MAINLINE DynoLog Dynamometers
SMART DYNO TECHNOLOGY

Dyno Torque Figures – "The Truth"

On the common types of Chassis Dyno's we see here in Australia, (Mainline DynoLog or Dyno Dynamics), both of these dyno's, calculate power at the roller in the same fashion. That is, we measure Roller RPM and Roller Torque and these two variables are used in the traditional Power calculation formula, either metric or imperial, you get the same result:

HP (@ roller) = (roller torque ft/lbs x roller rpm)/5252

Or

kW (@ roller) = (roller torque Nm x roller rpm)/9543

When the term Roller Torque is used, this means we are measuring Torque from a Load Cell that is attached in some fashion to the Retarder (Eddy Current Retarder/PAU) that is coupled to the Drive Rollers (the knurled rollers). The Retarder applies a braking force to the Rollers, and since the Retarder Frame is restrained from turning by the Load Cell, the force is transferred into the Load Cell which measures force in typically Kg or pounds force. The length of the arm the Load Cell is attached to is precisely known, so, with force over a given length, we can determine "Torque" in Nm or Ft/lbs.

Roller RPM is usually measured by an Inductive speed sensor of some type, or a Shaft Encoder, or in the old days on a Vane Dyno, a Tacho generator.

These two inputs are used by the Dynamometer Control System to calculate the Power. Now, because we measure Torque down in the Dyno bed from a device that is coupled to the Roller, **ANY** gear multiplication, or gear reduction, will influence the Torque measured at the Roller. So some variances that come into the equation are:

- Torque Converter slip ratio
- Transmission ratio
- Differential ratio
- Tyre size
- Roller size

These variables all influence the Torque as measured at the roller. Some people will then initially think, the lower the gear, the more Torque, so the more Power we will make, **THIS IS NOT TRUE.**

Remember the formula for calculating Power, we have Torque **AND RPM**, so if we use a lower gear ratio, the corresponding Roller RPM will be reduced by the same factor as the Torque is increased, so we end up with the same power. This is a purely mathematical explanation.

The reason some of the confusion happens in regards to Torque (roller torque) on a Chassis Dyno, is there are two common sizes of rollers used on dyno's here in Australia, those being 219mm or 273mm (these are raw, un-machined sizes).

The larger diameter roller will have a higher Torque reading at a given Road Speed, but have a corresponding lower Roller RPM, the torque value increase will be the difference in Roller Diameter, we've done the maths for you, and the 273mm roller will have 24.6% more torque.

What this means is, a particular car may have 200RWKW, but it may have 500Nm on a 219mm roller, but 623Nm on a 273mm roller.

We now need to understand the Torque that gets to the roller, and why it is normally higher than at the Crank. Remember we listed all the things that will influence the Torque at the Roller, Gearbox Ratio, Diff Ratio, Tyre size etc. If we simplify it somewhat, we'll use a gearbox ratio of 1:1 in the following example, and we are not accounting for driveline loss in this example.

Take a traditional LS1, a torque figure of 530Nm is quoted at the crank. If the Gearbox Ratio is 1:1, so we have 530Nm going into the diff, now if we have a diff ratio of 3.46:1 (this is a gear multiplication), we then have 1833Nm at the axles. (Those that have had their cars dyno'd on a Dyna Pack Hub Dyno will be accustomed to these numbers). The next step in the Torque journey is the Tyre to Roller ratio.

This is where the Dyno Roller size will affect this value. If we transfer the 1833 axle Nm thru a 650mm tyre to a 219mm roller (this is now a Gear Reduction), this ratio is 1:2.968, so we divide our 1833 by 2.968, gives us 617.58Nm on a 219mm Roller.

In the case of a 273mm Roller, our ratio is 650/273 = 2.3809, so we divide the 1833 axle Nm by 2.3809 giving us 769.87Nm roller Torque on our 273mm roller.

