It also defines how the cam acts in this range we are calling the power band of the cam. Such 1,600 RPM to 5,800 RPM operating range. This cam will begin to make power from 1,600 RPM and the power will begin to fade out at 5,800 RPM. So it is very important that you match the cam with the rest of the components of the setup. Like an intake manifold that performs from 1,500 RPM and flows until 6,500 RPM would not match a 1,600 to 5,800 RPM cam. This miss match does effect the stall because in the case above the torque at idle is weaker. So the need for more stall increases depending on how far off you miss match the components for this setup. There are hundreds of cams for all types of vehicles and how they want to be driven. There are also flat tappet or hydraulic roller cams. Please **consult the manufacturer** of your choice anytime you are going to buy a cam. For our case study will use a specific cam and study how and why the cam can affect the actual stall RPM in the torque converter.

We are going to use a cam that has good street manners for drivability. At the same time we are adding more power through a longer RPM range than factory. This would be a .488 Intake & 510 Exhaust lift. The duration at .050 is .234 for the intake and .244 for the exhaust. The lobe separation is a .112. The operating range for this cam is 1,500 to 6,500 RPM. This cam is talked about as a mild cam or “a couple of steps over stock”. This cam will directly effect the stall in the torque converter by its duration and lobe separation. In this case it will draw down the stall 200 RPM from the duration at 50 starting at the .230 range. The lobe separation will further weaken the torque at idle dropping the stall an additional 200 RPM. A diameter change will be more than likely depending on the rest of the setup.

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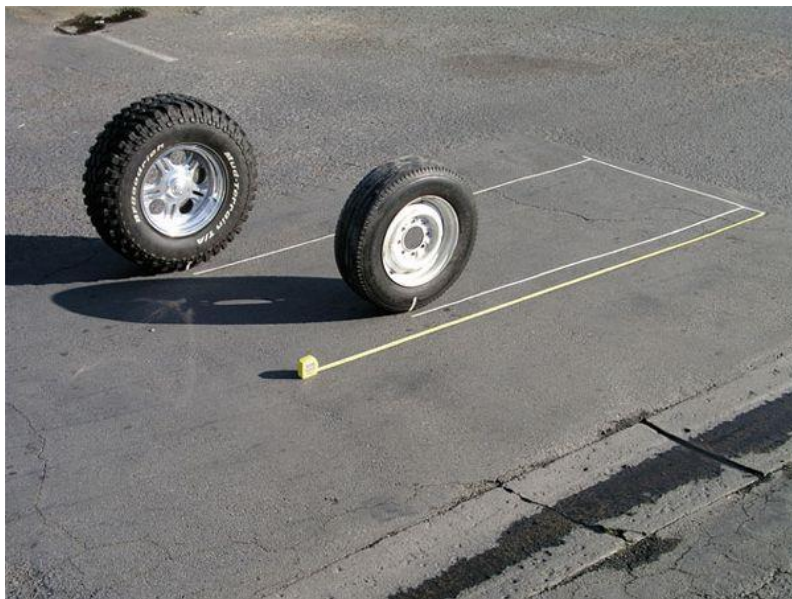
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The curb weight or as the vehicle sits is what we will be using. Many times people will mistake curb weight for gross vehicle weight rating. The gross vehicle weight is the weight of that vehicle plus the additional weight that it is designed to carry, such as passengers, luggage and fuel. These all combine with the weight of the car to equal the gross vehicle weight. We must also remember that the torque converters' output comes from **Fluid Pressure Vs. Resistance**. The heavier the vehicle weighs, the more resistance that there is in moving it. Conversely, a lighter vehicle takes less resistance to move. This brings us to the resistance against the pressure that tries to move the vehicle. The more resistance (weight) against the torque converter, the higher the stall speed to move that weight. The less resistance against moving the vehicle, the lower the stall will be in the torque converter. To understand this principal, we will use a vehicle with a curb weight of 3550 lbs. that will tie all of these posts together.

