

1125 Exhaust Shootout Test Report

By Al Lighton

Introduction

Several Buell 1125 series mufflers exist in the US marketplace, and sorting out which one is best for one's needs is difficult with the limited data available. The only truly meaningful way to make a valid comparison of the mufflers is to have the performance information developed on the same motorcycle, on the same dynamometer (dyno), with the same methods. And for the test to be truly representative of the MUFFLER performance, the motorcycle needs to be fueled properly with each muffler fitted.

In order to perform such a test, all the necessary equipment, test motorcycle, dyno, mufflers, etc. would need to be collected together in one place. Vendors and Badweb sponsors generously contributed the necessary HW. This includes:

- Terry and Jim of JT&S Performance provided the dynamometer and service area to do all the equipment changes for an entire weekend.
- David Fincham provided the 09 1125CR test bike.
- Kevin Drum of KD Fab provided an original 1125 SS Drummer and a prototype 1125 Chambered Drummer muffler.
- Jennifer Barnard of D&D provided a D&D 1125 muffler.
- Chad Azevedo of Jardine provided a Jardine Aluminum RT-5 1125 muffler
- Dean Adams of KEDA Design provided an RT-1 and an RT-3 1125 muffler
- Brian Reinhart supplied a CES 1125 muffler
- Jeff Northrop of FMF provided an FMF APEX 1125 muffler
- Dris Hammadi of Twin Motorcycles (The Netherlands) provided a TorqueHammer 1125 muffler
- Tim Barker of Barkers Performance Exhaust provided an 1125 Barkers muffler
- Erik Buell Racing provided the baseline race map
- Al Lighton of American Sport Bike provided the audio test equipment, tuning headers, and the programmable Race ECM

None of this equipment would be worth anything if the necessary people weren't there to run it. The participants were:

- Terry Parsley of JT&S provided his dyno expertise and tuning skills for operating the dyno room
- FiremanJim Higgins of JT&S provided his wrenching skills for the many header and muffler swaps that occurred
- David Fincham assisted Jim with the pipe wrenching and operated the motorcycle for most of the drive by testing.
- John Kingsford helped on lots of little tasks getting ready for the testing
- Eric Barrows did most of the photo work

- Al Lighton of American Sport Bike ran the audio recording system, helped with the bike tuning, coordinated much of the pre-test logistics, performed much of the post test data reduction, and authored this test report.

The testing could not have been possible without the generous time and equipment donations from the above people. Very special thanks go to Terry, Jim, and Christine Freeman of JT&S for their extraordinary hospitality during the entire race weekend and testing. The entire shop was dedicated to the effort for the duration.

Purpose

The purpose of the testing was to establish the relative performance metrics for all of the 1125 Slip-on exhausts mufflers readily available in the U.S., with as many variables removed as possible.

Test Equipment

2009 1125CR

Land and Sea #055-500-1K Motorcycle/ATV Dyno, running Dyno-Max Pro software version 9.38

Erik Buell Racing PCM tuning SW

PC Based CoolEdit2000 Digital Audio recording SW

Shure SM58 Microphone

Lexicon Alpha Mic Preamp/A/D Converter (See Figure 23)

Exetech SPL meter (See Figure 23)

NCI/Weigh Tronix 7620-50 postal scale

1125 stock headers equipped with O2 sensor bungs to allow wideband O2 sensors to independently sample front and rear exhaust gas mixtures

Buell Stock muffler

Jardine RT-5 muffler

FMF muffler

D&D muffler

CES (Brian Reinhart) muffler

TorqueHammer muffler

KEDA Design RT-1 muffler

KEDA Design RT-3 muffler

Drummer standard SS muffler

Drummer chambered SS muffler

Barkers Performance muffler

HMF volunteered to send us a pipe, but at the last moment elected not to, so we couldn't try to find one from other sources. It was a noticeable absence given it's market position. Several other lesser known 1125 exhaust manufacturers were invited to participate but either declined to send us samples for testing, or just didn't have one ready. Those were HardRock Motorsports (HR1 Riot), X1MotoWerks, and Hawk Performance. There are several other exhausts available in the European markets for the 1125, but they are not as easily obtained here in the US and were not contacted.

Exhaust Descriptions

Each of the mufflers tested are described briefly below. All of the mufflers tested were slip-on mufflers that start at the end of the Buell stock headers. We would have liked to have tested full systems, but engine rotation for fitment would have been required and time constraints wouldn't have permitted us to do this.

Buell Stock muffler

The Buell Stock muffler (Figures 1 & 2) is a black paint coated mild steel chambered muffler with no internal packing. A somewhat bulky external appearance coupled with a somewhat heavy weight and subdued exhaust note mask the really serious engineering contained on the inside. A tri-pass resonance chamber with a mini-Catalytic converter on international and California models make it compliant with EPA, CARB and international emissions and noise limit laws with as minimal an impact on power as possible.

D&D

The D&D 1125 muffler (Figures 3 & 4) was one of, if not THE, first 1125 aftermarket muffler to the market. It features all stainless construction. Our test sample was a faux TI satin finish stainless steel muffler, but a highly polished stainless version is also available. A one piece .040 wall thickness stainless steel inlet pipe with an integrated collector joins the stock headers to the muffler. No "donut gaskets" are used at the header interface as on the stock muffler, just slip fits with clamps. A front support is welded to the inlet pipe. The core baffle is a large 2.4 inch ID, with a small 8" long expansion chamber. The D&D was one of the easiest to fit on the bike, everything lined up nicely. The D&D exhibits a very high level of craftsmanship, with beautiful "stacked nickel" TIG welds of minimal size at each joint. The collector is pure artwork inside and out.

Jardine

The 1125 Jardine RT-5 muffler (Figures 5 & 6) is available in a polished aluminum (what we tested), Satin Titanium, or Carbon Fiber (CF), canister, each with a CF end cap. The construction of each is identical other than the exhaust can outer shell material. The construction is a fairly standard glass pack design with a cylindrical perf core surrounded by fiberglass/ceramic packing. Like all pipes of this design, occasional re-packing is required to maintain proper performance and longevity. Short Stainless steel stub pipes (.030" Wall thickness) ahead of the collector/inlet pipe (also .030" stainless) are clamped with no "donut gaskets" to the stock headers as on the stock muffler, just slip fits with clamps. Springs are used to keep the collector stub pipe connected to both these short stub pipes as well as the main muffler body. No front support is provided, which is a durability concern. Fit is very good due to the additional slip joints and no constraint of a front mount. Build quality is very good, with nicely done TIG welds with minimal internal splatter. Early Jardine pipes were not tucked in as tightly, and could touch down easily in hard right leans, but this has been fixed in later model RT-5 mufflers, which are slightly shorter and tucked in closer to enhance ground clearance.

FMF

The FMF Apex muffler (Figures 7 & 8) is available in a Carbon Fiber shell with a TI end cap (what we tested), or Titanium trapezoidal shaped canister with a Carbon Fiber end cap. The current web site for the APEX slip on only lists the latter, so the CF canister version we tested MAY be discontinued. The construction is a fairly standard glass pack design with a cylindrical perforated core surrounded by

fiberglass/ceramic packing. Like all pipes of this design, occasional re-packing is required to maintain proper performance and longevity. A nice touch is a heat sensitive repack indicator sticker that changes color when repacking is required. A one piece .030" wall thickness stainless steel inlet pipe with an integrated collector joins the stock headers to the muffler. No "donut gaskets" are used at the header interface as on the stock muffler, just slip fits with clamps. Springs are used to connect the muffler and inlet pipe. A front support is welded to the inlet pipe. The welds are fairly clean, with minimal internal splatter, but many are a bit larger than necessary, and they aren't quite up to the level exhibited on the D&D or Jardine. A noise reduction insert that can be fitted at the inlet to the muffler in two positions: facing forward for maximum noise reduction, or facing rearward for less impact on power. Fit to the bike is good with no issues noted.

CES

The CES (Figures 9 & 10) muffler was developed by Custom Exhaust Solutions for Brian Reinhart for use on his own 1125R. CES and Brian will build these in small lots based on demand. The one we tested was the third prototype. It is constructed entirely of stainless steel, including all internal packing, and is a single piece unit, consisting of equal length inlet and outlet pipes connected to a stainless canister with an internal "X" crossover collector. A small sculpting on the muffler wall around the kickstand mount allows the muffler to be large while still tucking up close to the engine. The CES pipe was the only one that used the stock donut gaskets at the header interface, and the combination of the single piece construction with the donut gaskets made for a more difficult fitment than any of the other pipes. Subsequent discussions with Brian indicate that future iterations will be built with separate inlet pipes. The CES was, at 14.3 lbs, the heaviest of the aftermarket pipes we tested. The muffler supports are nicely braced and appear sturdy enough to support the extra weight, and a front mount is provided.. It is the only pipe tested that featured dual exhaust tips. Workmanship is very good, especially for a prototype, with clean minimally sized welds throughout.

Torquehammer

The Torquehammer muffler (Figures 11 & 12) was developed by Bud and Dris of Twin Motorcycles in the Netherlands. As opposed to the other European brands, Twin Motorcycles (Dris) has a strong presence on US bulletin boards and volunteered a pipe for inclusion in the testing. The Torquehammer is a single piece unit like the CES, but uses a collector near the header mate with a long single .040" wall thickness large OD mid-pipe feeder to the large three chambered canister. It has an all-stainless steel construction with no fiberglass packing. The entire pipe is coated with a ceramic flat black coating that held up well during the testing. It is the second heaviest of the pipes tested. No donut gaskets are used at the mate to the header, and even no clamps or slots are used at those joints, just a tight slip fit. A front mount is provided. Fit was good, though not quite as easy as the multi-piece mufflers that allowed more degrees of freedom of movement. Workmanship on our sample was not as high as on the other production pipes tested. The welds were in many cases larger than required, weren't as well formed, and there was a fair amount of internal burn-through "warting" in the collector. They were structurally sound, just not pretty.

KEDA Design RT-1 and RT-3

The KEDA Design "Rolling Thunder" RT-1 muffler (Figures 13 & 14) and RT-3 muffler (Figures 15 & 16) are two of the limited production mufflers offered by Dean Adams. Dean didn't set out to become a muffler manufacturer, he just built some for his own bike and folks from web BBoards encouraged him

to build more. The RT-1 and RT-3 mufflers we tested were the original prototypes and are therefore a little more cosmetically rough than the commercially available versions, but are functionally identical. An RT-2 and RT-4 version is also available, but weren't tested. The RT-2 is identical internally to the RT-1, but has dual exhaust tips. The RT-4 is a dual 4 canister design. All feature heavier .065" wall thickness 304 SS tubing and materials throughout. The RT-1 (and RT-2) use both stainless steel wool and super sport packing. The RT-3 (and RT-4) only super sport packing is used and they are user re-packable. According to Dean, the packing used should last at least 10-20K miles per the manufacturer, possibly longer depending on the abuse it gets. All the various configurations can be altered to each customer's specs, everything is hand crafted and made the way they want it. Neither the RT-1 nor RT-3 have a front mount fitted. Both use nice rubber grommet mounts at the hard points. Fit to the bike for each is good with no mounting issues noted. The prototypes we tested had decent weld quality, but weren't quite up to the level of the D&D or Jardine.

SS Drummer and SS Chambered Drummer

The SS Drummer muffler (Figures 17 & 18) and the SS Chambered Drummer muffler (Figures 17 & 18) are the latest in the line of custom fabricated mufflers from KD Fabrication. Previous SS Drummer mufflers for the XB series utilized stainless shells with aluminum end caps, but 1125 Drummers are made entirely of stainless steel. The standard SS Drummer utilizes a similar construction as the XB drummers, with an internal perforated metal plate sandwiching 1/2" of fiberglass packing material against the outside shell. The SS Chambered drummer utilizes multiple internal chambers with no internal packing. Both use the same stainless inlet pipe with an integrated collector. The short collector pipes are .040" thick stainless, the longer inlet pipe is .060" thick, painted with high temp black exhaust paint. A front mount is provided. Fit was very good. Workmanship on the production SS Drummer was excellent, with nice sized welds, ground smooth in many places. The SS Chambered Drummer test specimen is the prototype, so it is a little rougher than the production SS Drummer that was tested, with external burn-through "warting" from the internal baffle welding. The paint on the inlet pipe is not suitable to the temperatures it is exposed to, it discolored almost immediately. Future versions of this pipe will use an uncoated inlet pipe/collector as on most of the other pipes tested here.

Barker Performance

The Barker Performance muffler (Figures 17 & 18) is an aluminum and stainless steel glass pack oval type canister with a unique twist to it: the inlet pipe after the collector isn't a straight tube as in all the other designs. Instead, the exhaust uses megaphone/reverse cone pulsewave tuning to broaden the HP and torque curves. Tim Barker developed the pipe in conjunction with Taylor Knapp on the Latus Daytona Sportbike. Like all pipes of this design, occasional re-packing is required to maintain proper performance and longevity. The canister shell is made of 6061 aluminum, and the megaphone collector/inlet pipe is .040" stainless, and is clamped with no donut gaskets to the stock headers as on the stock muffler, just slip fits with clamps. No front support is provided, which is a durability concern. The rear muffler body clamp is a beautiful piece of billet artwork, not a formed band like one typically sees for a clamp like this. Fit is very good with no constraint of a front mount, this was the easiest of all the pipes to mount. Build quality is excellent, with nicely done minimally sized TIG welds with no internal splatter evident in the collector, and perfect seams at both end caps. A noise reduction insert that can be fitted at the of the muffler, and different inserts are available at extra cost from Barker's. The pipe is available in several colors for a small extra fee.