Remember the larger roller will be doing less rpm at a given road speed, so the same power will be present.

To simplify this somewhat, both Dyno manufacturers have a term that makes the differences in Roller sizes a non-issue, this term is Motive Force on a Mainline DynoLog, or Tractive effort on a Dyno Dynamics. Motive Force/Tractive Effort is a Calculation (this where some dyno operators get it wrong, they believe the dyno measures Tractive effort).

Motive Force/Tractive Effort is calculated as such, Roller Torque/Roller Radius, so in our example above, we have 617.58Nm / 0.1095metres (radius of 219mm roller) giving us 5640 Newtons (not Newton Metres as Newtons are related to a linear force , Newton Metres are related to a twisting Force). On our large roller, we have 769.87Nm / 0.1365 giving us 5640 Newtons.

So a Dyno with 273mm diameter rollers will have Roller Torque figures approximately 24.6% higher than a Dyno with 219mm rollers, but both dyno's would show the same Power and Motive Force.

In order to simplify the Torque values even further, both Dyno Manufactures have what we term "Derived Torque", which is a calculated value based of RWKW and "Engine

RPM", this calculated "Derived Torque" takes any gear multiplication out of the equation, so one very good way of using Derived Torque is, if you have a particular car that had 3.46 diff gears, and has now been changed to 3.7, the Derived Torque value will not be affected, whereas the Roller Torque will, due to the fact the overall gearing of the car has changed.

On a Mainline DynoLog, the user has 4 available RPM signals available to the software for it to Calculate the Derived Torque, Tacho RPM (ie HT lead, injector trigger etc), OBDII Tacho RPM, ECU Serial/CAN Data Stream, or lastly, Derived RPM from the Roller Speed. The first 3 options will provide very accurate Derived Torque values, whereas using Derived RPM (which is based on a ratio of vehicle dashboard tacho against roller speed), will not be very accurate on a Automatic car due to the varying slip ratio of a torque convertor, but will be accurate at whatever point the Derived RPM figure was set. Dyno Dynamics also have a version of Derived Torque; we believe it's just called RWNm or just Torque Nm on a Graph when printed.

While we always suggest that users of our system should use use Derived Torque on a Report given to customers, they can do as they please, and a lot just use and/or print Roller Torque. It only takes a few seconds to choose to display Derived Torque.

All of our reports do report Motive Force, so for a comparative point of view to a Dyno Dynamics Dyno Graph, compare the Tractive Effort to Motive Force on a Mainline DynoLog.