There are many different choices when it comes to gear ratios. As the ratio gets larger, the engine has to turn more RPM to make the axle rotate the same number of revolutions. A 3.08:1 rear gear ratio would be considered a road gear for cruising or top end speed, as the engine turns the driveshaft 3.08 revolutions for every one revolution of the axle. Therefore, a 4.11:1 would be considered a pulling gear for 4x4 vehicles to gain low-end torque. It is also a usable gear ratio to compensate for tall tires, commonly used for drag racing.

The height of the tire makes a big difference on actual output & the performance of the vehicle. Most ring and pinion gears are designed for a 26" overall diameter (OD) tire. That means for every 1.48xxx inches over 26" OD, you can take 1 whole gear set out (less) in order to get the final drive ratio. For our calculations and easier math, we round it up and use 1.5 inches over the 26" OD tire. As you can see in the picture below, the taller tire will travel further than the smaller tire with only one revolution.



If our test vehicle has a 3.73 rear gear ratio with a 26" OD tire, then the gear ratio will run true because of the tire height.

1. If we had changed the 3.73 gear to a 4.56 gear ratio, the torque converter would in fact stall less due to the lower resistance needed to move the vehicle.
2. With the 3.73 ratio, if we went from a 26inch tall tire to a 27.5" OD tire, the roll out of the tire will give us 3.55 rear gear output & performance. (that is 1 whole gear ratio less) **Note: NOS and Superchargers/turbos like the longer or lower gears to give them the time needed to load up.**
3. The same is true for the opposite, if you went to a 24.5" OD tire from the 26" OD tire, then your ratio will increase (that is 1 whole gear set more) to 3.90 output & Performance.

When considering gears & tire combinations, there is another factor that comes into play. That factor is **Rolling Resistance**. You can have too much tire. An oversized tire or even tires with not enough air in them can hinder the performance and speed of the vehicle, not to mention that the actual weight of the oversized tire is higher. This is known as "unsprung" weight, which also includes the weight of the wheel, rotors and other rotating parts. This increased rotating mass robs horsepower. With the gear ratio and the rollout of the tire, you can better see how much resistance there is against moving the vehicle. That resistance & the diameter of the torque converter directly dictates how the torque converter stalls.

Using the combined knowledge of all of these posts will help you to understand that actual stall range is variable and will directly depend on the entire setup of the vehicle. We are getting closer to the set-up. All of the information about the vehicle is needed in order to match the set-up. The torque converter is by far the most complicated component you can purchase for a vehicle **(Engine set-up Vs. Weight of the vehicle Vs. Rear gear with the rollout of the tire)**. For more information and videos on this subject, please visit our website www.accperformance.com. We have a method of matching up stalls that will pinpoint the stall range of your application with an accuracy of 99.5%. Let us help you pick the correct stall for your application and most importantly for how you want to drive your vehicle.

The Mysteries behind the Torque Converter Revealed: Part 5

Now we have covered the engines set up in part 1 In part 2 we have started on how the engine breaths and how that can affect the torque converter. Then in Post number 3 we checked out the heads and exhaust to finish up how the engine breaths. In post number 4 we talked about actual gear ratio Vs run out of the tire and how that affects the torque converter. If you missed the earlier posts, take a few minutes to catch up. We will be putting all of this information together.

Now we are moving into a complicated part that ties the engine torque curves and horse power together. Unlike most things you can't just turn it on and off. You have to match the cam with the rest of the **vehicles setup** and **how you want to use it**. An engine is a machine that has fixed parameters and is controlled by its components with the amount of fuel you give it. In order to have the best output all of the components must match or complement each other. All of the parts power bands or operating ranges must match each other. Just one thing can throw the entire setup out of whack. This can cause a ruff idle, the car bogging down, not enough vacuum to operate the vehicle.

First you have to understand that a cam tells the valves in the heads when to open and when to close via the lobes.



