Looking for Lost Horsepower by Larry Linder

Several weeks ago we had a chassis dynamometer get together at Precision Autosports on Factory road in Beavercreek. The shop is run by Jeff Whitman and his partner. Both very knowledgeable and considerate fellows. They are also very careful of your car - they are car guys too. I have known Jeff and his wife since they were in grade school.

The chassis dyno is a good way to see how your car runs without abusing it as you would do on a drag strip. The process is to tie the car down securely; we don't want to launch one out the door and into the creek. There are two tie downs in the rear and two in the front at a 15 degree angle. Once the car is secure with the tires on the dyno rollers so it can spin the roller. A large fan is set up in front of the car to simulate moving air through the radiator. There is one connection made to the ignition and that is a clip-on probe to get a good ignition signal for measuring RPM. This also allows a revlimiter to be programmed. The operator has a hand held control with a green light button that signals a start and a red light button that tells him when to lift his foot.

The operator sits in the drivers seat, he drives the car and shifts threw the gears until he gets to 4th or a direct drive gear. Once the computer in the dynamometer gives a green light and starts measuring the torque, the operator merely holds the throttle to the floor till the red light comes on and he then takes his foot off the gas. You can see what your car looks like at near red line in high gear - at well over 127 MPH.

Truths:

An engine produces power by burning fuel. The weight of the fuel/air burned is proportional to power - too rich or too lean and power drops off. Volumetric efficiency is the other term. This is how much fuel/air the engine can ingest compared to its displacement. An air/fuel ration of 18.1 is considered lean and is too lean for a carbureted engine but good for maximum economy. An air/fuel air ration of 14.33 is stoichiometric (chemically correct) producing $CO_2 + H_2O + N_2$ and is the point where the combustion is most complete. Maximum power requires an excess of fuel to make sure all of the air is consumed with the added fuel in the form of HC+ CO. This air/fuel ratio is 13.33 to 12.5 with 13.33 the ideal number. This is due to the fuel's molecular structure - so much for the chemistry review.

Old HP vs New HP:

The old HP for advertisements was brake HP at the flywheel with no accessories, no water pump, no alternator etc. The new HP ratings are net and are as installed with all accessories. The chassis dynamometer is a lower net rating because the efficiency of the intake air filter, exhaust system, gear box, differential, tires and all other parasitic are included. It is also how you normally drive your car on the street.

Test Data:

The test data shows the plots of Torque, vs. RPM. HP is calculated using the speed and torque. Peak torque, and peak HP are calculated by the dynamometer computer. The air/fuel ratio is measured by a heated oxygen sensor -

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this is sniffed by the little copper tube put up the tail pipe. All data is electronically smoothed. The most important measurement is the air/fuel ratio.

Actual Tests:

This is neat stuff; there are no winners and losers in the test. Sure we compare numbers but the object is to see how your engine makes HP and ways to improve it. It was a very enlightening experience to say the least. It was easy to see what made HP and what didn't. Each plot contains two dyno runs, each run has the torque, HP, and air/fuel ratio plotted. The color plots are a lot easier to read.

66' 390 HP 427 cid: (Plots 1 and 2)

The 390 HP 427 had a 750 CFM Holly instead of the stock 600CMF, an aluminum intake, new distributor, side exhaust and few other things that were visible. The HP output was not as good as we hoped it would be. The air/fuel ratio told the complete story. Off idle wide open throttle the fuel air ration went very lean, it was lean in the 1 - 4 K RPM range and went dead lean at the top end. The primary jets were changed to a larger size and the fuel pressure was set to 4.5 lb. so we didn't overload the needle and seat. This brought the fuel air ratio in the mid RPM range closer to 13.3. The secondary had the right size jets - same as what GM delivered with the engine - imagine that. The secondaries were not opening soon enough to supply more fuel to the engine. A much lighter secondary vacuum diaphragm spring was installed and the next test it ran worse. The secondary vacuum diaphragm was disassembled and we found the spring was out of place. This was fixed and we made another test run. The improvement was pretty dramatic with a 20 HP gain in power. The final fuel air ratio was . a little rich but not by much. The off idle bog and lean fuel air ratio could be helped with a different accelerator pump cam on the Holly. It also showed why the 390 HP 427 engine was originally equipped with a 600 CFM and not a 750 as in the test. The 750 never fully opened and a 600 CFM would be fully open and the off idle problem would be gone.