Figure 1 Buell Stock Muffler

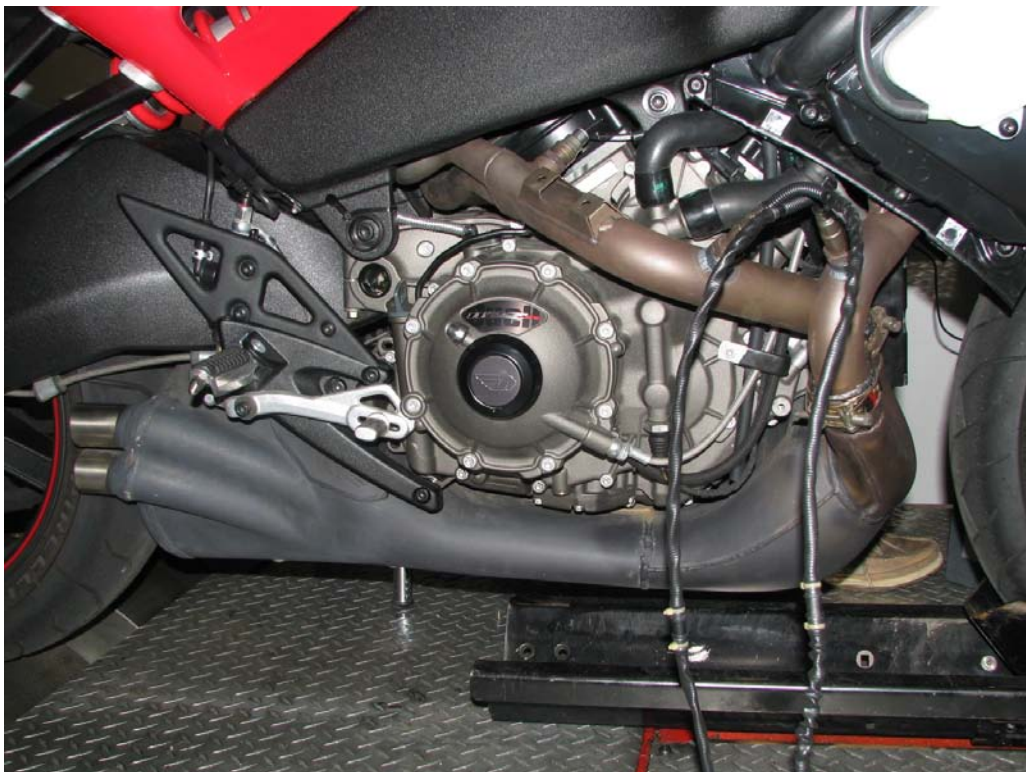


Figure 2 Buell Stock Muffler, Mounted



Figure 3 D&D Muffler

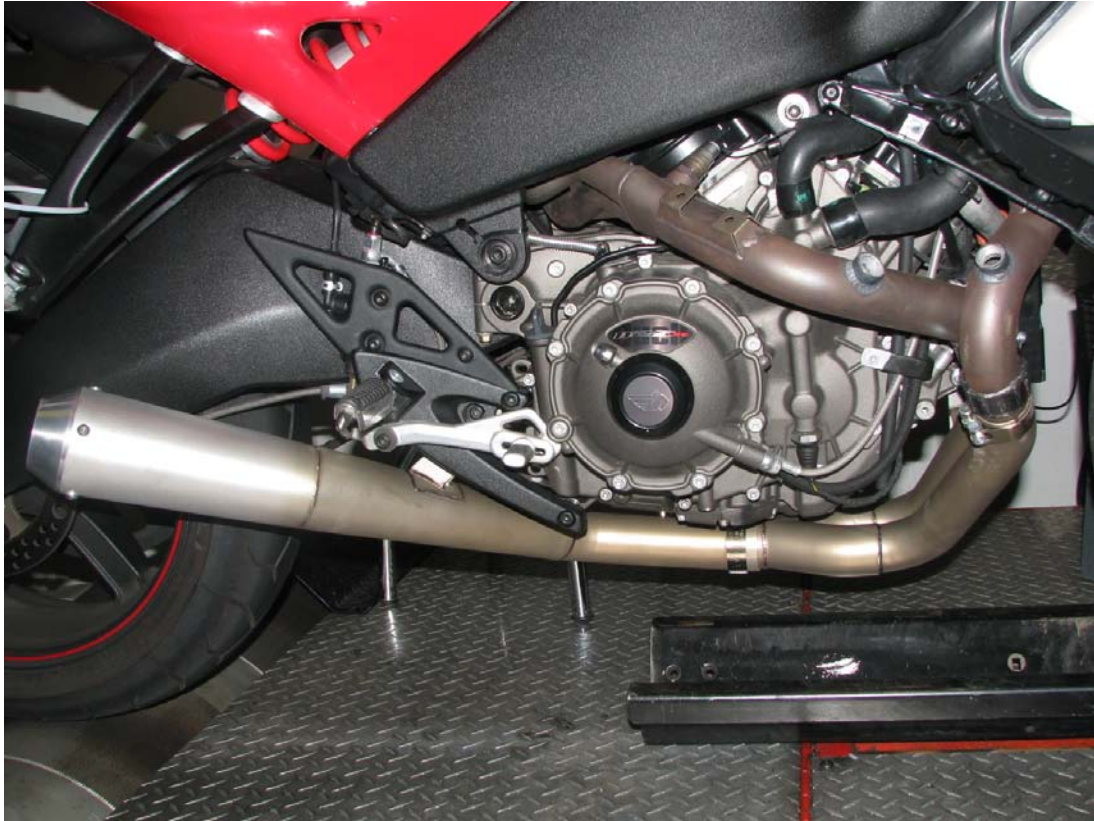


Figure 4 D&D Muffler, Mounted



Figure 5 Jardine RT-5 Aluminum Muffler



Figure 6 Jardine RT-5 Aluminum Muffler Mounted



Figure 7 FMF APEX Muffler

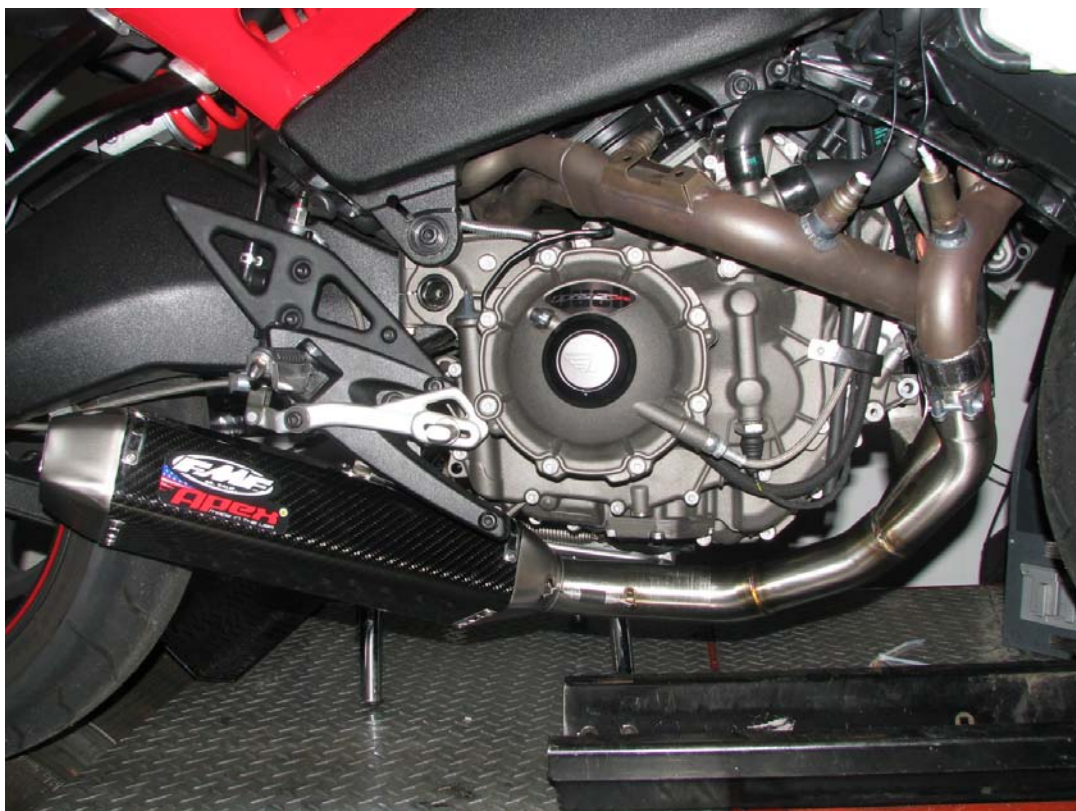


Figure 8 FMF APEX Muffler, Mounted



Figure 9 CES Muffler

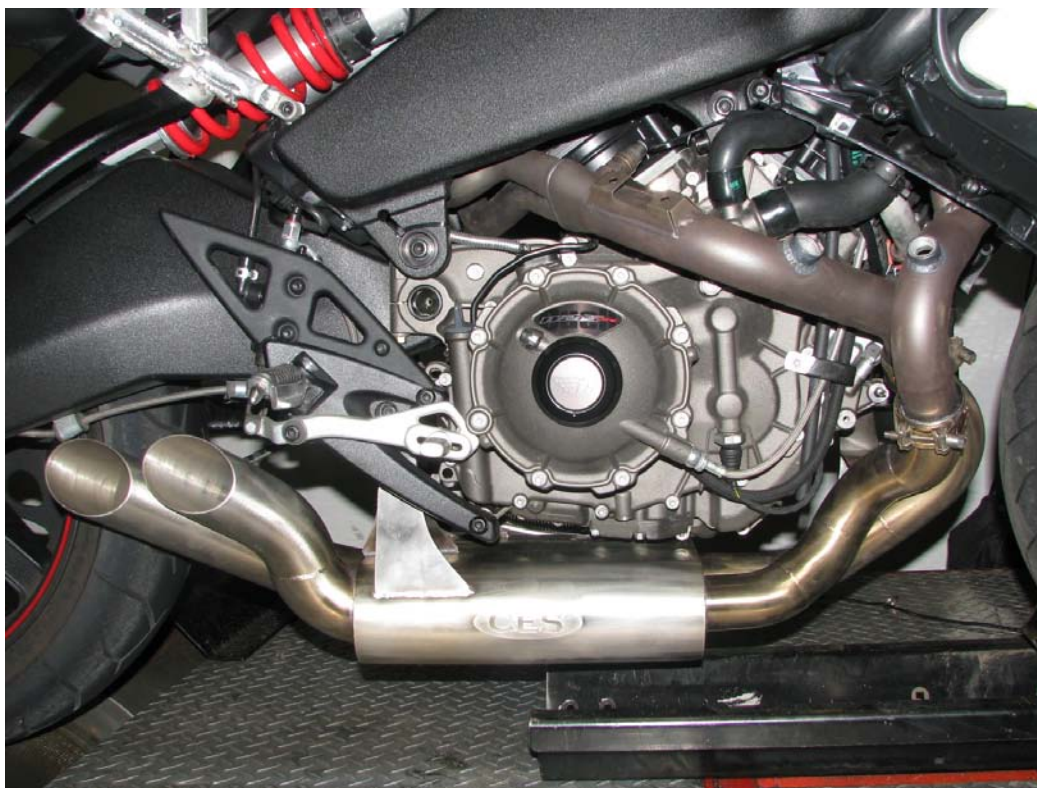


Figure 10 CES Muffler, Mounted



Figure 11 TorqueHammer Muffler

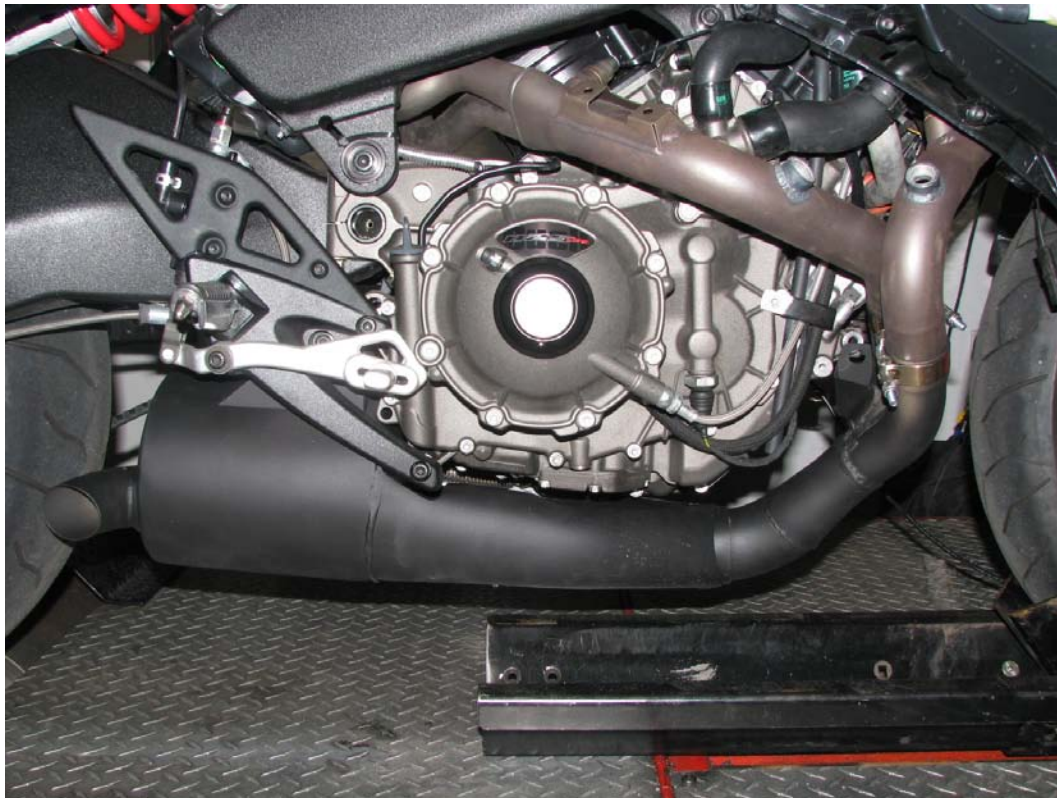


Figure 12 TorqueHammer Muffler Mounted



Figure 13 KEDA Design RT-1 Muffler

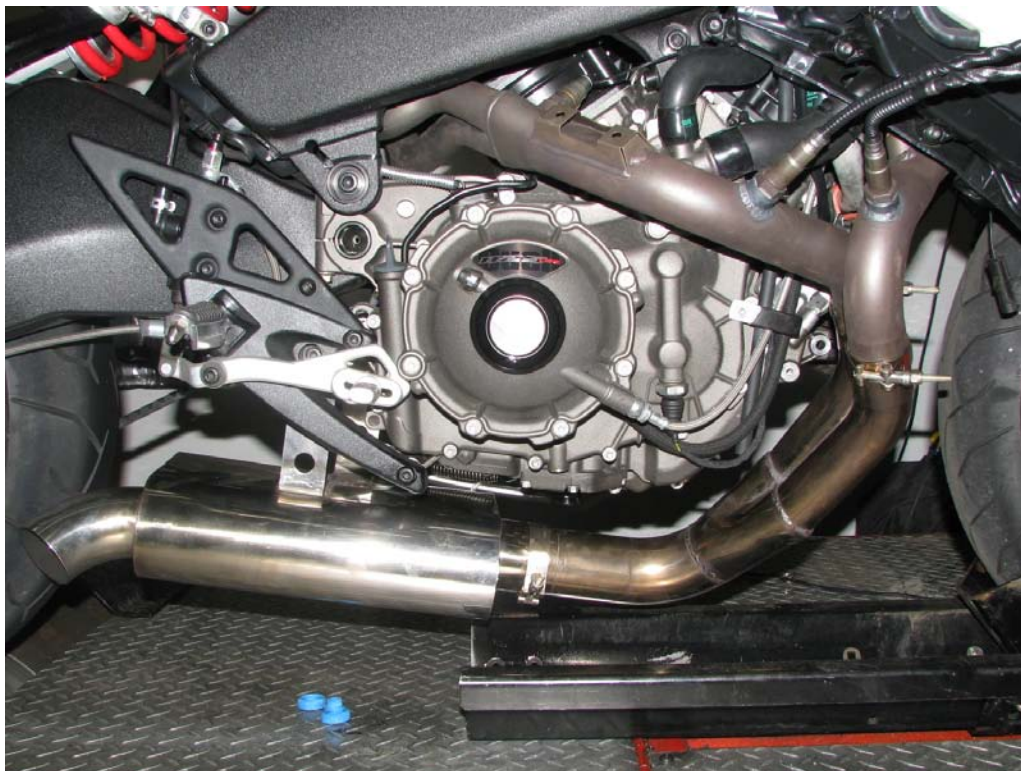


Figure 14 KEDA Design RT-1 Muffler Mounted



Figure 15 KEDA Design RT-3 muffler



Figure 16 KEDA Design RT-3 muffler Mounted



Figure 17 SS Drummer muffler

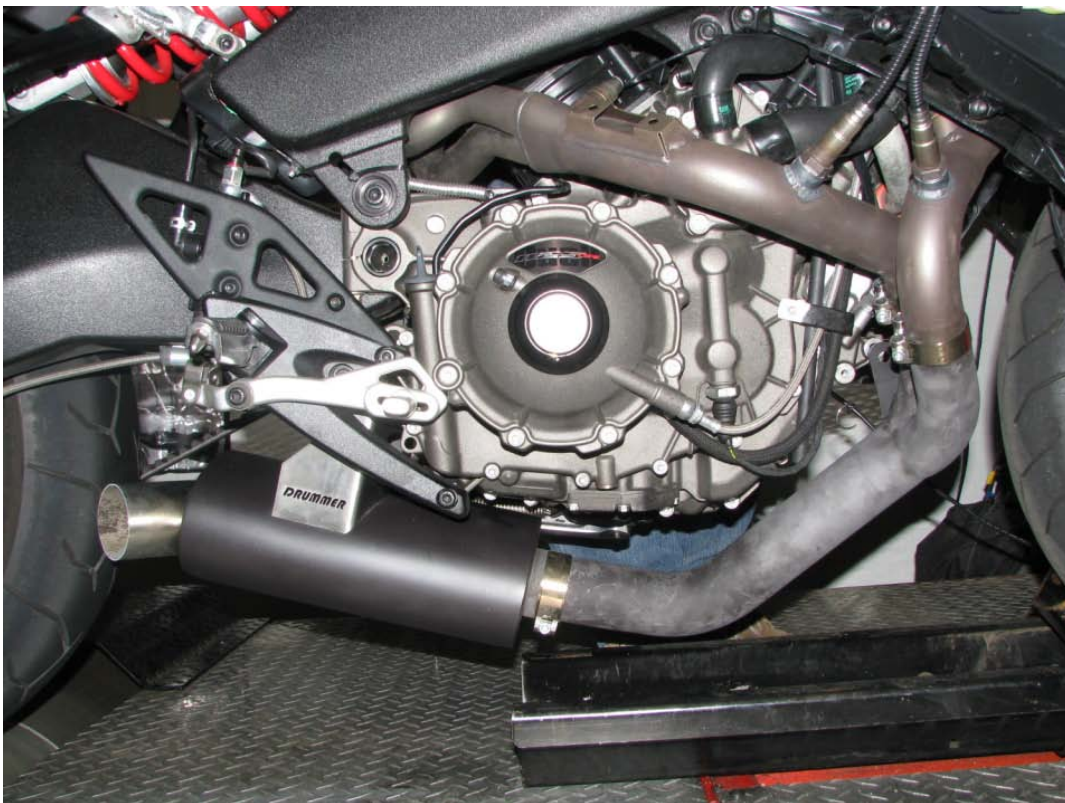


Figure 18 SS Drummer Muffler, Mounted



Figure 19 SS Cambered Drummer muffler

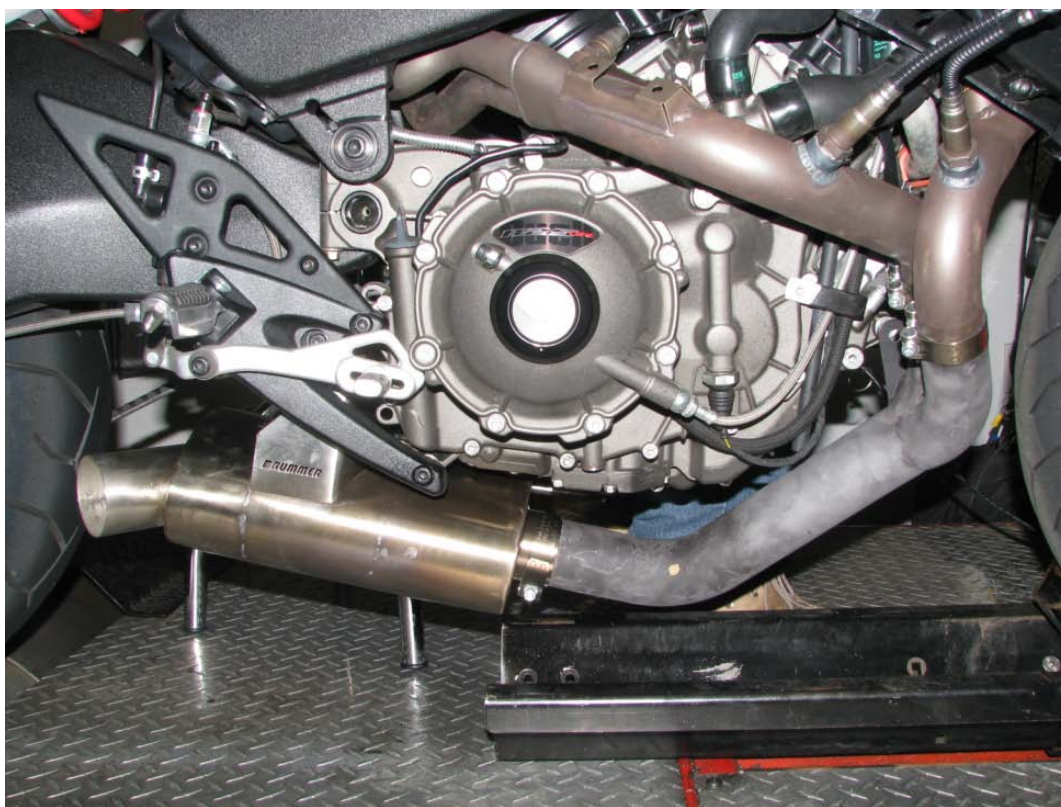


Figure 20 SS Chambered Drummer Muffler, Mounted



Figure 21 Barkers Performance muffler



Figure 22 Barkers Performance Muffler, Mounted



Figure 23 SPL Meter and Mic Preamp



Figure 24 SAE J2825 Motorcycle Sound Test Setup



Figure 25 Drive-by and Static Recording Distance

Test Procedure

Pre-Test Setup:

1. Pivot test bike Engine down, mount Wideband O2 sensor bung equipped stock headers.
2. Disconnect speed sensor and put the instrument cluster in diagnostic mode monitoring AFV. Operate the stock bike on the dyno until the front and rear cylinder AFVs read 100. Disconnect narrowband O2 Sensors.
3. Park a loud bike (D&D equipped XB was used) at the drive by distance. Rev it up and generate 100dBC on the SPL meter. Hold it at that volume and adjust the gain of the Mic preamp so that the on-screen waveform reads -24 dB (i.e., -24dB on the waveform plot equals 100dBC)

The general test procedure for each muffler is as follows:

- 1) Weigh each muffler, record each value in Table 1.
- 2) Photograph each muffler off the bike.
- 3) Mount each muffler onto the test bike
- 4) Photograph each muffler on the bike.
- 5) Briefly warm up the bike
- 6) Perform [J2825 Idle test](#), record max SPL.
- 7) Perform [J2825 2000 RPM test](#), record max SPL.
- 8) Perform [J2825 5000 RPM test](#), record max SPL.
- 9) Record Audio on two drive-by runs. One pass should be in first gear, the second pass in second gear.
- 10) Park the bike at the drive-by distance, and do some static revs while recording
- 11) Hold the throttle at 6000 RPM for a few seconds while recording
- 12) Mount bike on Dyno
- 13) Thoroughly warm up bike on dyno.
- 14) Record two repeatable WOT pulls on the stock ECM
- 15) Install the programmable race ECM and load the race map supplied by Erik Buell Racing (FMF Map)
- 16) Record two repeatable WOT pulls
- 17) Remap the ECM front and rear cylinder full throttle fuel map to optimize the fueling for an A/F ratio between 12.5:1 and 13.5:1, or as close as possible to 13:1 given the time constraints. Record two repeatable WOT pulls.

Results

The weight of each of the mufflers is tabulated in Table 1.

The maximum sound level measured for each of the mufflers is shown in Table 2. See appendix A (separate ZIP archive) for .JPG pictures of the audio waveforms and .MP3 audio files of the recordings.

The MSRP for each of the mufflers and a hyperlink to the manufacturer site for the muffler is shown in Table 3.

The maximum performance levels achieved by each system for each significant run type are shown in Table 4. The peak torque, and the RPM that occurred at, is listed. The peak power, and the RPM that occurred at, is listed. The run (i.e., Race Map or Final Map) that gave the maximum Torque or HP is highlighted in yellow.

The Time to Speed achieved by each system for each significant run type are shown in Table 5. Lower is better, and it is a reasonable measure of the “power under the curve”, i.e., the total amount of power applied over the entire run. One pipe might have a higher peak power, but another might have more power over the entire run and would therefore have a lower time to speed. Note that this is NOT the same as a real world time to speed test, because there is no aerodynamic drag present. Aerodynamic drag follows square laws, which aren’t observable here.

Table 1 Exhaust System Weights

Exhaust System	Muffler Weight (Pounds)
Buell Stock 1125	21.4
D&D	6.9
Jardine	5.9
FMF	6.0
CES	14.3
TorqueHammer	13.9
KEDA RT-1	11.9
KEDA RT-3	8.3
SS Drummer	10.3
SS Chambered Drummer	10.3
Barker	6.4

Table 2- Audio data

Muffler	J2825 Static Idle (dBA)	J2825 Static 2000 RPM (dBA)	J2825 Static 5000 RPM (dBA)	Audio File (See Audio_files Subdirectory)
Buell Stock 1125	88	91.8	99	Stock_Muffler.wav
D&D	100.8	104.1	115.6	DnD.wav
Jardine	95.7	99	110.6	Jardine.wav
FMF	99.8	101.5	108.1	FMF.wav
CES	99.3	102.5	107.8	CES.wav
TorqueHammer	95.6	99.6	107.3	Torquehammer.wav
KEDA RT-1	99	101.8	111.2	KEDA_RT1.wav
KEDA RT-3	98.5	99.5	112.5	KEDA_RT3.wav
Drummer Standard	99.5	102.5	111.4	Drummer-standard.wav
Drummer Chambered	99.1	101.9	111.3	Drummer-chambered.wav
Barker	98.2	99.5	107.9	Barker.wav

Some general notes about the overall results are noted below.

- 1) We were under extreme time pressure on the testing. It started raining on Monday mid morning, and continued to rain for the rest of the day. We only completed the stock, D&D, and Jardine runs prior to the rain, and halted testing for the rest of the day because we couldn't complete the drive-by and static noise testing in the wet, and the humidity skyrocketed. Testing started again Tuesday morning, but we now had to do all the rest of the pipes in one day. We SHOULD have been doing more data review during the testing, but we were under the gun to get the work done in the allotted time.
- 2) We didn't run the stock pipe on the Race ECM, figuring that the stock ECM was designed for the stock pipe. In retrospect, that was a mistake, we should have. The aftermarket exhausts on the stock map didn't exhibit anywhere near the gains that they did on the Race ECM, and it would have been a good thing to have compared the gains on the aftermarket pipe to whatever gains might have been seen on the stock pipe with the same map. It is my hope to this test on the same bike in the near future if that test can be arranged.
- 3) For some unknown reason, we lost the data for the Jardine runs on the initial race map. We only have the data for the stock map and the final map. I suspect it was inadvertently overwritten with the final map results.
- 4) The FMF map was done first thing Tuesday morning before Terry arrived, and Terry had done all the dyno runs up to that point. We mistakenly did the run from 5K and up, instead of 4.5K and up as on all the other pipes. Not only does this affect the lowest part of the graph, but it meant that the time-to-speed started higher than the 60mph minimum.