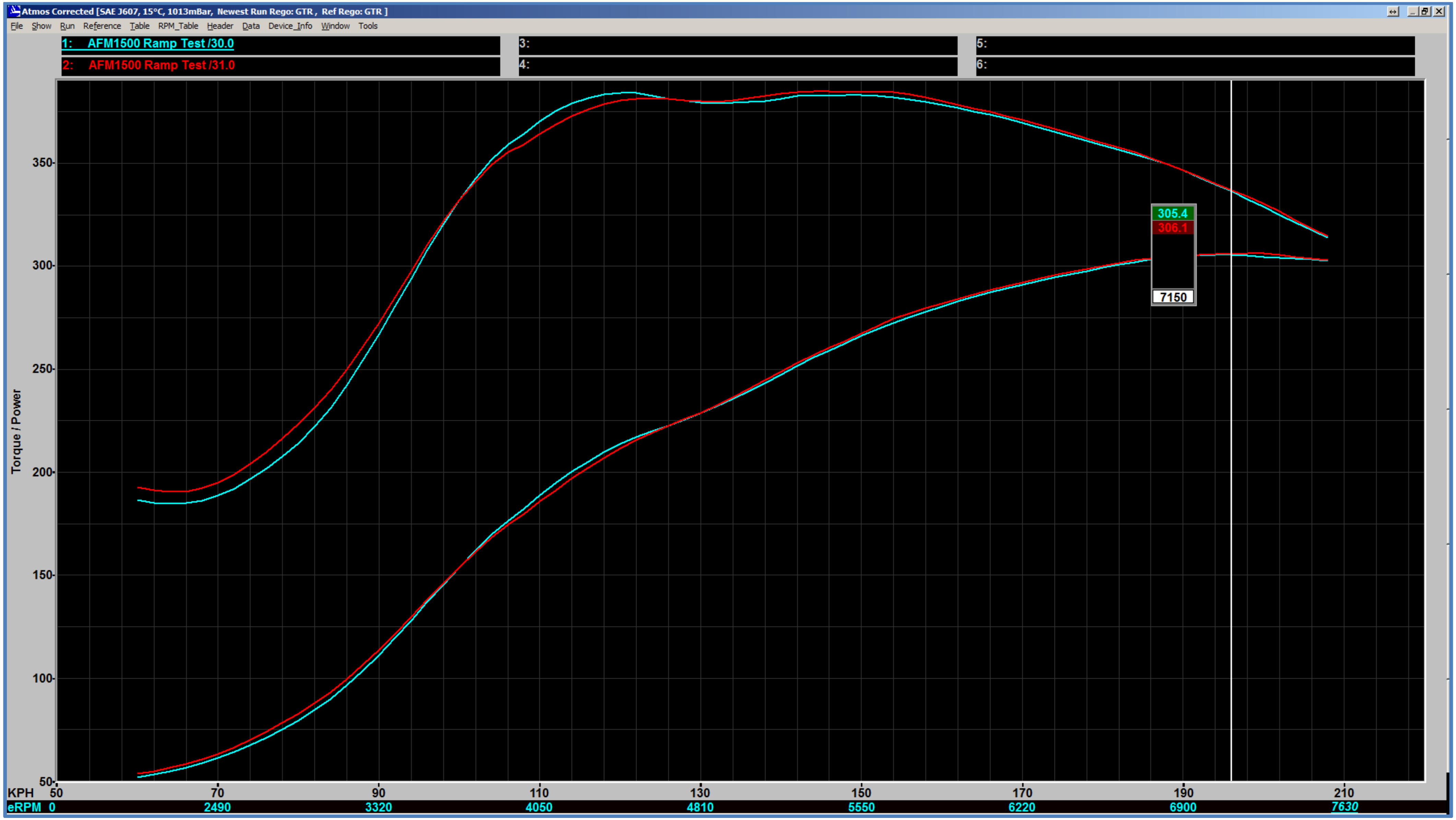
Now something to remember, the Motive Force or Torque trace, has the exact same shape curve when compared on a similar Graph Scale. Also, the Derived Torque shape will be the same shape as Roller torque for a manual car, but can be quite different and more "manual" car looking for an Automatic car.

Another benefit of displaying Derived Torque, that is you are a Horsepower and Foot Pounds of Torque junky, instead of kW and Nm, the Derived Torque and Horsepower will cross at 5252rpm, (just like it does on an Engine Dyno).

Below are a couple of Graphs showing the differing ways in which Torque/Derived Torque/Motive is displayed on a Mainline DynoLog Dynamometer. These examples are the exact same runs, but showing the different displays of Power, Torque, Derived Torque, and Motive Force. Engine speed is eRPM, which is sourced from the vehicle's ECU RPM data, logged in to the Dyno software.