66' 350 HP 327 cid: (Plot 3)

The 38 years ago the 350 HP 327 had the heads ported/polished, the 600 CFM Holly ventures resized, the intake manifold and exhaust manifolds were flow matched to the heads, 2 1/2 exhaust system and factory off road under car mufflers. The rest was as delivered by GM. The bias ply tires cost a lot of rear wheel HP. The fuel/air ratio was almost 13.4 all the way to redline. The head and manifold improvements are worth about 100 HP at the flywheel and 50 hp at the rear wheels.

65' 425 HP 396 cid: (Plot 4)

The 425 HP 396 was a very original and car without any engine modifications. The bias ply tires cost a lot of HP on this car too. The more HP output the more the tires lose. The air / fuel ratio was almost 13.4 all the way to redline. This would indicate that the only way to get more power was to improve the volumetric efficiency by head, manifold modifications and the cam

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07' 405 HP 366 cid: (plots 5 and 6)

The 2007 with 387 HP at the rear wheels blew us all away. This was 30 HP increase over the stock exhaust. It was very apparent that

the engineers at Chevrolet new how to improve the volumetric efficiency of this engine. With the stock exhaust system the fuel air ration went a little rich at the top end. After the exhaust modifications the fuel air ratio was perfect as the computer adjusted it for load, temperature and fuel condition. The only draw back was the total noise - yes it was a lot louder.

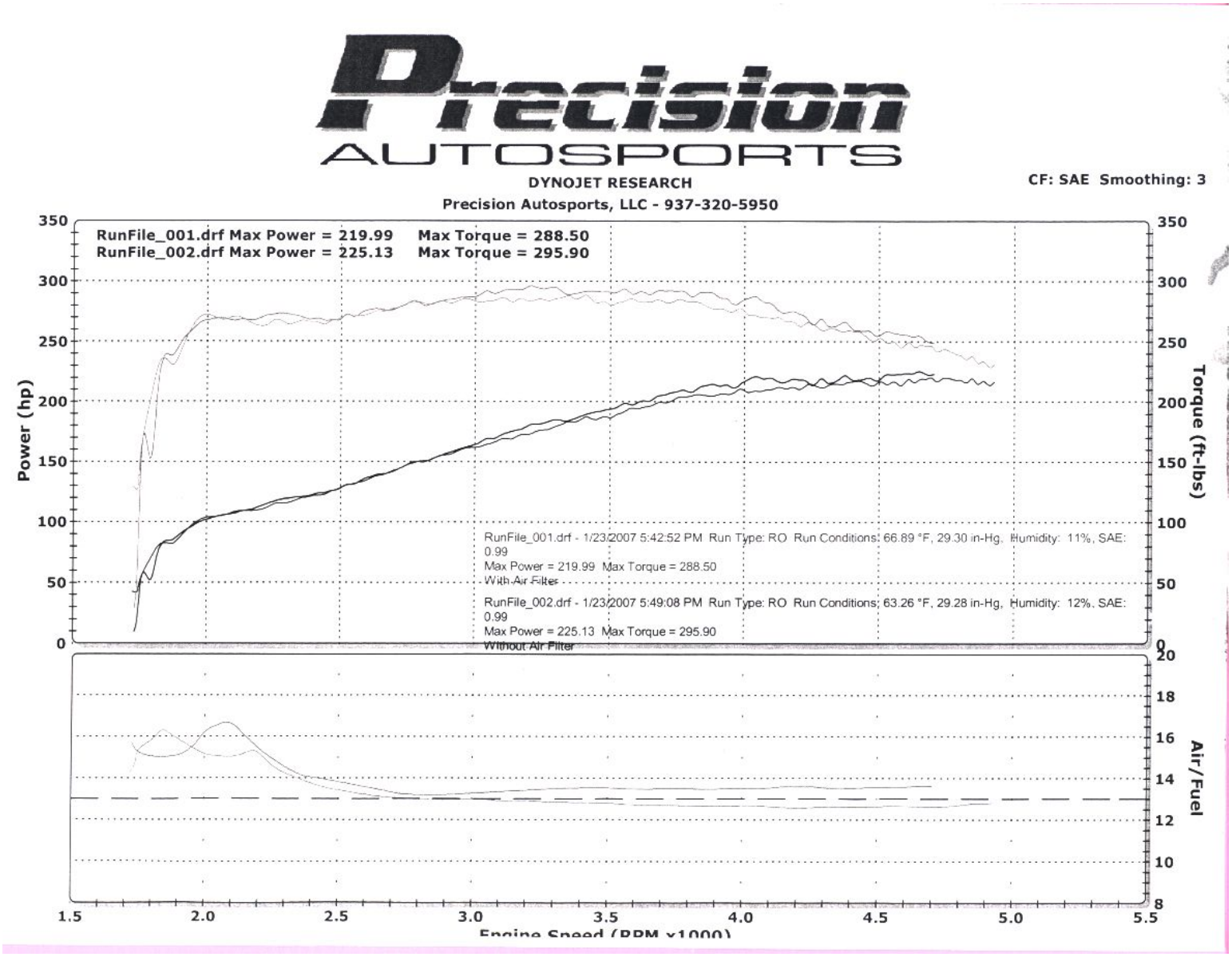
Conclusions:

Once the fuel air ratio was correct no more HP could be had by changing the tune of the engine. Internal and external changes were required to improve volumetric efficiency. The stock air filter was worth 4 to 5 HP on the older cars. This was comparing a good stock paper element and no filter. The base plate was left in place. On the carbureted cars you could see the standing cloud of fuel vapor over the carburetor on the 327 and 396. It also points out the merits of ram manifolding and fuel injection.

This is the first of several parts of the Search for the Lost HP.

Larry

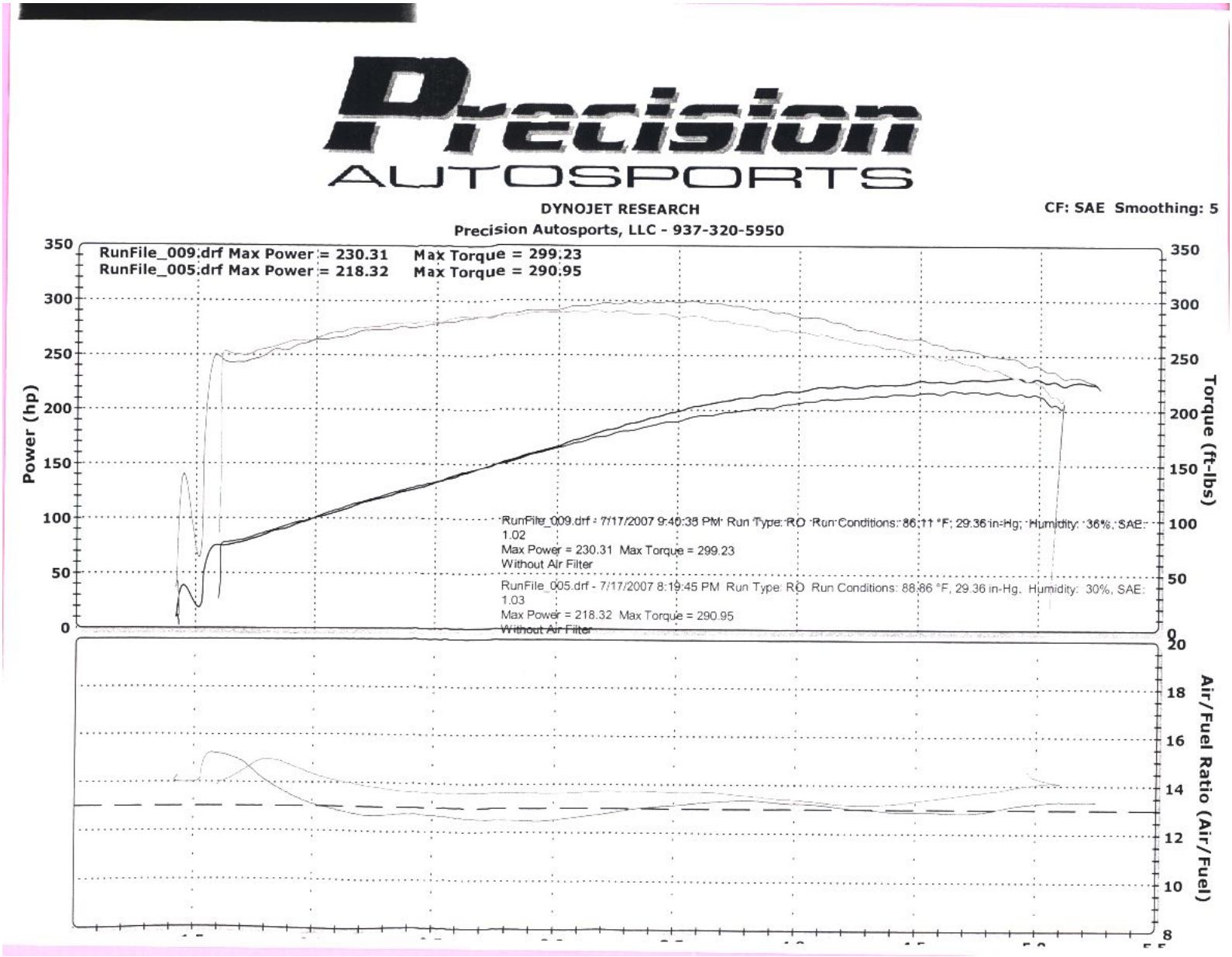