- 5) The stock bike was driven by with a different setting on the audio input control (95dB at -15dBc). The second pipe (Jardine) was loud enough to make us change the level calibration for all that and all subsequent drive by passes. So only the stock pipe was recorded with hotter audio input levels. Given the quietness of the stock exhaust, and the fact that everyone knows what the stock pipe sounds like, we didn't feel compelled to re-record the stock pipe at the same levels as all the rest of the passes.

- 6) Reviewing the audio files after the testing was completed revealed the error of our method. We should have done the drive by recording AFTER the dyno runs, using the Race ECM instead of the stock ECM. The amount of snap, crackle, and pop due to leaner than optimum mixtures makes many of the pipes sound more brittle than they would on a richer map. Sharp explosions have a lot of very high frequency content and sound even more brittle in digital recordings than they did in real life.
- 7) The audio recordings were all at the same record level, with the same mic position. Some pipes that had very loud SAE test results weren't as loud in the drive-by testing, and others were VERY loud in those drive-by tests. It's all about tail pipe angle. The CES, with its side firing, up pointing tips, almost blew through 0 db on the audio recording. The D&D, which was extremely loud, is pointing largely to the rear and doesn't hit the mic as hard.
- 8) Drive-by space was limited. We would have liked to have kept the throttle pinned all the way past the mic, but the rider would probably have died in the resulting collision with parked vehicles further up the road. It was less than optimum, but it's all the space we had.
- 9) Terry and I weren't on the same page with regard to data retention. I would have liked to have stored the data from every tuning run, but Terry was overwriting each run between the initial Race ECM run and the final 13:1 AFR run. So while we were looking at the data and making adjustments on the fly to get to the desired result, we didn't retain all the intermediate data.
- 10) The test bike was a 2009 1125CR that has not had the charging system recall work completed. As a result, we were plagued with discharging battery issues for the entire test. However, we monitored battery voltage, and we had three batteries that we cycled into the bike. With one on the bike, two were on chargers off the bike. If the battery voltage dropped too far, we swapped in one of the charging batteries. Battery voltage is used in the algorithms in the ECM that control injector duration. We don't believe that this had any impact on the results.
- 11) The pictures of the pipes off the bike were taken outside, and it was starting to rain. Some water drops are visible on some of the pipes in the pictures.
- 12) The pictures on the bike were taken with the bike on the dyno. Some were done AFTER the runs, and some exhibited header discoloration during the runs.

But probably the biggest results issue that merits discussion is that the highest Torque and HP runs didn't always occur on the runs where we'd tuned to an AFR of $13:1 \pm 0.5:1$. Some pipes had their best performing runs on the initial race map. Per #7 above, the intermediate runs that we didn't retain would have been beneficial here, as there may have been an even better run in the middle. But the differences in the peak values is usually fairly small. One explanation for the MAY be that these low back pressure pipes MAY have some reversion O2 reaching the O2 sensors, and what we thought was 13:1 in the combustion chamber may actually have been a bit richer than that.

Another point that certainly merits discussion is the starting point of 4500 RPM. We chose 4500 RPM because, quite frankly, anything lower than that for WOT throttle pulls in top gear aren't particularly practical. When you roll from 3000 or 3500 to WOT in an instant, the bike is very chuggy and lurchy on the dyno, regardless of which pipe is mounted, and the transient fueling is a bit of a mess as well. This is not to say that 1125 bikes aren't routinely operated between 3K and 4.5K, as they surely are. But jumping from 10% to 100% throttle at those RPMs isn't all that useful in top gears. The throttle bodies and cams on this engine just don't make for happy operation in that domain.

One point that is almost always raised in discussions concerning dyno results is the applied correction factor. ALL of the results in this test use SAE correction factors. There is a weather station connected to the dyno that monitors ambient temperature, pressure, humidity, etc. The dyno software takes all of these weather inputs and calculates a correction factor based on the input. There are different types of correction factors that will all scale the data up or down, and the only really important thing is to ensure that the same factor method has been applied to all. Looking at the results, they are pretty consistently in the .98-.99 range.

The original rev A version of this report had Standard, not SAE, correction factor applied to the Chambered Drummer. The factor was 1.0240, vs the correct SAE correction factor of .9845, which is a 3.95% change. This shows why it is important to have the same correction factor applied to all data for valid comparison.

Other factors besides the weather station impact the algorithms used by the dyno software to calculate the final results. Examples of these are the dyno drum inertia constants, the assumed driveline inertia constants, friction loss constants, etc. These factors are configurable in the run setup screens. We created a template for the runs, and the same template was used for ALL runs. There is no variability in the runs based on these configurable constants.

Table 3 Exhaust System MSRP and Web Link

Muffler	MSRP	Manufacturers Web Site
Buell Stock 1125	\$303	
D&D	\$692	http://www.danddexhaust.com/catalog/2008/02/53414m.htm
Jardine Aluminum	\$521	http://www.jardineproducts.com/products/searchType/vehicleSearch/sfID1/28/sfID2/8/sfID3/9
Jardine Carbon Fiber	\$626	http://www.jardineproducts.com/products/searchType/vehicleSearch/sfID1/28/sfID2/8/sfID3/36
Jardine Titanium	\$626	http://www.jardineproducts.com/products/searchType/vehicleSearch/sfID1/28/sfID2/8/sfID3/37
FMF	\$549	http://www.fmfracing.com/Products/STREET/478
CES	\$1099	http://www.4customexhaust.com/ (no pipe specific data here)
TorqueHammer	€650,00	http://www.twinmotorcycles.nl/webshop/artikel.asp?guid=YXHFSC&aid=1936&cid=110&s=&a=
KEDA RT-1	\$599	http://www.keda-design.com/shop/article_4/RT-Type-1-Custom-SS-Race-exhaust.html?shop_param=cid%3D1%26aid%3D4%26
KEDA RT-3	\$549	http://www.keda-design.com/shop/article_8/RT-Type-3-Custom-SS-Race-exhaust-4%22-round-muffler.html?shop_param=cid%3D1%26aid%3D8%26
Drummer SS Standard	\$995	http://www.kdfab.com/drummer1125ss.htm
Drummer SS Chambered	\$995	N/A
Barker	\$395	http://www.barkersexhaust.com/atv-utv-motorcycle-exhausts/Motorcycle/Buell/1125-R/Buell-1125-R-Slip-On-Exhaust.html
KEDA RT-2*	\$649	http://www.keda-design.com/shop/article_7/RT-Type-2-Custom-SS-Race-exhaust_dual-outlet.html?shop_param=cid%3D1%26aid%3D7%26
KEDA RT-4*	\$899	http://www.keda-design.com/shop/article_9/RT-Type-4-Custom-SS-Race-exhaust.html?shop_param=cid%3D1%26aid%3D9%26