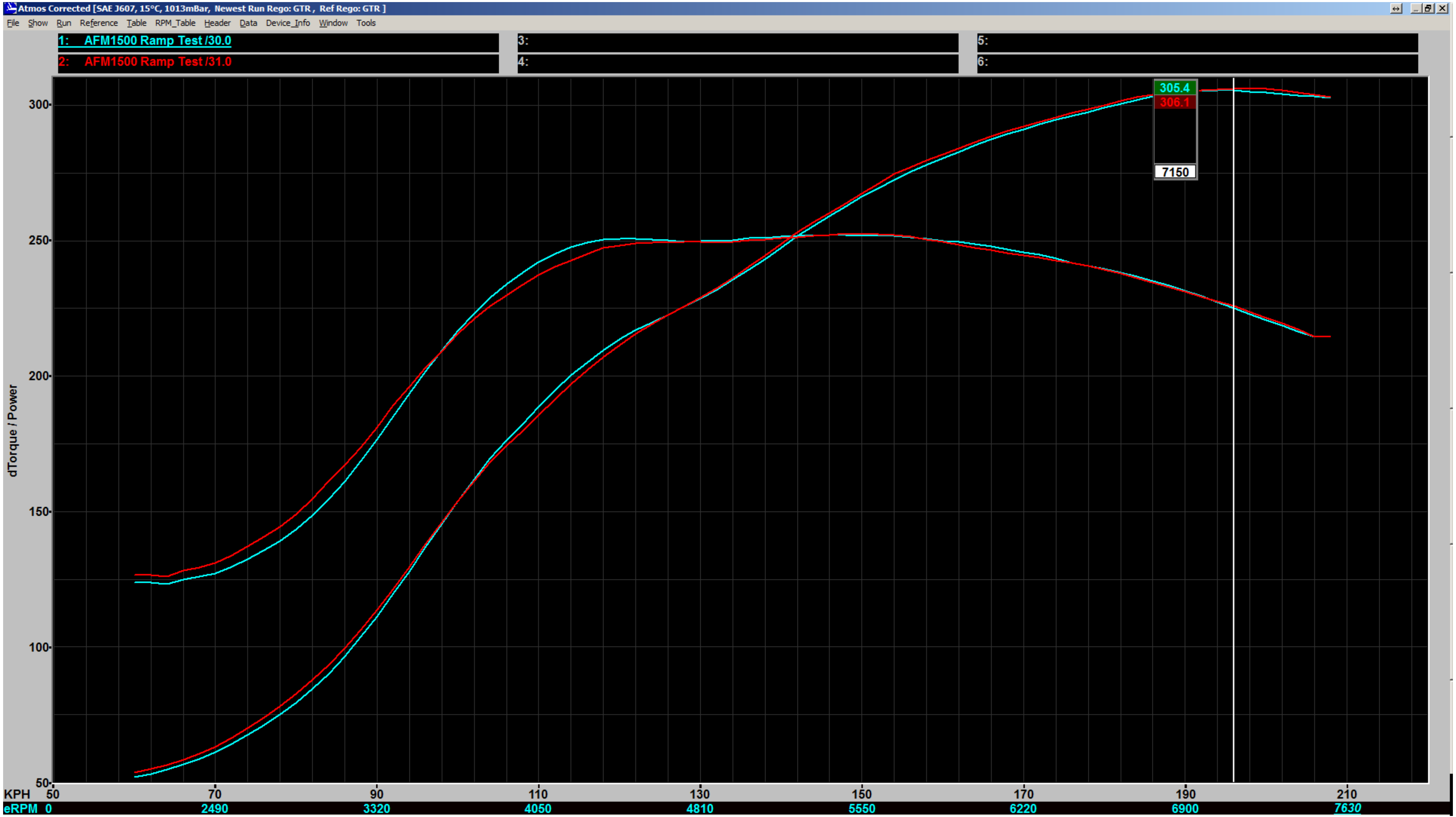
Power and Roller Torque:

(Power = Hp Torque = Ftlbs)