Dyno Plot 1



66' 390 HP 427 cid

First Run

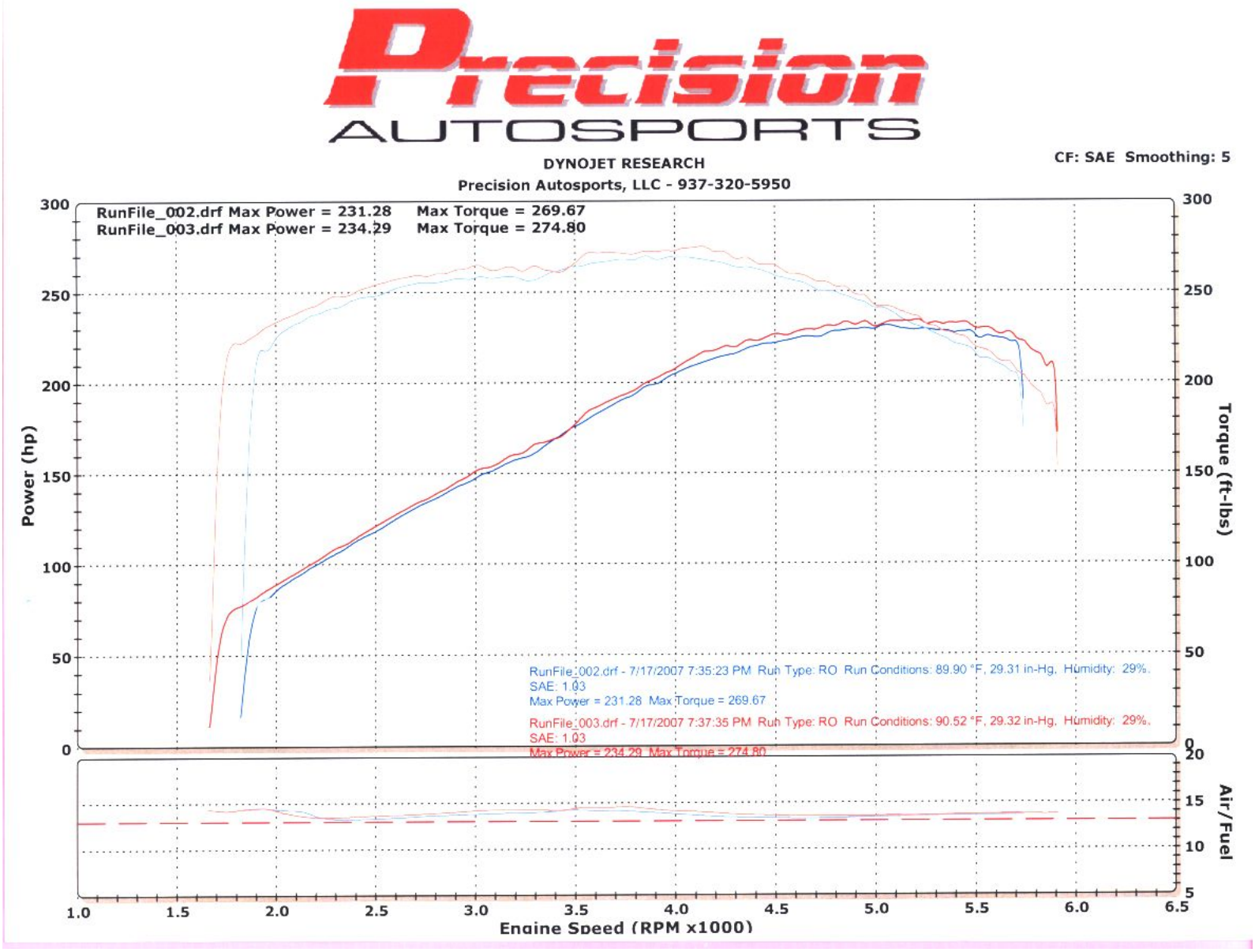
Dyno Plot 2



66' 390 HP 427 cid

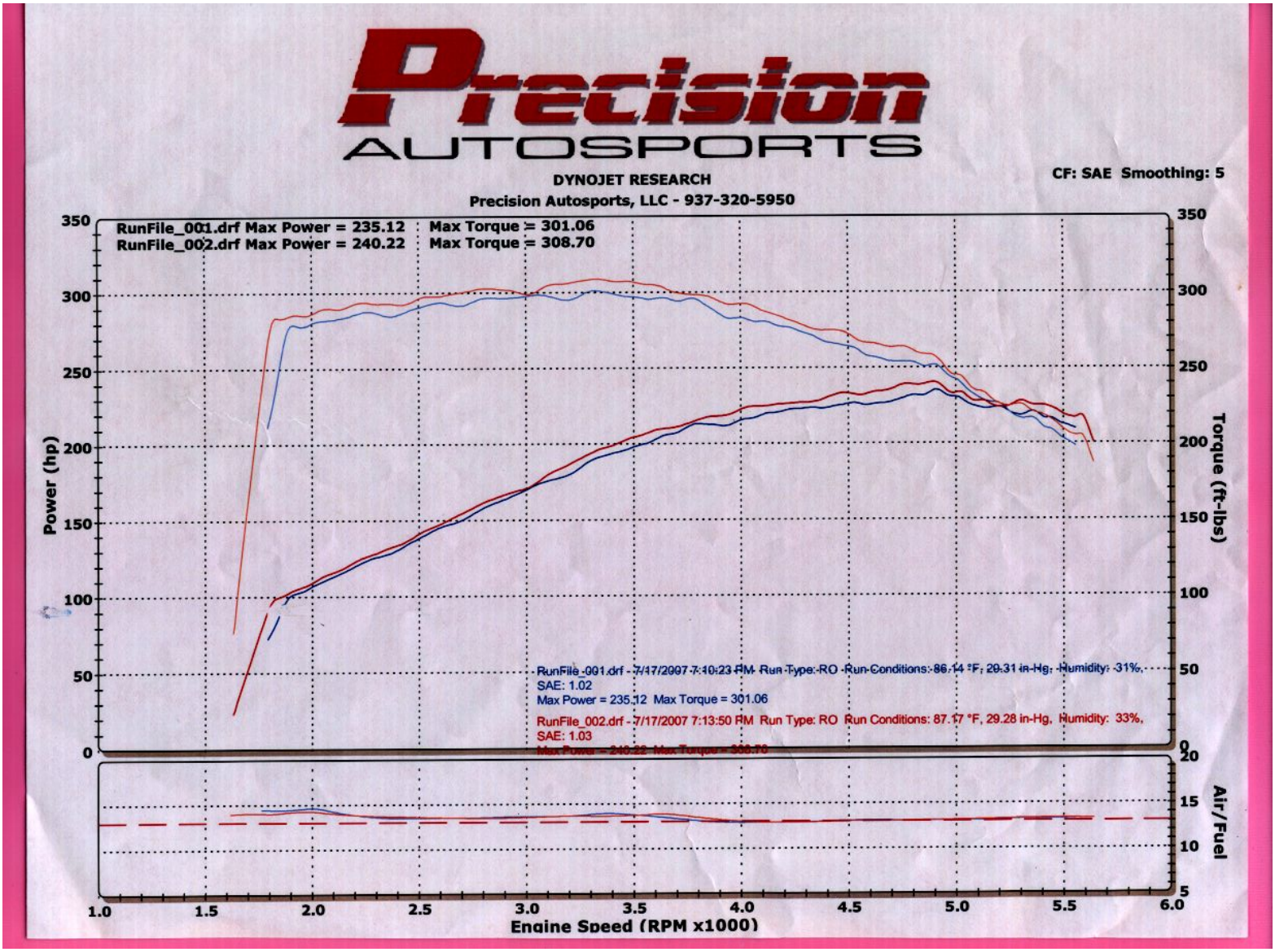
Second Run

Dyno Plot 3