*- not tested

Table 4 1125 Exhaust Performance Data, HP & Torque

Exhaust	Run Class	Peak Torque	Peak Torque	Peak Power	Peak Power	Correction
		(lb-ft)	RPM	(RWHP)	RPM	Factor
Buell Stock 1125	Stock Map	70.24	6600	121.6	9900	0.9754
	Race Map					
	Tuned Map					
D&D	Stock Map	74.06	8000	122.8	9800	0.9751
	Race Map					
	Tuned Map	76.38	7900	129.1	9900	0.975
Jardine	Stock Map	69.21	6800	122.7	9900	0.9769
	Race Map	77.53	7700	130.1	9900	0.9767
	Tuned Map	77.31	8100	131.3	10000	0.9781
FMF	Stock Map	70.19	6800	119.6	9800	0.9721
	Race Map	78.8	8000	132.8	10000	0.9721
	Tuned Map	75.9	8100	131.3	9900	0.9748
CES	Stock Map	71.87	6700	123.6	9800	0.9847
	Race Map	78.93	6700	129.6	9800	0.9849
	Tuned Map	78.94	6700	131.4	10000	0.9847
TorqueHammer	Stock Map	69.33	6800	118.1	9900	0.9926
	Race Map	77.81	8000	130	9700	0.9886
	Tuned Map	78.81	7900	132.2	9900	0.9925
KEDA RT-1	Stock Map	79.09	8000	129.8	9600	0.995
	Race Map	82.73	7800	137.1	9900	0.9923
	Tuned Map	80.09	8000	135	9800	0.9894
KEDA RT-3	Stock Map	74.31	8100	128.3	9800	0.9941
	Race Map	82.11	8000	137.8	9900	0.996
	Best Torque	80.77	8000	135.6	10000	0.9938
Drummer SS	Stock Map	71.13	8000	125.7	9800	0.9943
	Race Map	80.75	7900	137.3	9800	0.9905
	Best Torque	81.4	7900	136.5	9700	0.9902
Drummer SS Chambered	Stock Map	78.78	7800	130.3	9800	0.994
	Race Map	77.95	8000	133.2	9900	0.9845
	Best Torque	78.53	7900	133.2	9800	0.9843
Barker	Stock Map	72.67	8000	125.9	9800	0.9885
	Race Map	82.68	7700	137.4	9700	0.9863
	Best Torque	79.81	7900	135.2	9800	0.9828

Table 5 1125 Exhaust Performance Data, Time-to-Speed

Exhaust	Run	Time, 60MPH to 100MPH (Seconds)	Time, 100MPH to 140MPH (Seconds)	Time, 60MPH to 140MPH (Seconds)
Buell Stock 1125	Stock Map	3.756	3.89	7.646
	Race Map	N/A	N/A	N/A
	Tuned Map	N/A	N/A	N/A
D&D	Stock Map	3.598	3.725	7.323
	Race Map	N/A	N/A	N/A
	Tuned Map	3.591	3.523	7.114
Jardine	Stock Map	3.855	3.912	7.767
	Race Map	3.641	3.506	7.147
	Tuned Map	3.622	3.503	7.125
FMF	Stock Map	N/A	4.002	N/A
	Race Map	N/A	3.444	N/A
	Tuned Map	3.598	3.548	7.146
CES	Stock Map	3.371	N/A	N/A
	Race Map	3.474	3.599	7.073
	Tuned Map	3.47	3.573	7.043
TorqueHammer	Stock Map	3.947	4.199	8.146
	Race Map	3.688	3.61	7.298
	Tuned Map	3.641	3.576	7.217
KEDA RT-1	Stock Map	3.591	3.616	7.207
	Race Map	3.458	3.398	6.856
	Tuned Map	3.546	3.48	7.026
KEDA RT-3	Stock Map	3.71	3.805	7.515
	Race Map	3.435	3.435	6.87
	Best Torque	3.508	3.489	6.997
Drummer SS	Stock Map	3.81	3.936	7.746
	Race Map	3.429	3.428	6.857
	Best Torque	3.405	3.427	6.832
DrummerSS Chambered	Stock Map	3.646	3.613	7.259
	Race Map	3.664	3.532	7.196
	Best Torque	3.668	3.527	7.195
Barker	Stock Map	3.764	3.845	7.609
	Race Map	3.326	3.352	6.678
	Best Torque	3.427	3.43	6.857

Performance Graphs

Dyno plots are not easily parsed if there are more than three or four runs given per plot, especially for color blind folks like me. The lines smear on top of each other, and it is hard to follow one line or the other where they cross. In order to show the data more clearly, the comparison runs that show all the pipes on the same plot have been split into separate HP and Torque plots so that the vertical scales can be optimized. The legend for each graph is ordered Top to Bottom at an RPM where it is easiest to discern one line from another.

Figure 26 shows the maximum HP plot for each pipe, regardless of which run generated that max HP.

Figure 27 shows the HP plot for each pipe on the Race map.

Figure 28 shows the HP plot for each pipe on the Final map.

Figure 29 shows the maximum Torque plot for each pipe, regardless of which run generated that max Torque.

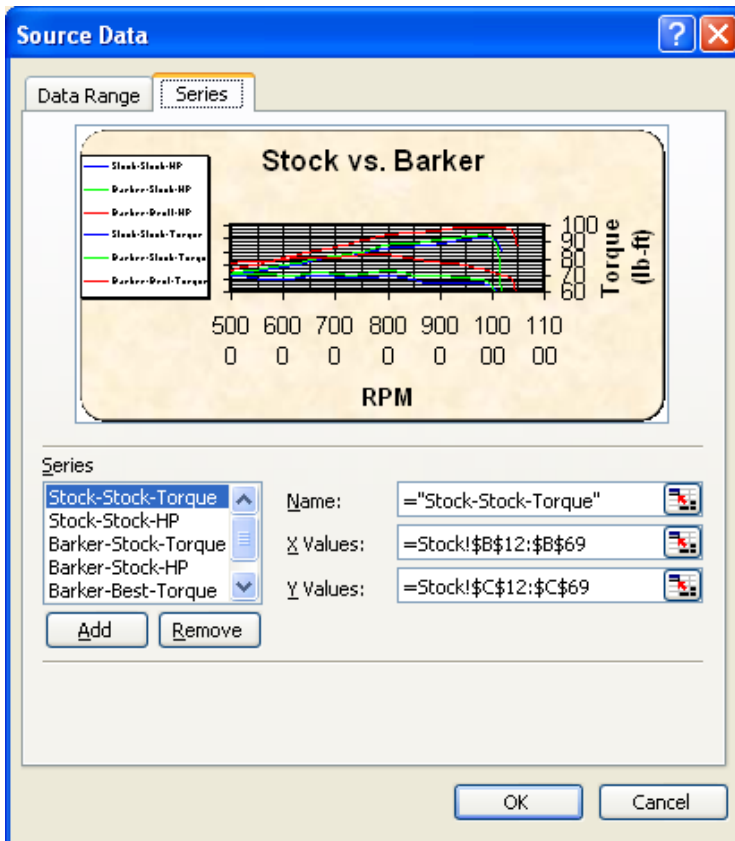
Figure 30 shows the Torque plot for each pipe on the Race map.

Figure 31 shows the Torque plot for each pipe on the Final map.

Figure 32 is the stock pipe plot.

Afterwards, there are two plots for each pipe. The first shows the HP, Torque, and front and rear cylinder AFR graphs for each of the three runs: Stock ECM, Race ECM with the “generic” race map (FMF based) supplied by Erik Buell Racing, and the tuned race map with the AFR flattened to 12.5:1 to 13.5:1. The second plot shows the stock muffler plot on the same graph with each mufflers stock ECM plot and the plot from either the initial Race ECM map or the final tuned ECM map, whichever was higher.

However, one can plot virtually anything you want to see if you use the Excel data file. If you know a little about how to select the range data that appears in the plot, you can see anything you want. For example, if you open the spreadsheet and go to the any one of the graphs, you can right-click on the graph, and select “Source Data”. Click on the “Series” tab, and you will see exactly where the data for each series comes from. That data is formatted like this:



The data for each pipe (i.e., stock ECM, Race ECM, Final ECM) is located in the same place on each sheet:

Column B: RPM for Stock ECM run
 Column C: Torque for Stock ECM run
 Column D: HP for Stock ECM run

Column H: RPM for Race ECM run
 Column I: Torque for Race ECM run
 Column J: HP for Race ECM run

Column N: RPM for Final ECM run
 Column O: Torque for Final ECM run
 Column P: HP for Final ECM run

So all you need to do to select what appears on the graph is to select the right sheet name and the right columns, and the graph will update to the data that you've selected. The above screen shot is Excel 2003, it is a little bit different in Excel 2007, but the general gist is the same.

You can also view the graphs that are here in the report at a larger scale on the screen using the plots in the Excel sheets.