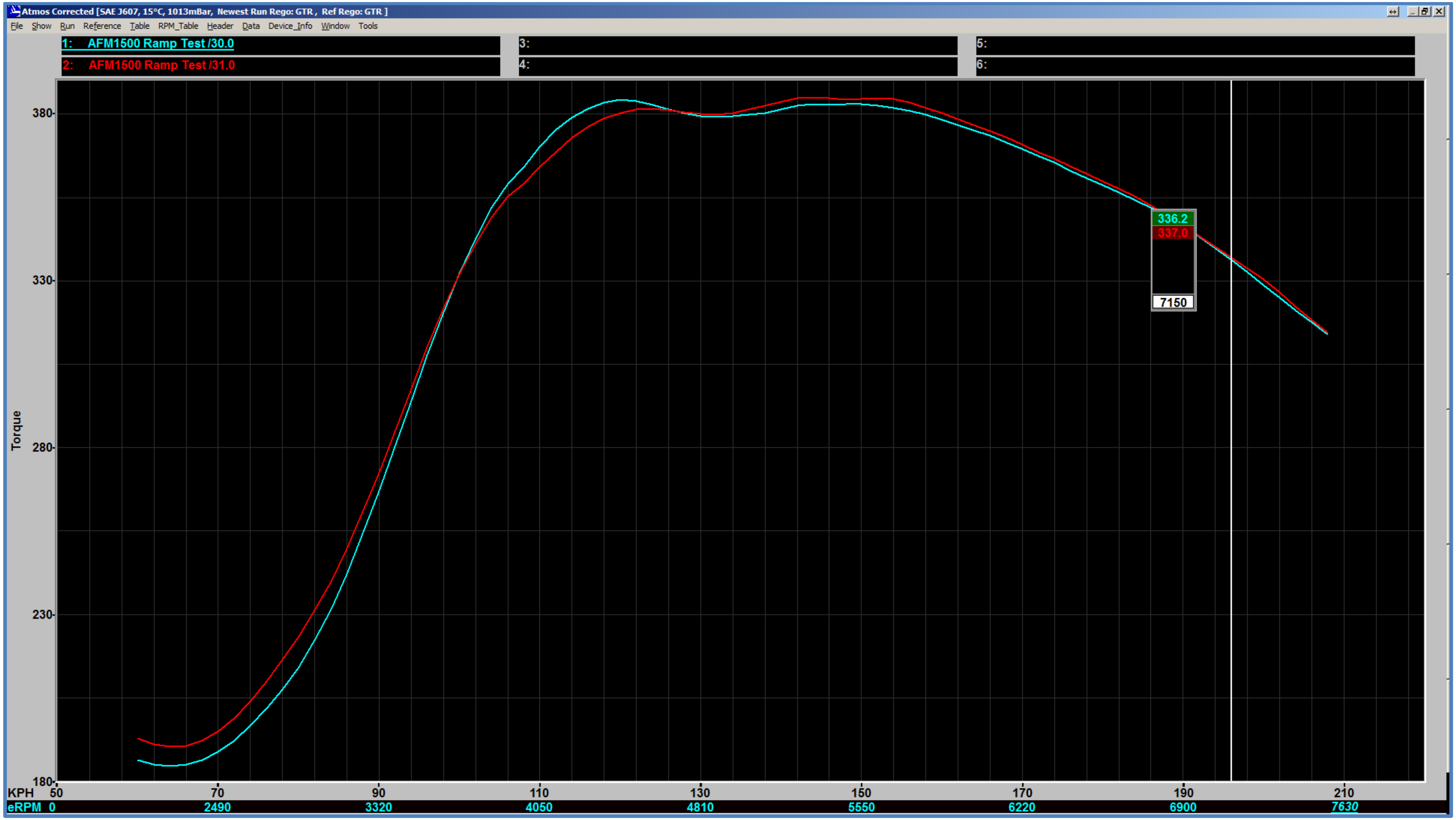
Power and Derived Torque:

Power = Hp Torque = Ftlbs)