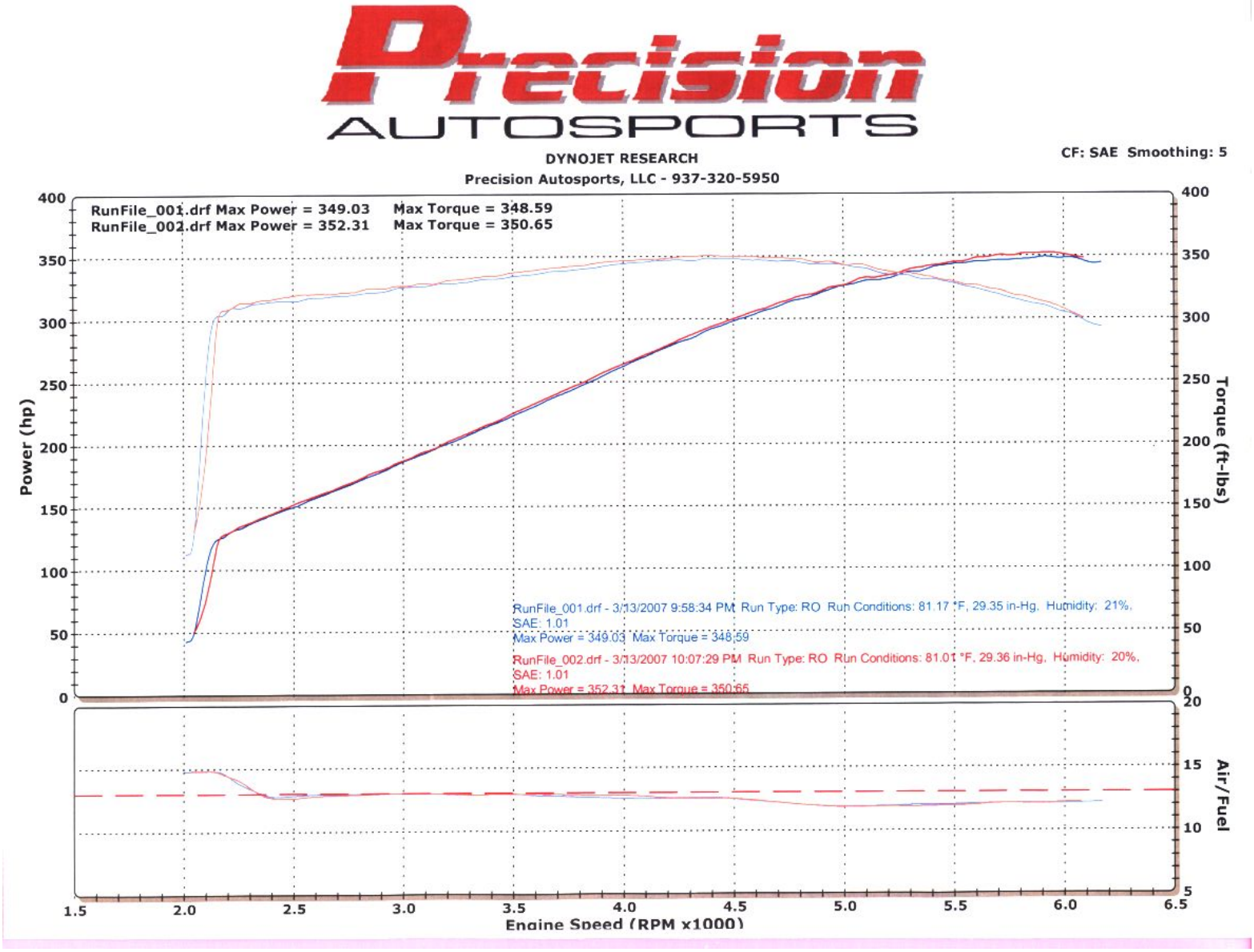
66' 350 HP 327 cid

Dyno Plot 4



65' 425 HP 396 cid

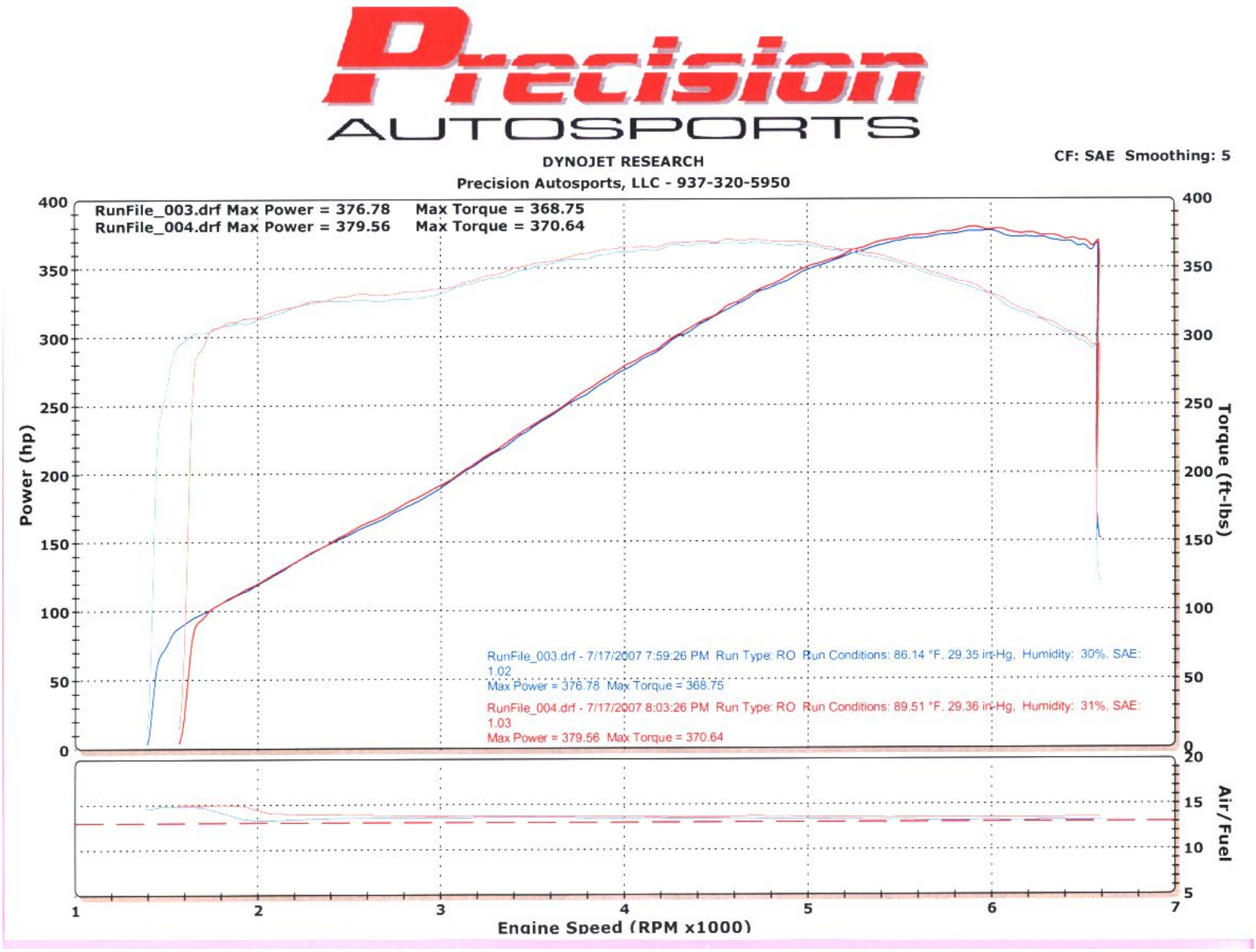
Dyno Plot 5



07' 405 HP 366 cid

First Run

Dyno Plot 6



07' 405 HP 366 cid

Second Run