Max HP, Legend Ordered @ 8750 RPM

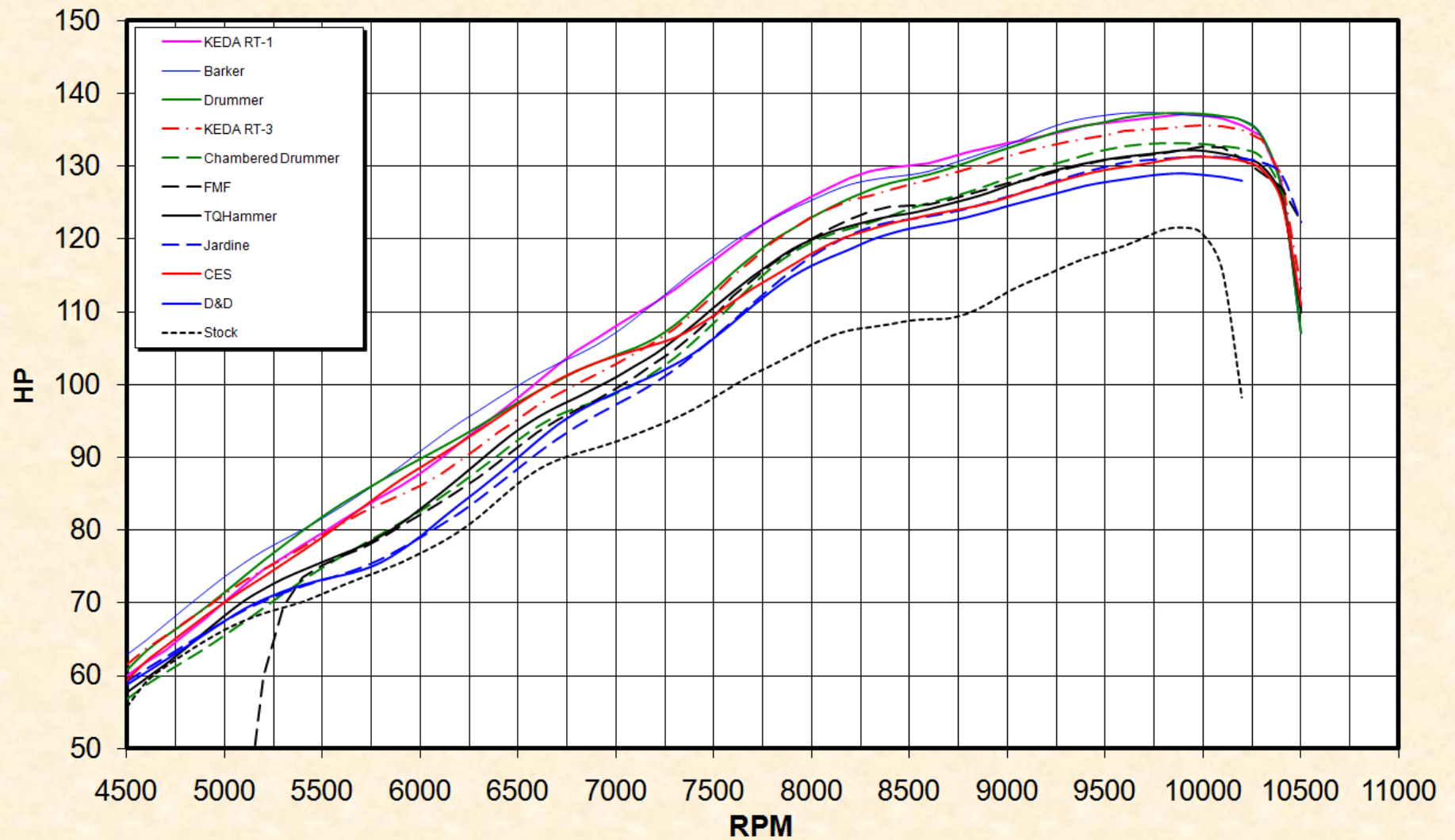


Figure 26 – Max HP, Regardless of Map

HP, Race Map, Legend Ordered @ 9500 RPM

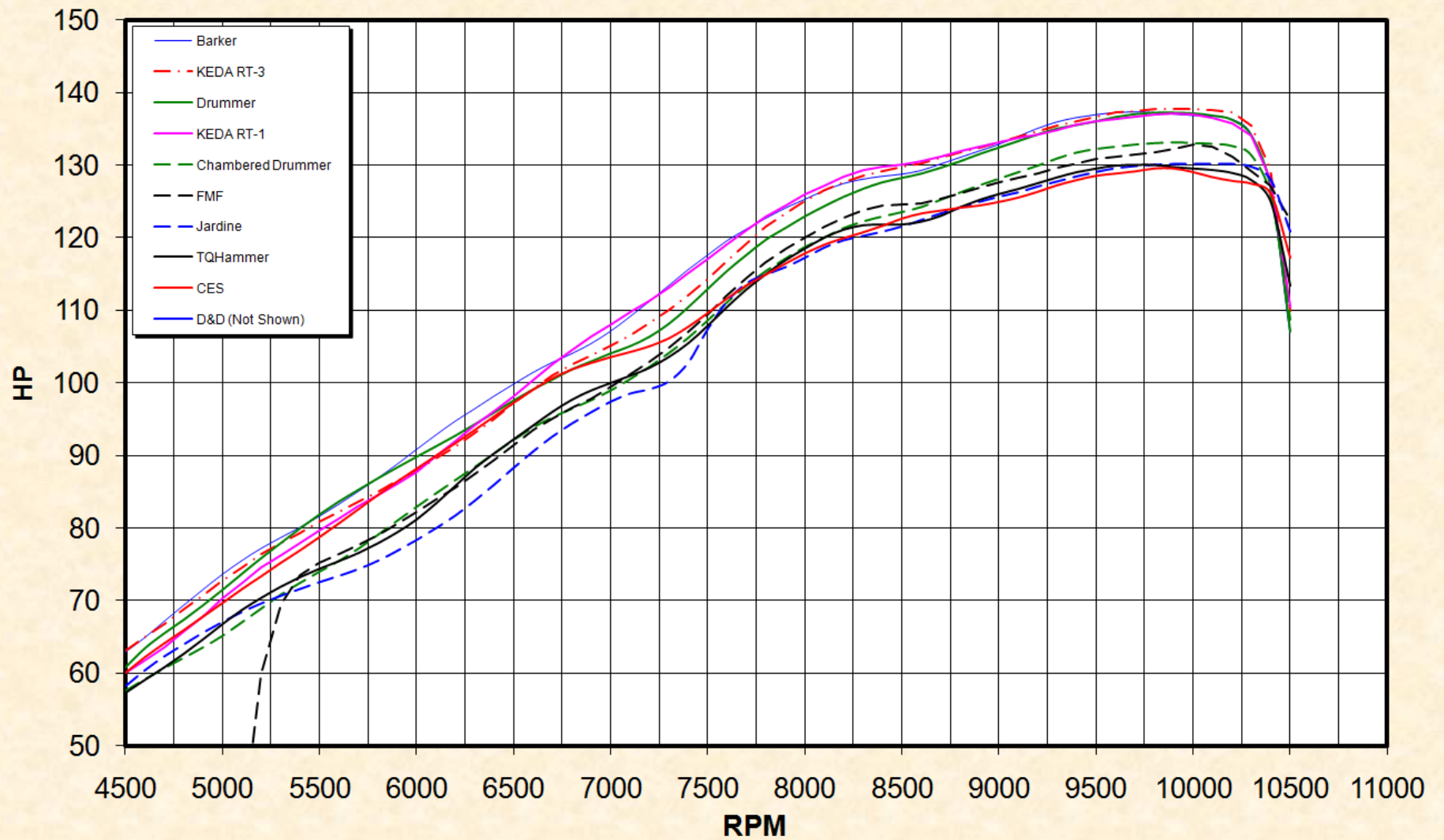


Figure 27 – HP, Race Map, un-tuned

HP, Final Map, Legend Ordered @ 9500 RPM

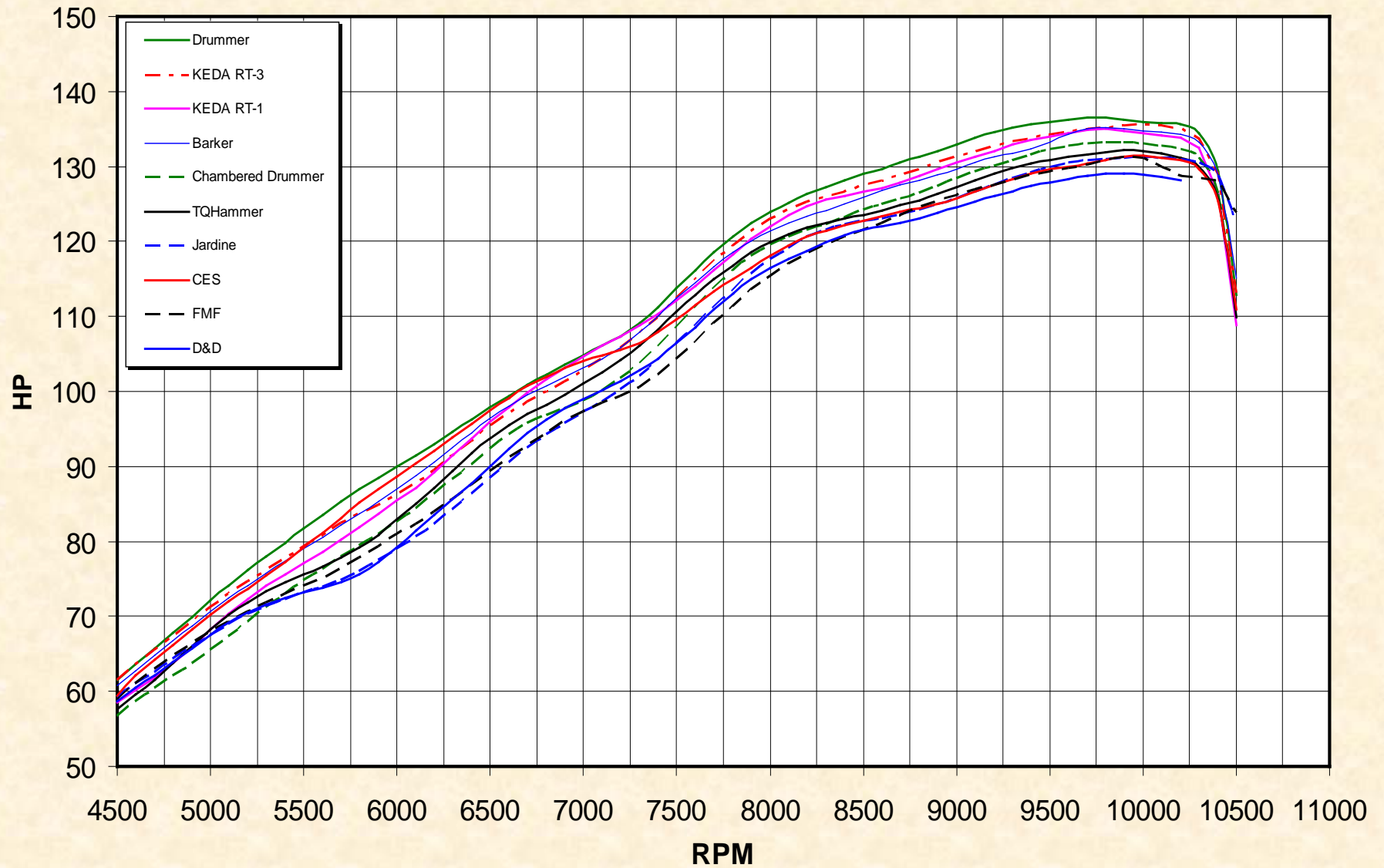


Figure 28 – HP, Final Tuned Map

Max Torque, Legend Ordered @ 8000 RPM

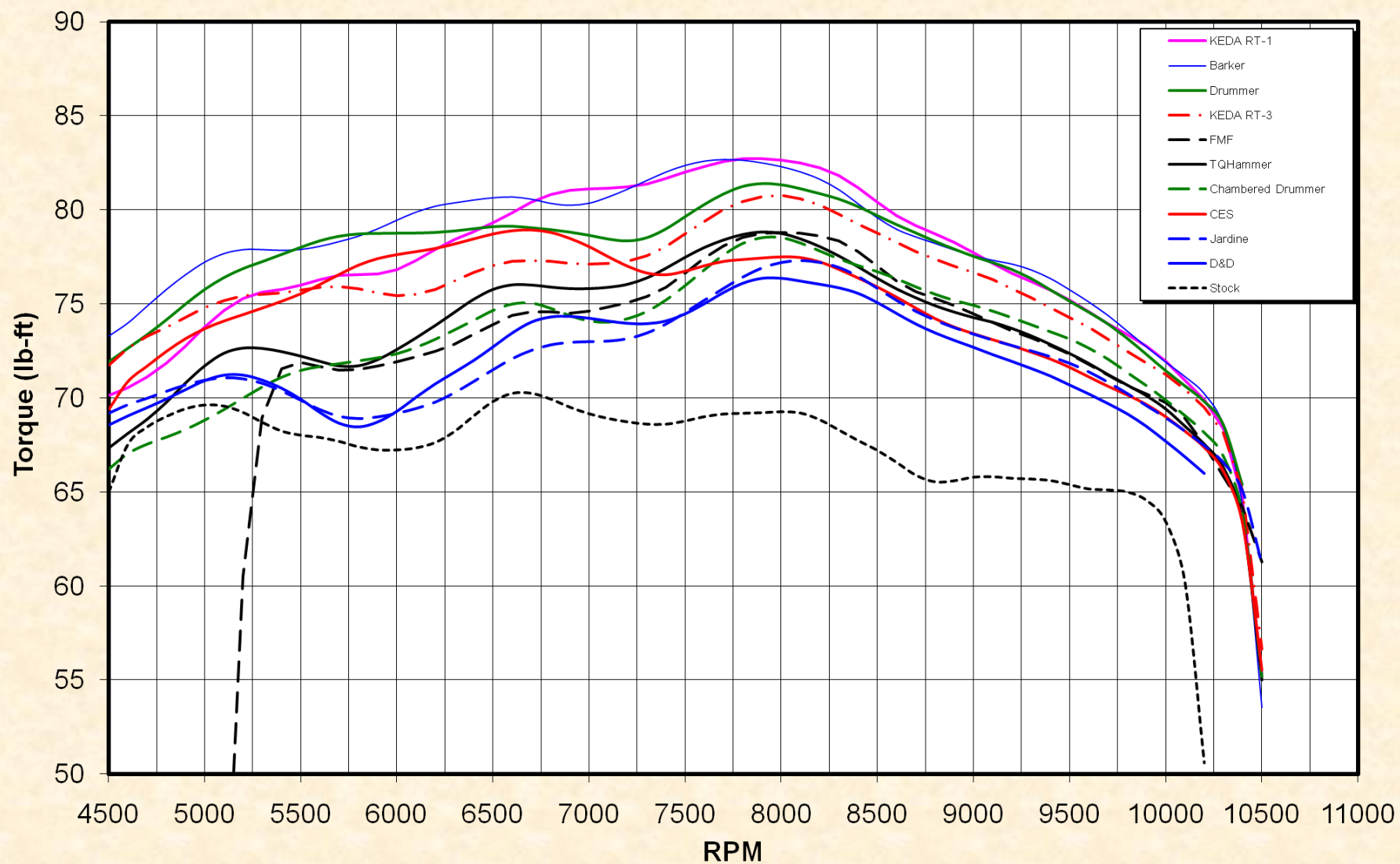