The cam has several lobes all the way down the shaft. These lobes raise and lower the intake & exhaust valves. The 4 cycle engine works as follows;

1. The intake valve opens as the piston moves down from the top of the cylinder and sucks the air & fuel mixture into the cylinder.
2. The intake valve closes before the piston begins to round the bottom to move up, as it moves back up the cylinder, it squishes or compresses the air & fuel mixture.

3. As the piston rounds the top again, the spark plug fires and combusts the fuel / air mixture forcing the piston down.
4. The piston then rounds the bottom again as the exhaust valve begins to open to release the combusted fuel out the exhaust valve.

Each cam comes with an ID card call a “cam card”. This will have all of the cam specifications on it. The specs will show the distance or how far into the cylinder the valve will push into the cylinder. Like .520 thousandths of one inch. There is also something called split lift where the intake is .520 the exhaust valve could be .528. There is also 2 different kinds of “duration” on a cam card. The first is advertised duration or over all duration of the cam. The second reading for the duration is the duration at .050 thousandths of one inch (also known as “at 50”) of the stroke into the cylinder. They are both informative, however the “at 50” measurement is more descriptive on when the cam is going to begin its power band range. Then you come to the “Lobe Separation” & “Center Line” of the cam. This will tell you how choppy the cam is and its ability to idle. The lower the numbers go, it will diminish the vacuum and the engines ability to idle. The need for a higher stall increases as those numbers decrease. This just shows some cams are designed with the same lift and exhaust depths into the cylinder. (Like .488 lift on the intake valve and .509 on the exhaust lift.) The greater the lift on these profiles or lobes will increase the distance the valve travels into the cylinder. This will allow a larger volume of air & fuel mixture in the cylinder for more power. The duration of the cam is dealing with how long the valves stay open and defines the power band. It also defines how the cam acts in this range we are calling the power band of the cam. Such 1,600 RPM to 5,800 RPM operating range. This cam will begin to make power from 1,600 RPM and the power will begin to fade out at 5,800 RPM. So it is very important that you match the cam with the rest of the components of the setup. Like an intake manifold that performs from 1,500 RPM and flows until 6,500 RPM would not match a 1,600 to 5,800 RPM cam. This miss match does effect the stall because in the case above the torque at idle is weaker. So the need for more stall increases depending on how far off you miss match the components for this setup. There are hundreds of cams for all types of vehicles and how they want to be driven. There are also flat tappet or hydraulic roller cams. Please **consult the manufacturer** of your choice anytime you are going to buy a cam. For our case study will use a specific cam and study how and why the cam can affect the actual stall RPM in the torque converter.

We are going to use a cam that has good street manners for drivability. At the same time we are adding more power through a longer RPM range than factory. This would be a .488 Intake & 510 Exhaust lift. The duration at .050 is .234 for the intake and .244 for the exhaust. The lobe separation is a .112. The operating range for this cam is 1,500 to 6,500 RPM. This cam is talked about as a mild cam or “a couple of steps over stock”. This cam will directly effect the stall in the torque converter by its duration and lobe separation. In this case it will draw down the stall 200 RPM from the duration at 50 starting at the .230 range. The lobe separation will further weaken the torque at idle dropping the stall an additional 200 RPM. A diameter change will be more than likely depending on the rest of the setup.

Using the combined knowledge of all of these posts will help you to understand that actual stall range is variable and will directly depend on the entire setup of the vehicle. We are getting closer to the entire set-up. All of the information about the vehicle is needed in order to match the set-up. The torque converter is by far the most complicated component you can purchase for a vehicle **(Engine set-up Vs. Weight of the vehicle Vs. Rear gear with the rollout of the tire)**. For more information and videos on this subject, please visit our website www.accperformance.com. We have a method of matching up stalls that will pinpoint the stall range of your application with an accuracy of 99.5%. Let us help you pick the correct stall for your application and most importantly for how you want to drive your vehicle.