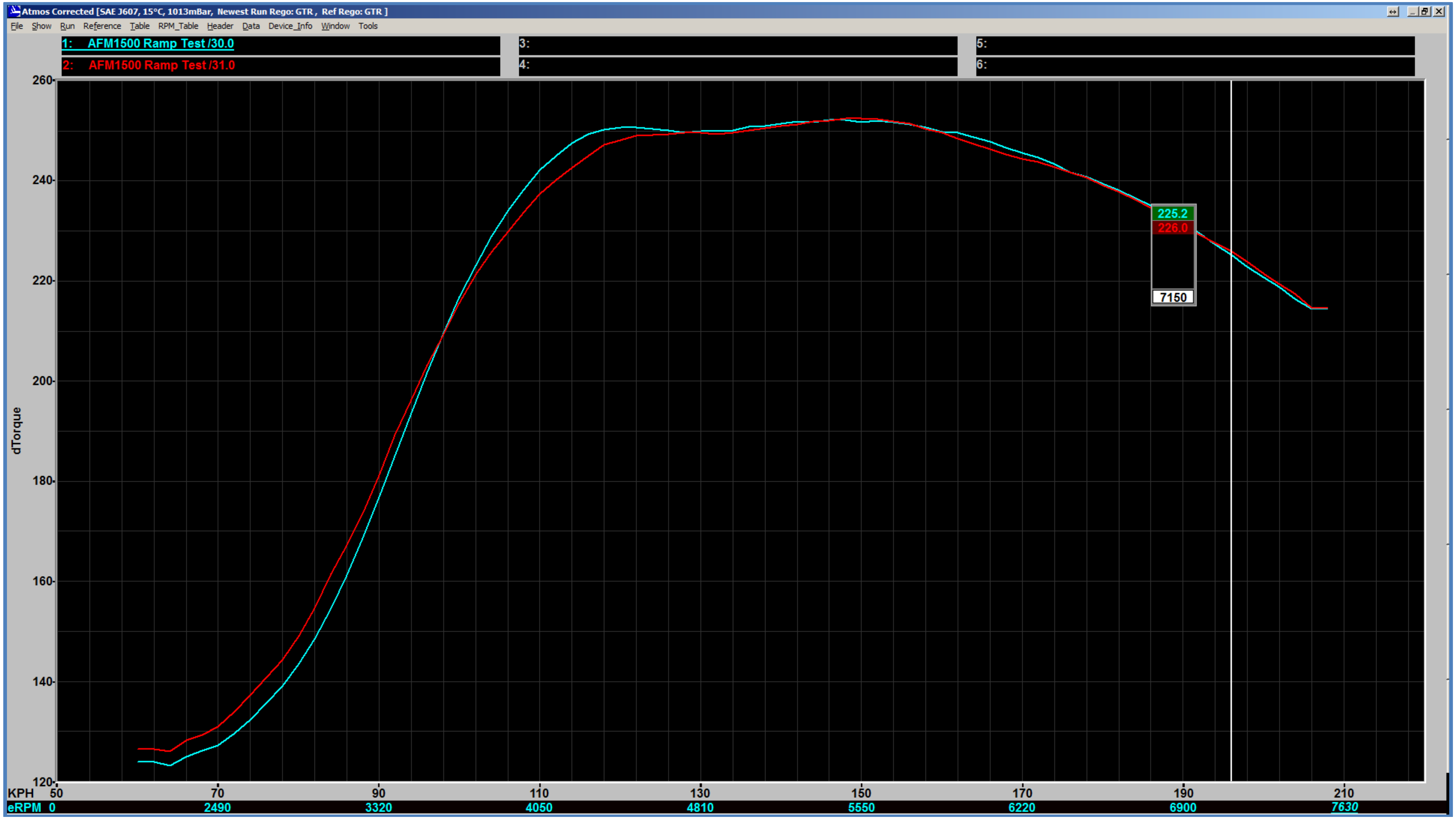
NOTE: *Power and Torque will "Crossover" at 5252 engine rpm* (When imperial units of measure are used)

Roller Torque Only:
(Torque = Ftlbs)



Derived Torque Only:

(Torque = Ftlbs)



Motive Force Only:

(Motive Force = Lbs)