Figure 29 – Max Torque, Regardless of Map

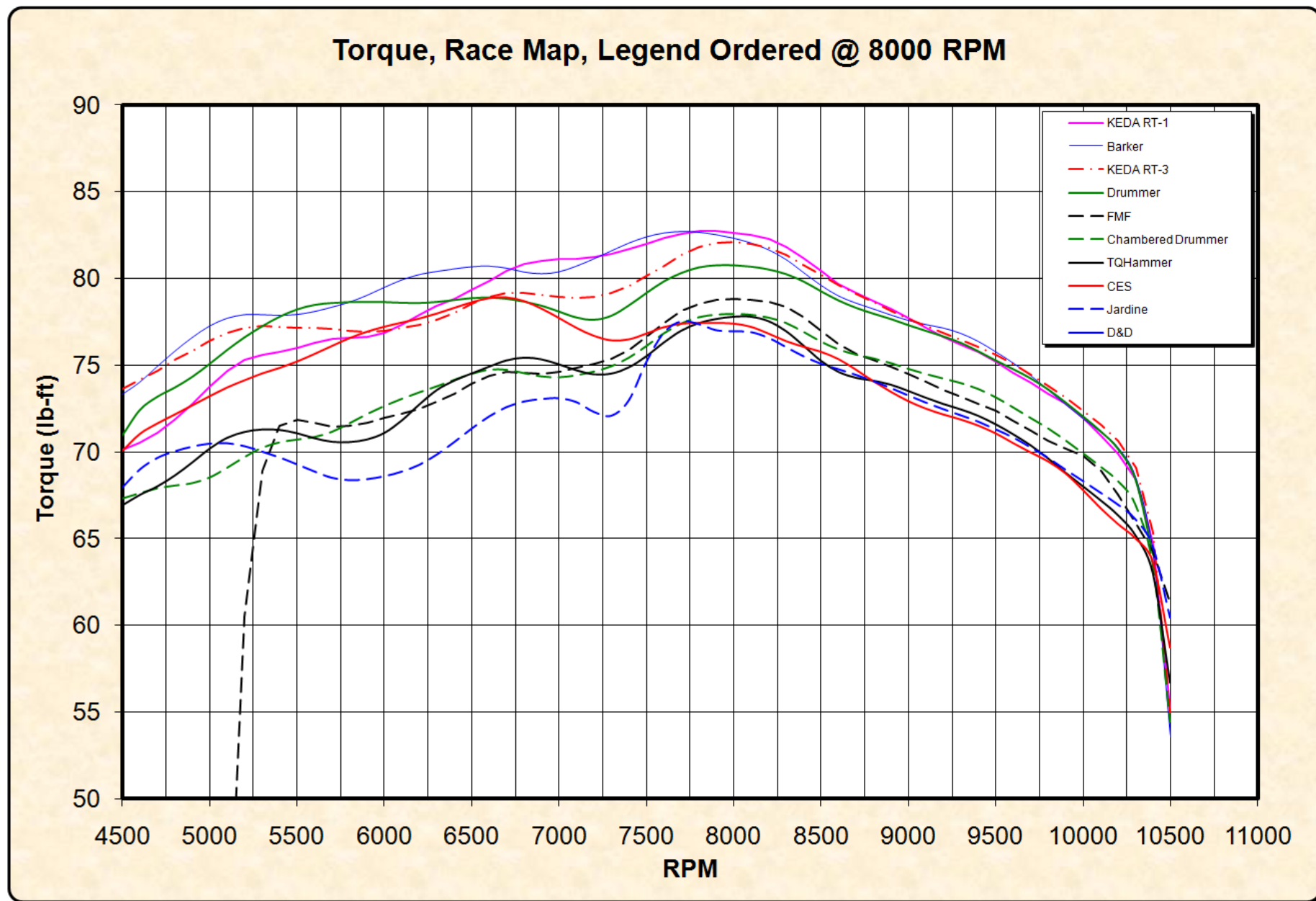


Figure 30 – Torque, Race Map, un-tuned

Torque, Final Map, Legend Ordered @ 8000 RPM

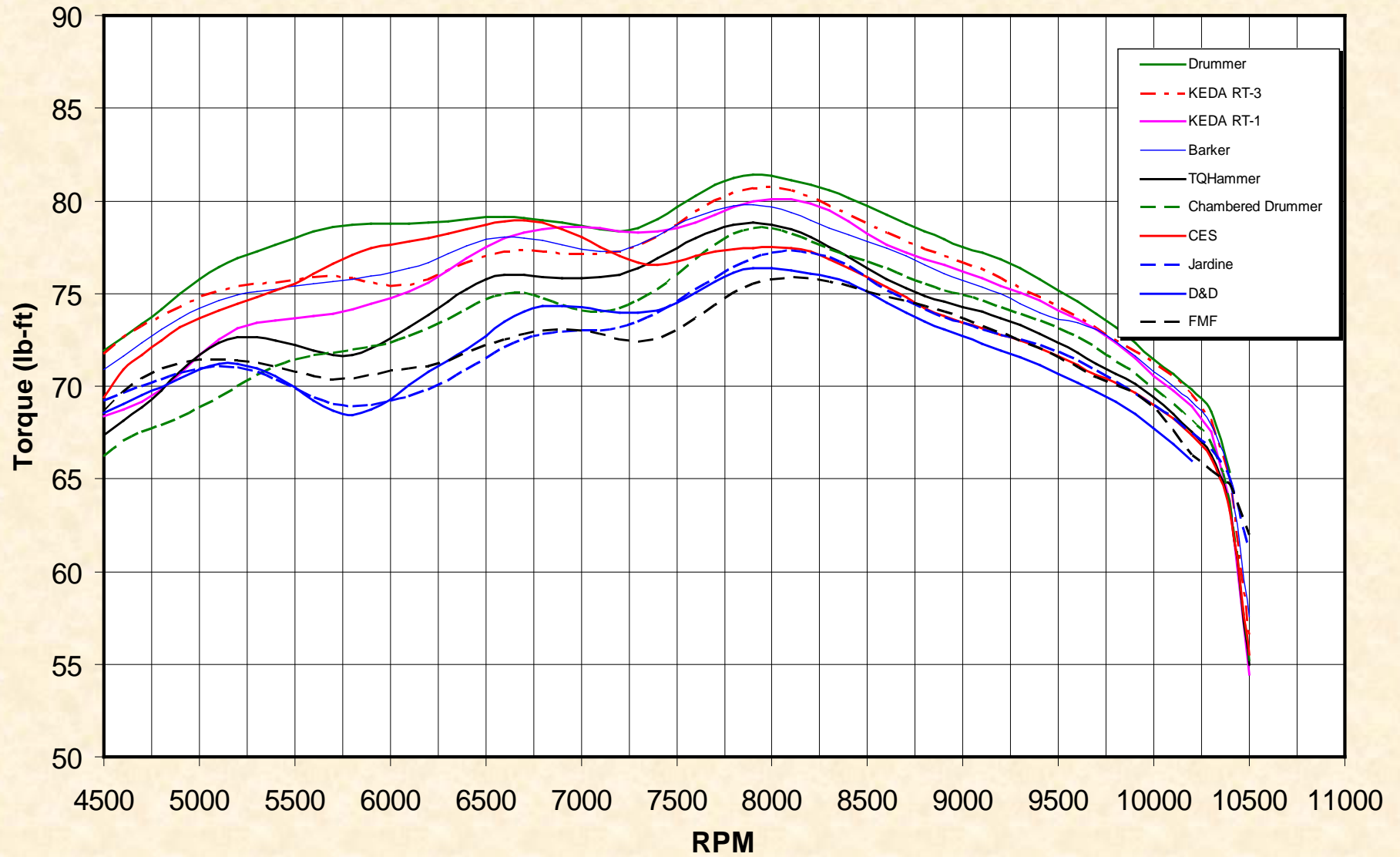


Figure 31 – Torque, Final Map

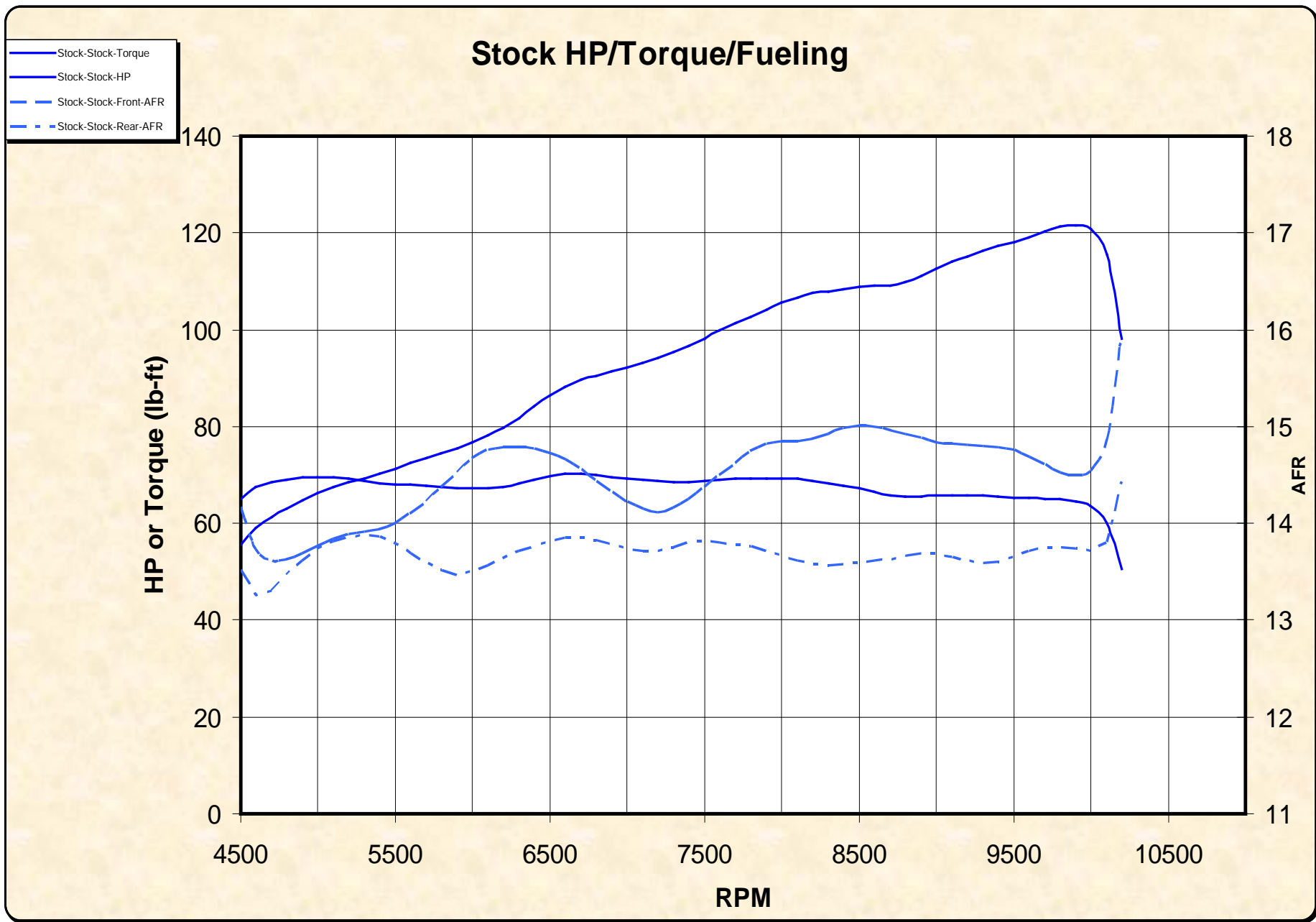


Figure 32 – Stock Muffler, Torque and HP

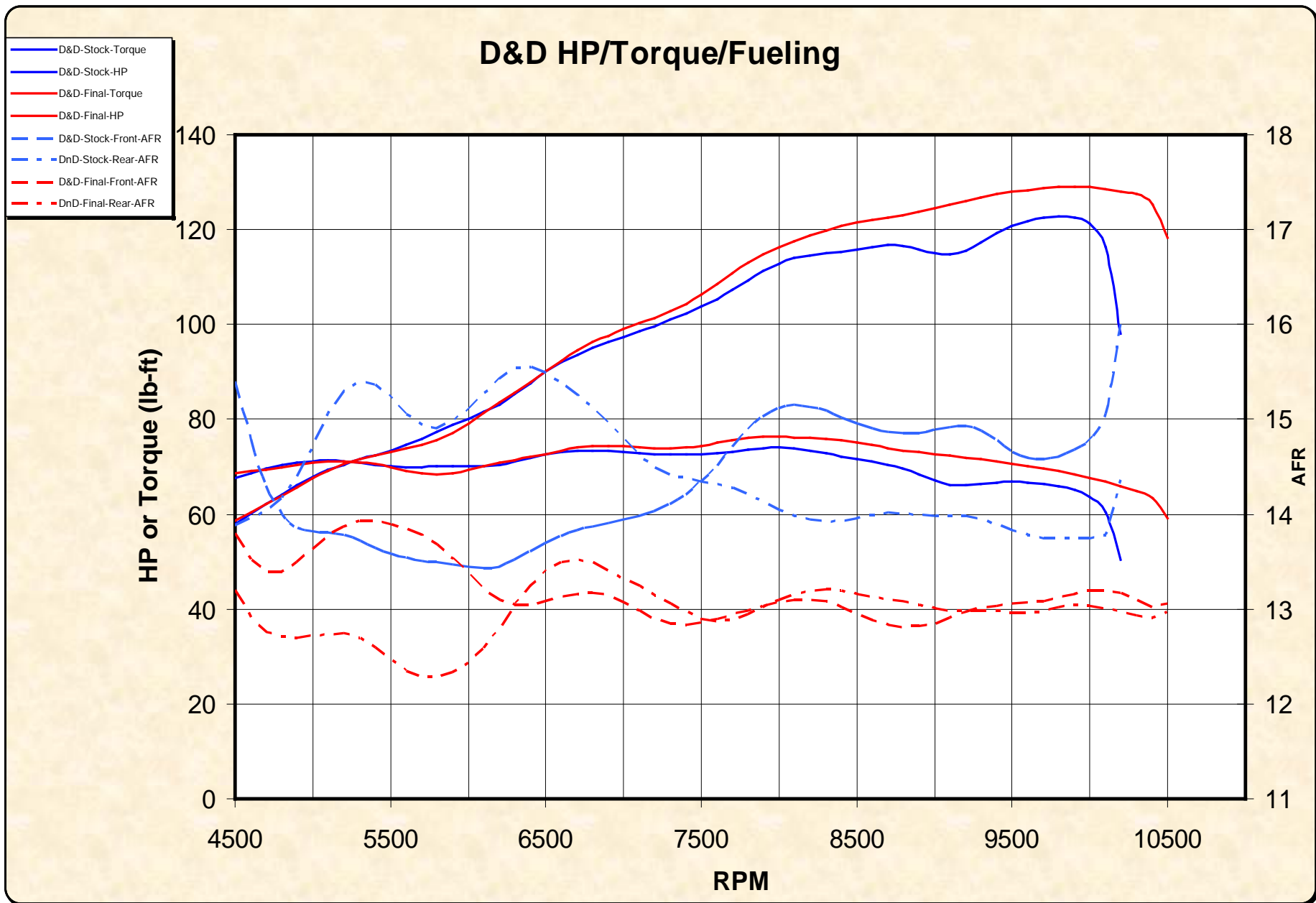


Figure 33 – D&D Torque and HP

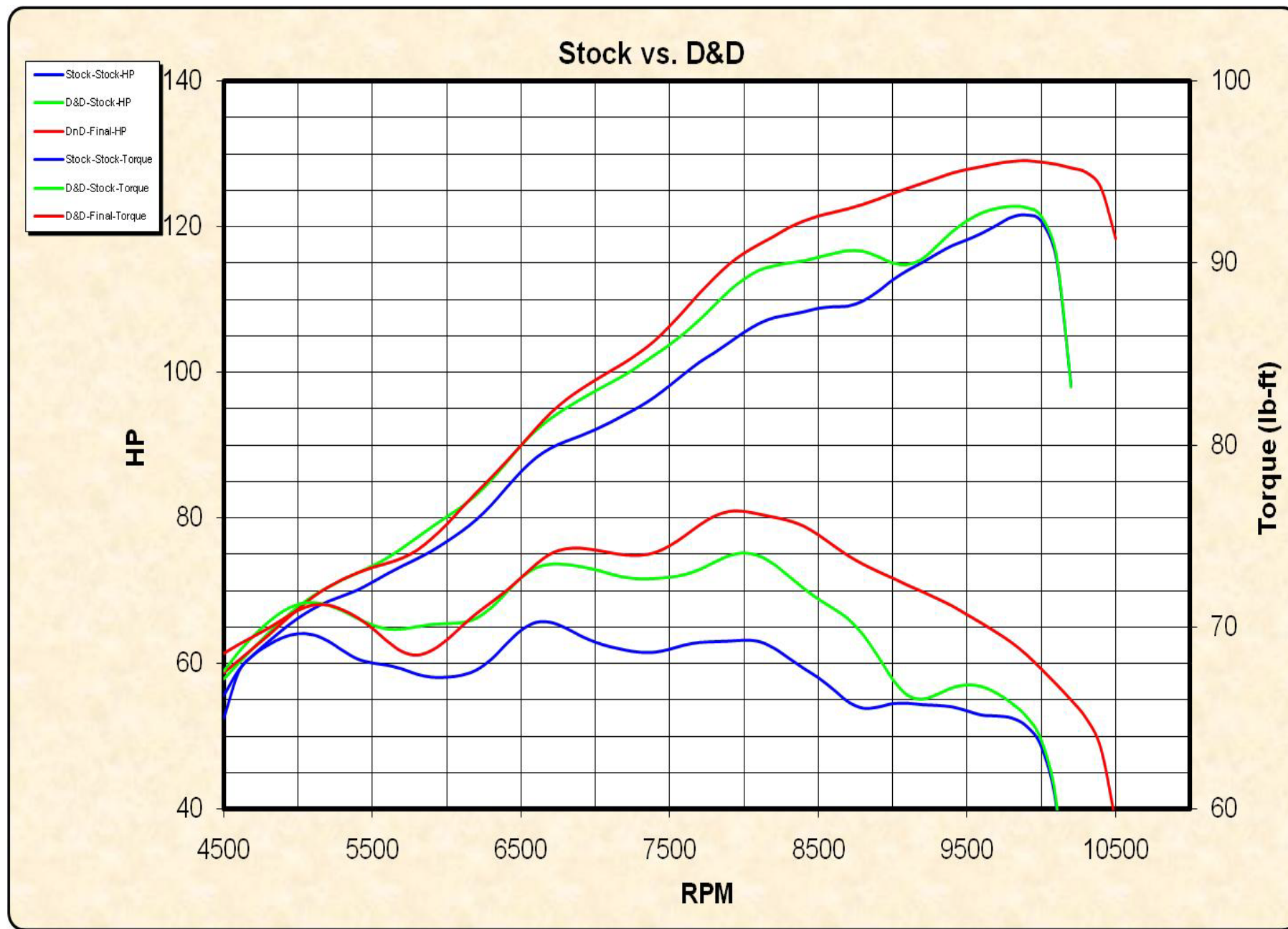


Figure 34 – Stock vs D&D

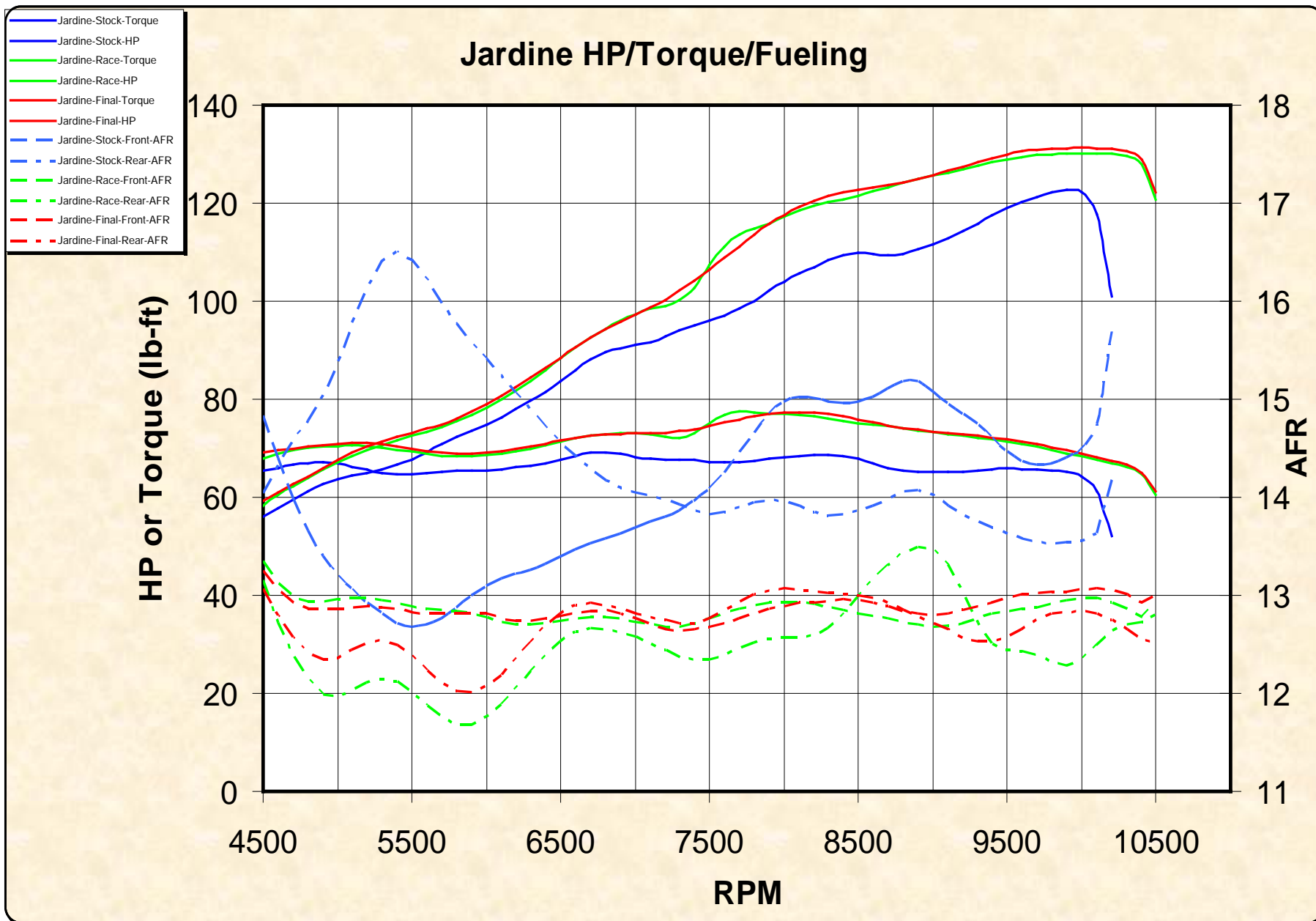


Figure 35 – Jardine Torque and HP

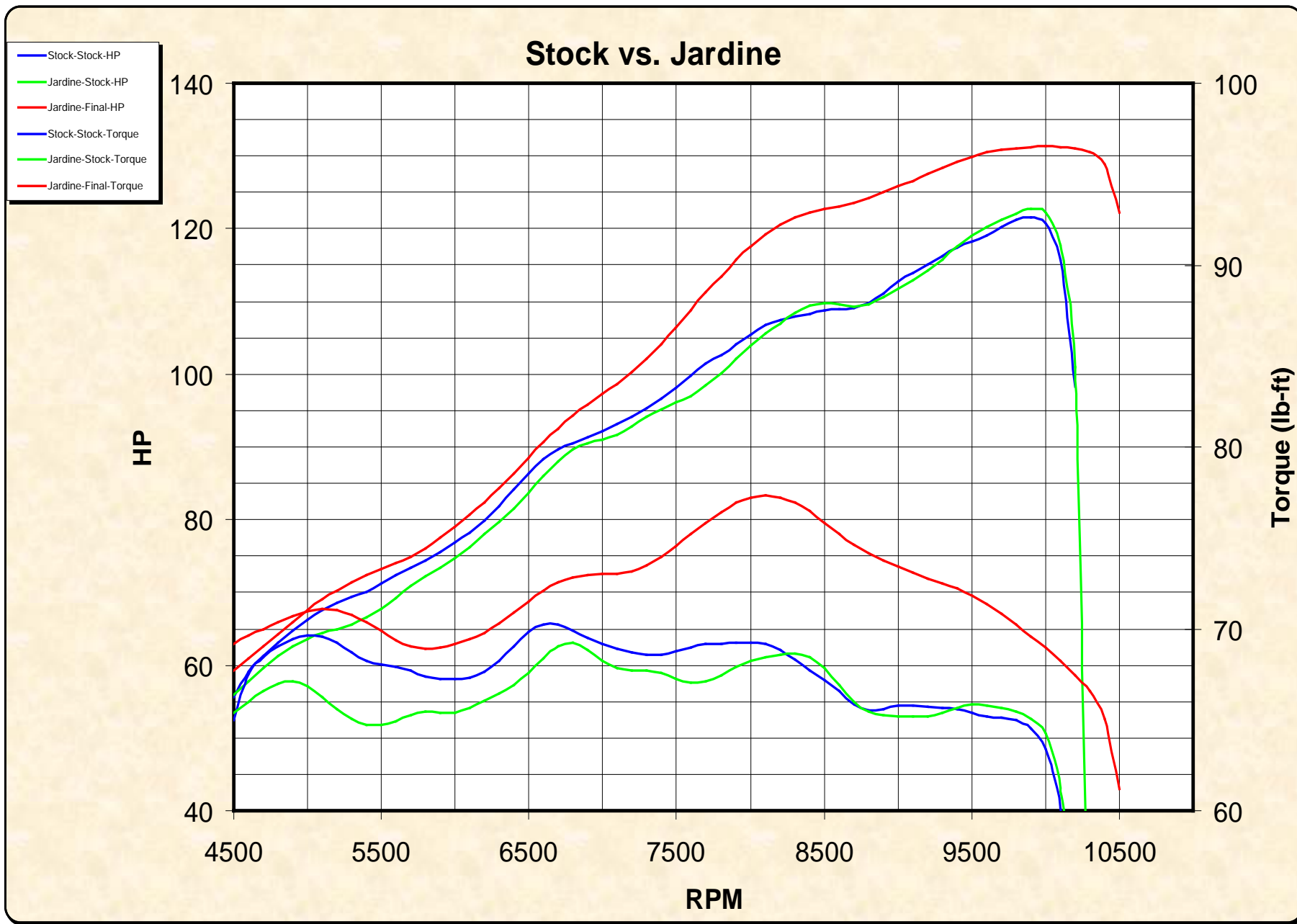


Figure 36 – Stock vs Jardine

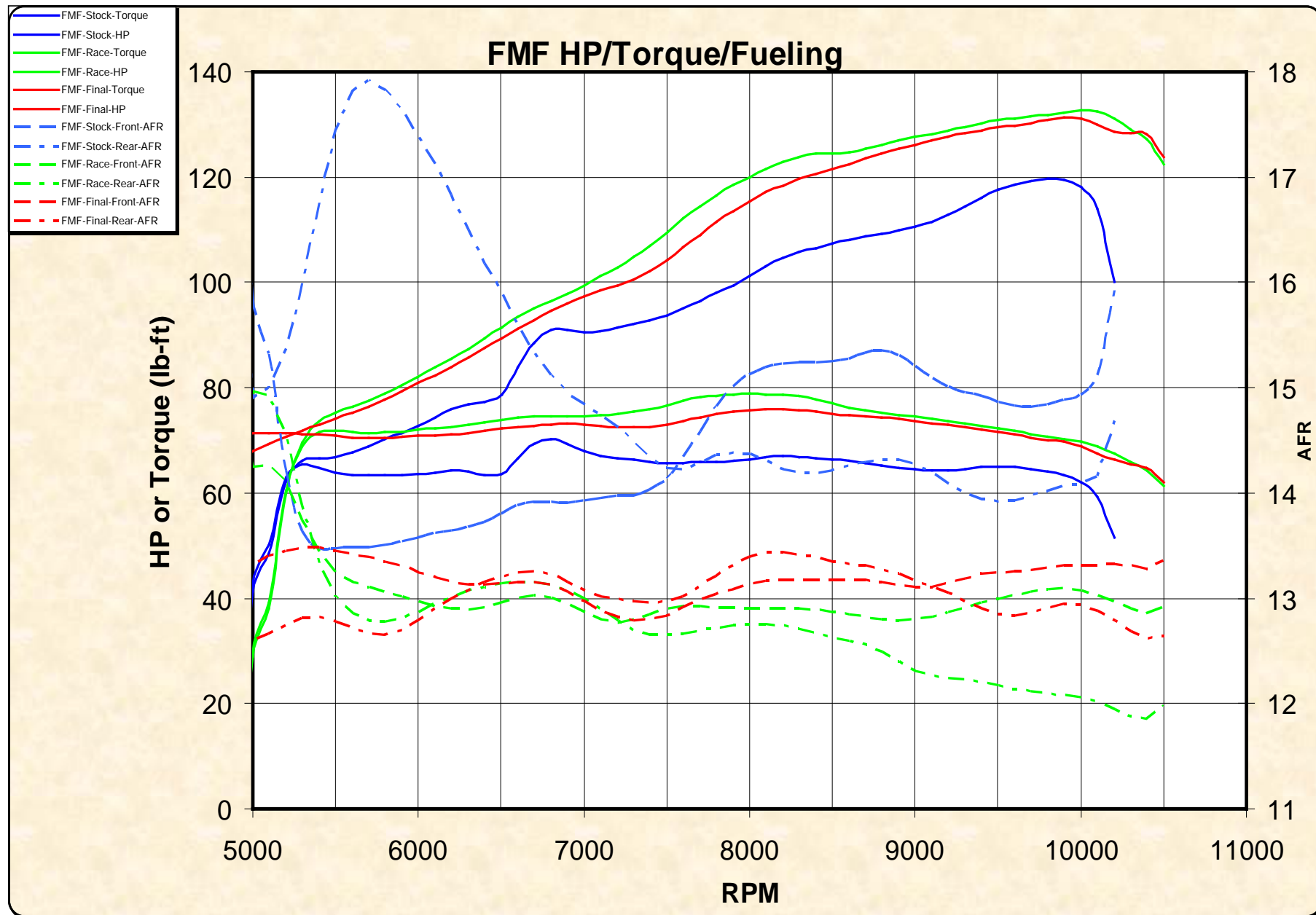


Figure 37 – FMF Torque and HP

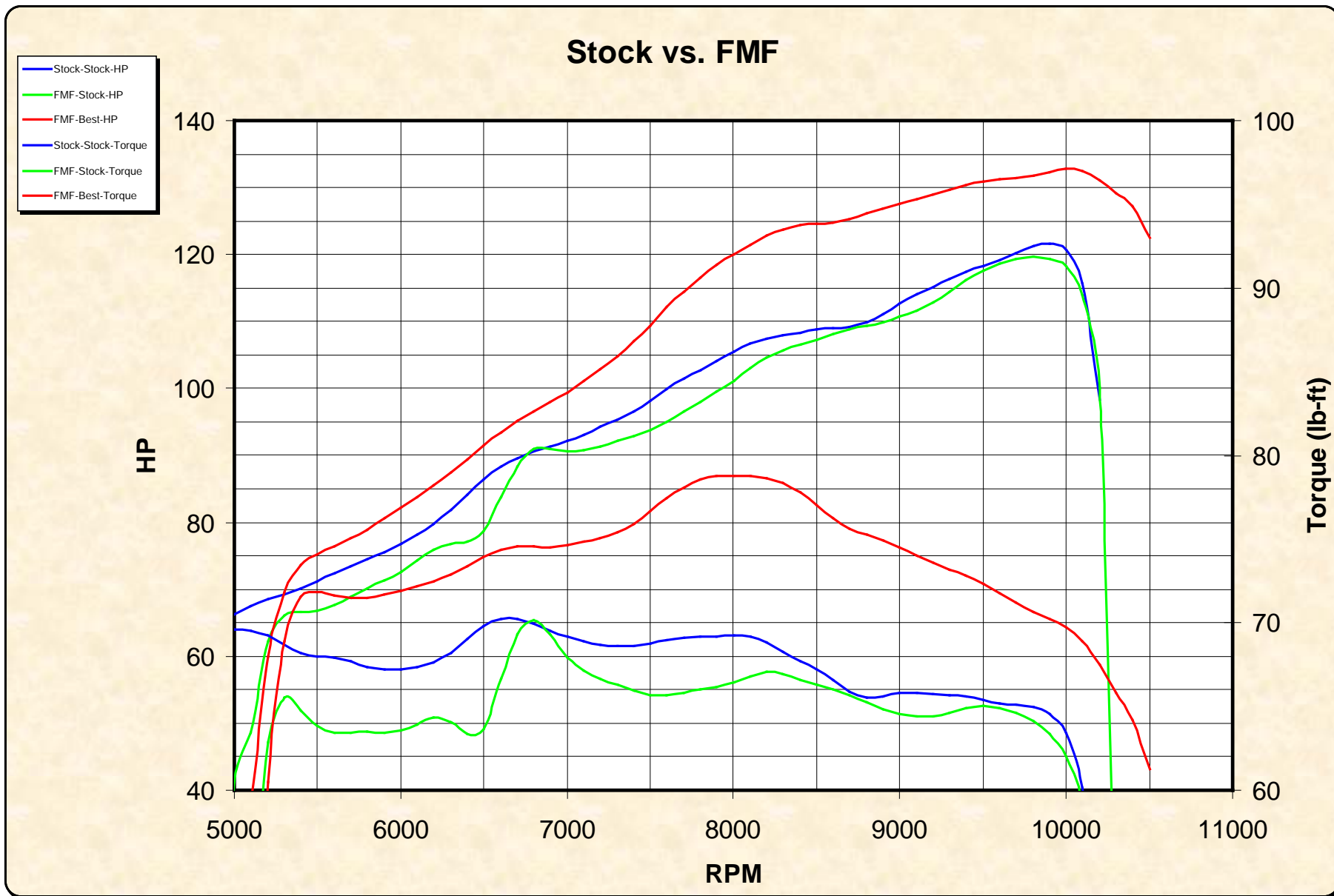


Figure 38 – Stock vs FMF

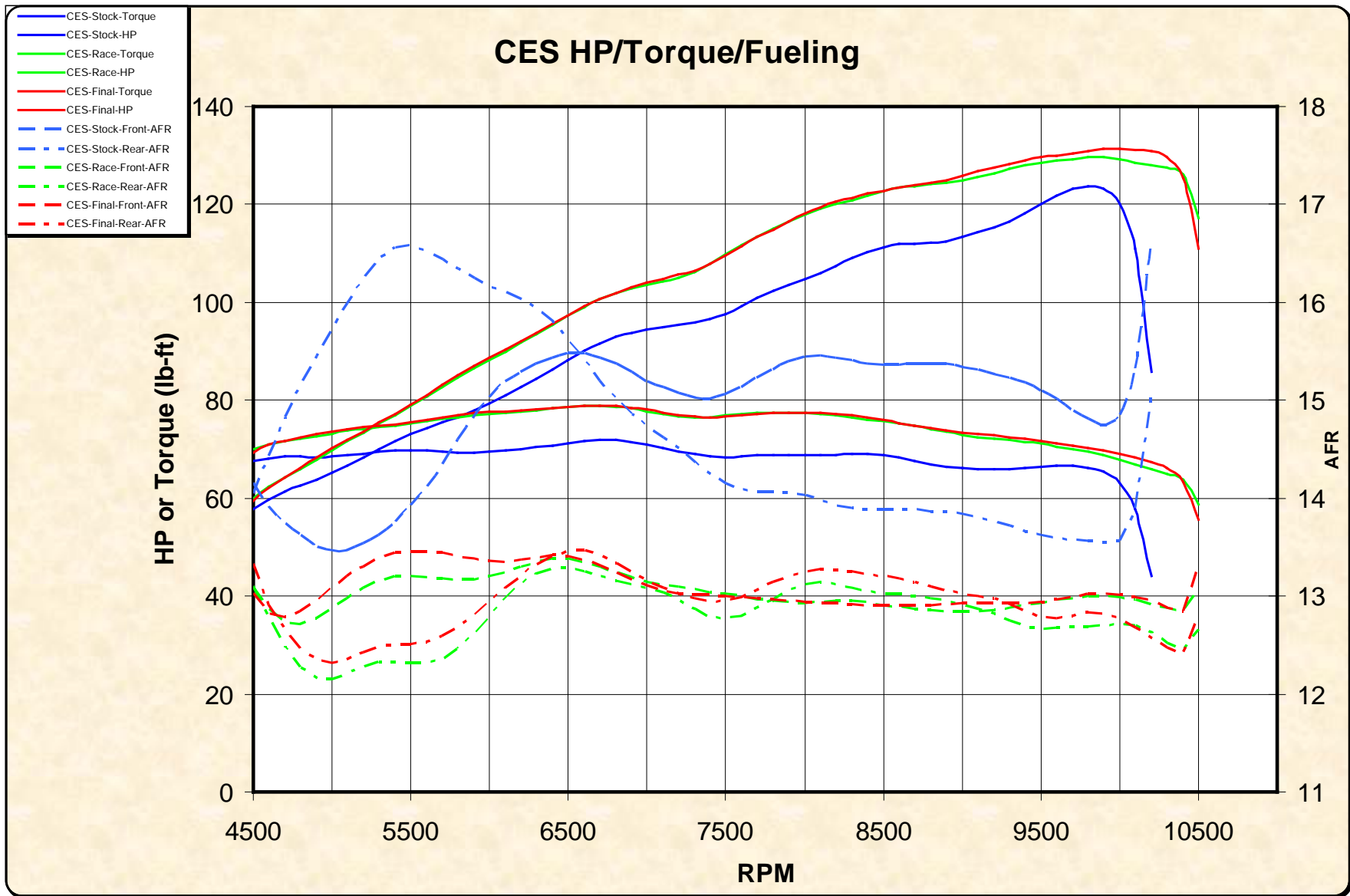


Figure 39 – CES Torque and HP

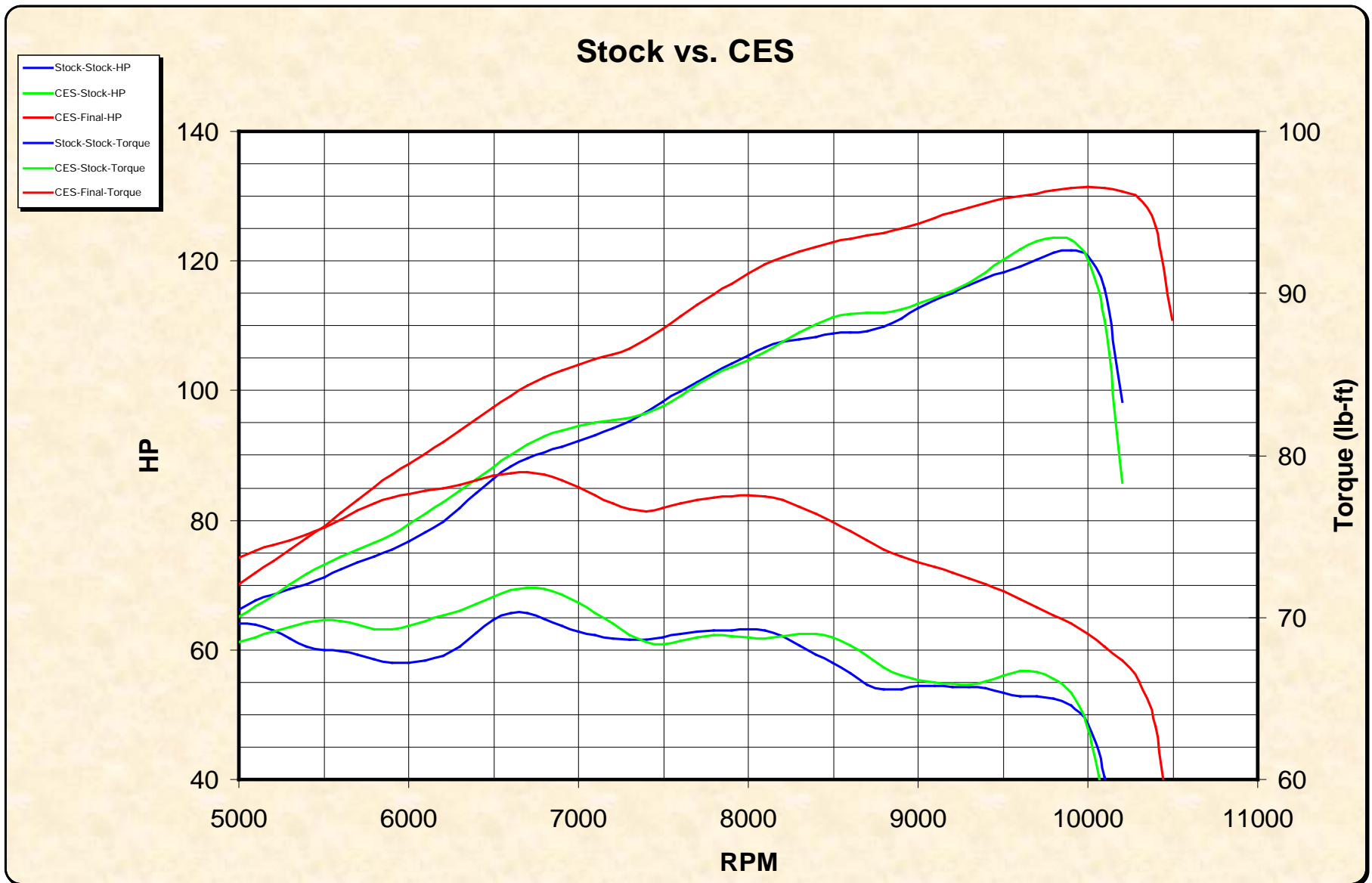


Figure 40 – Stock vs CES

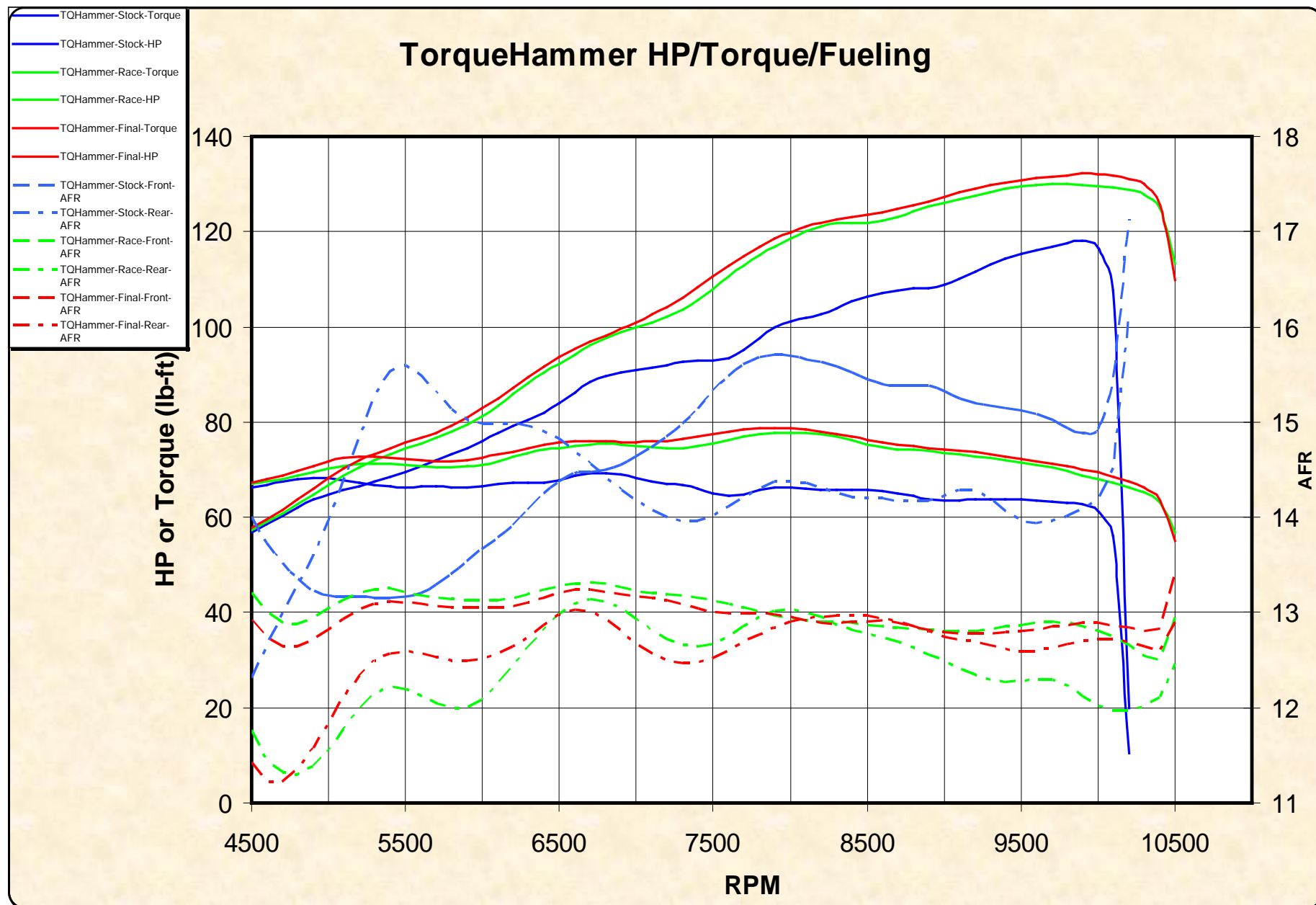


Figure 41 – TorqueHammer Torque and HP

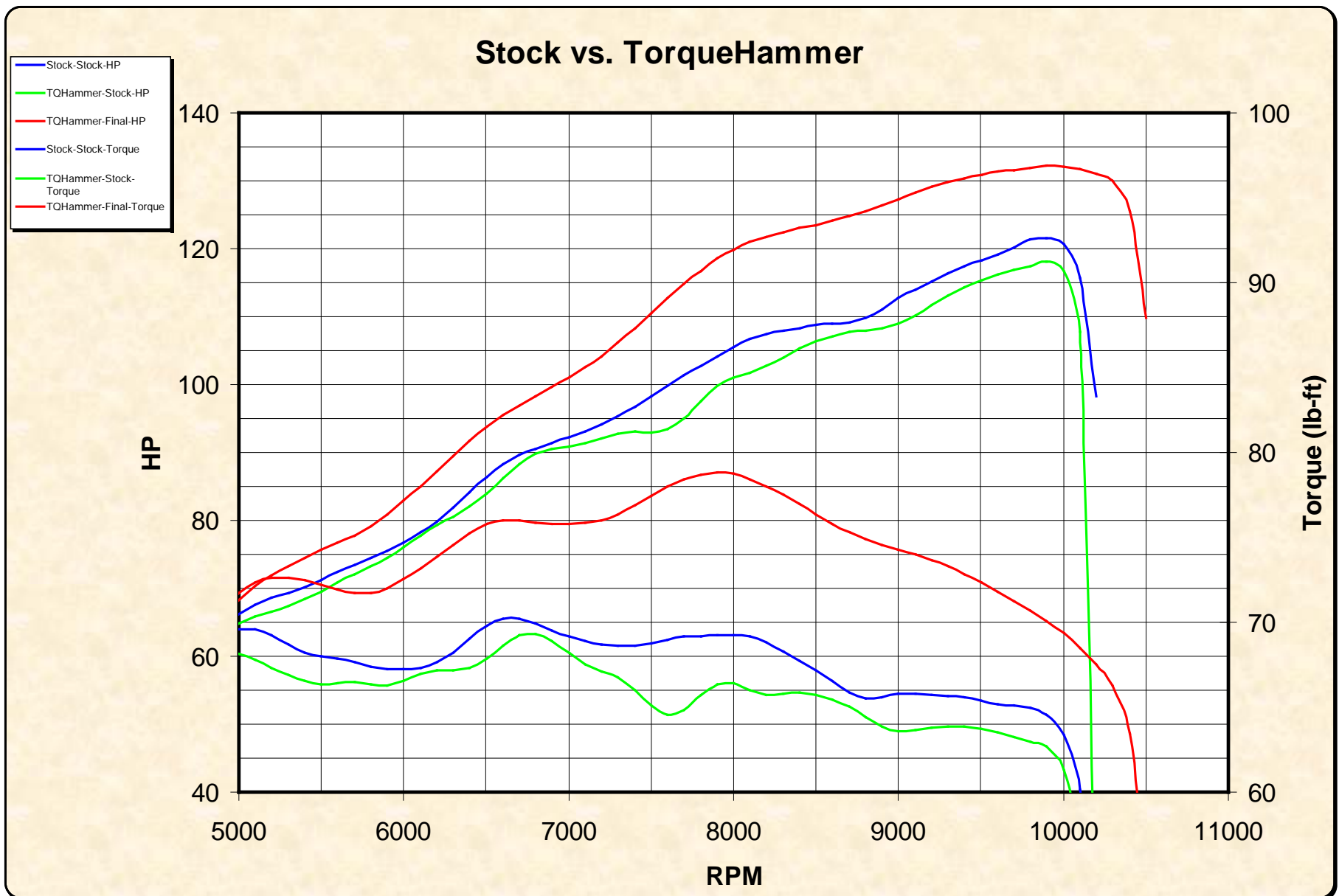


Figure 42 – Stock vs TorqueHammer

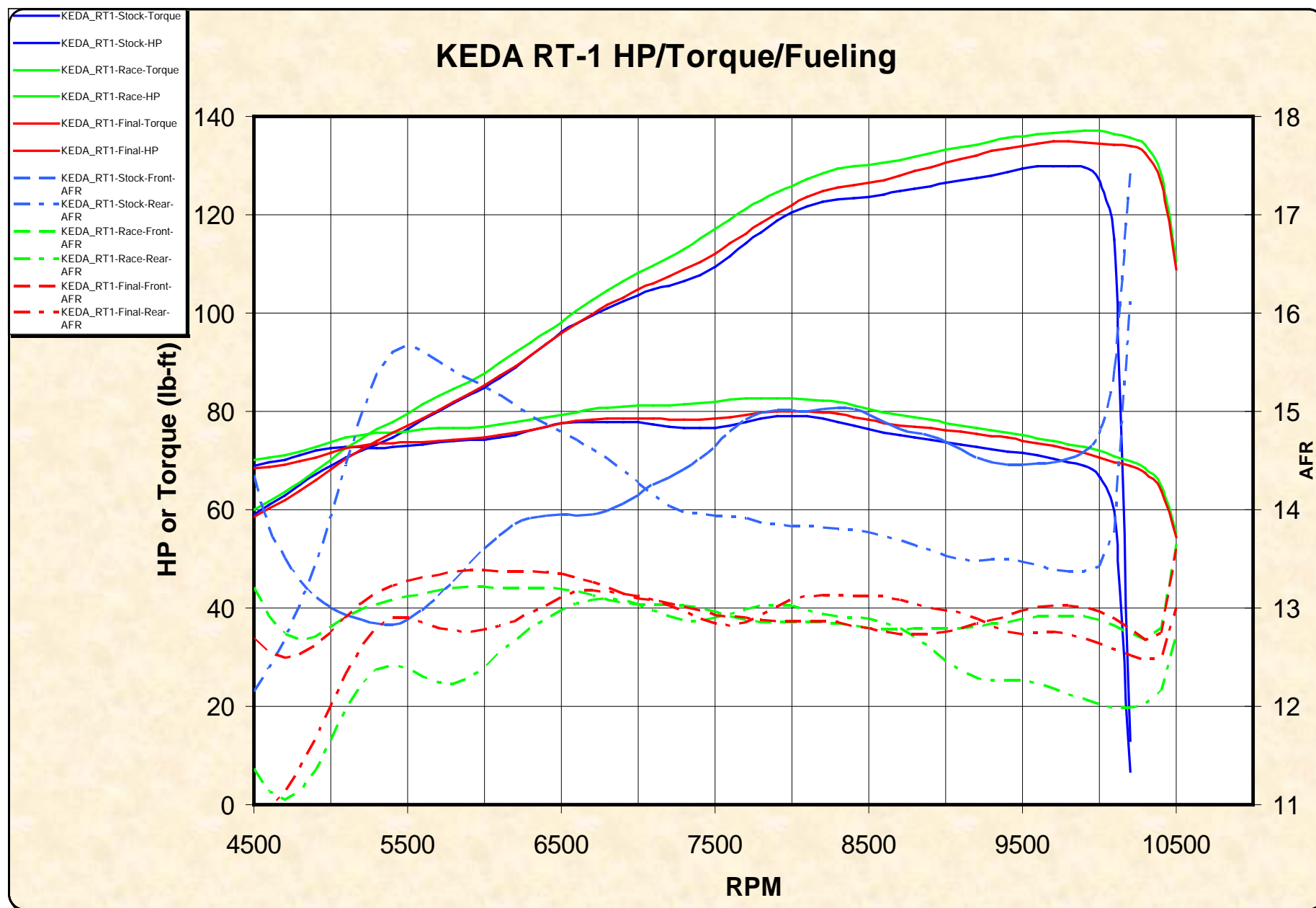


Figure 43 – KEDA RT-1 Torque and HP

Stock vs. KEDA RT-1

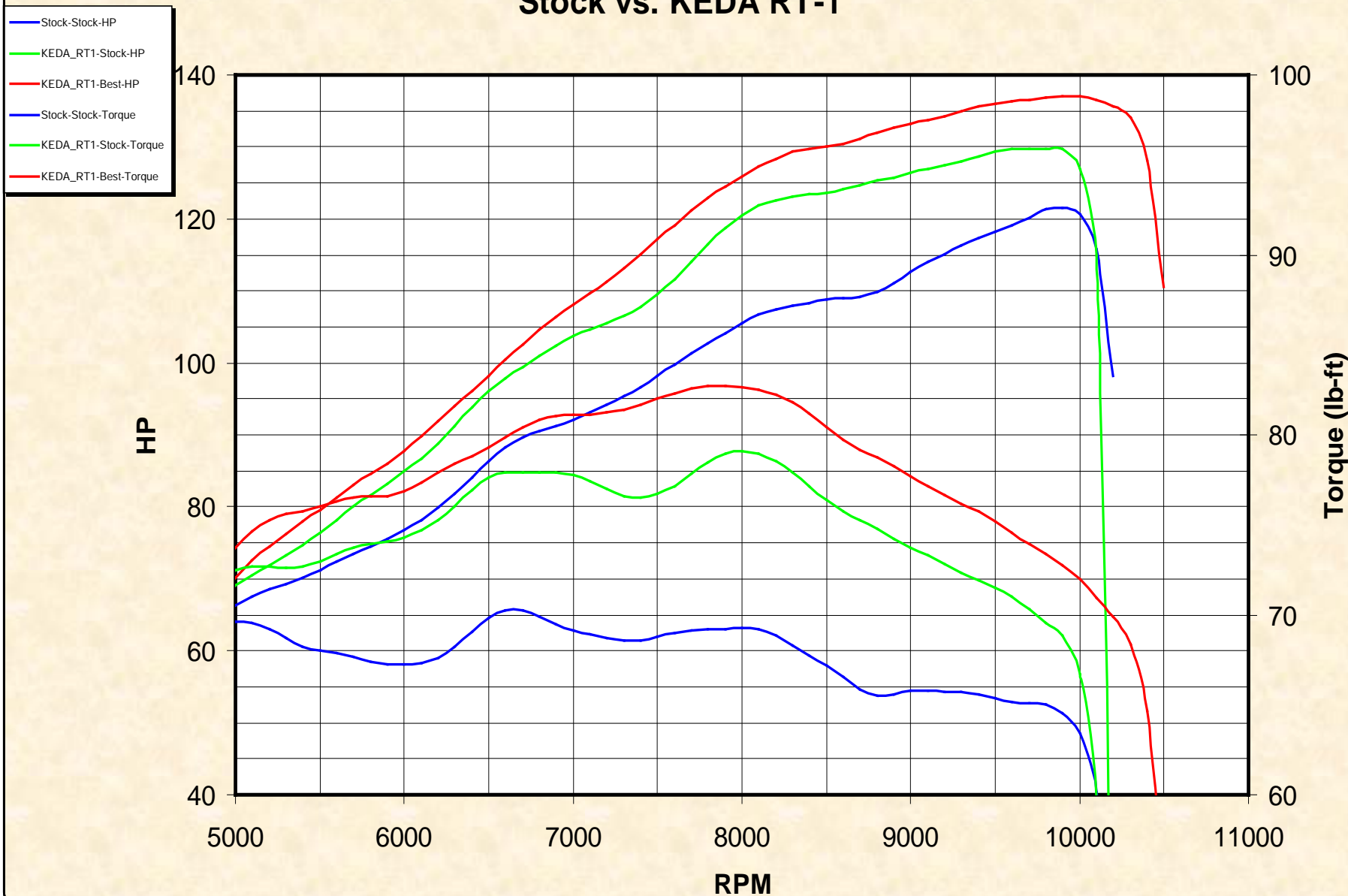


Figure 44 – Stock vs KEDA RT-1

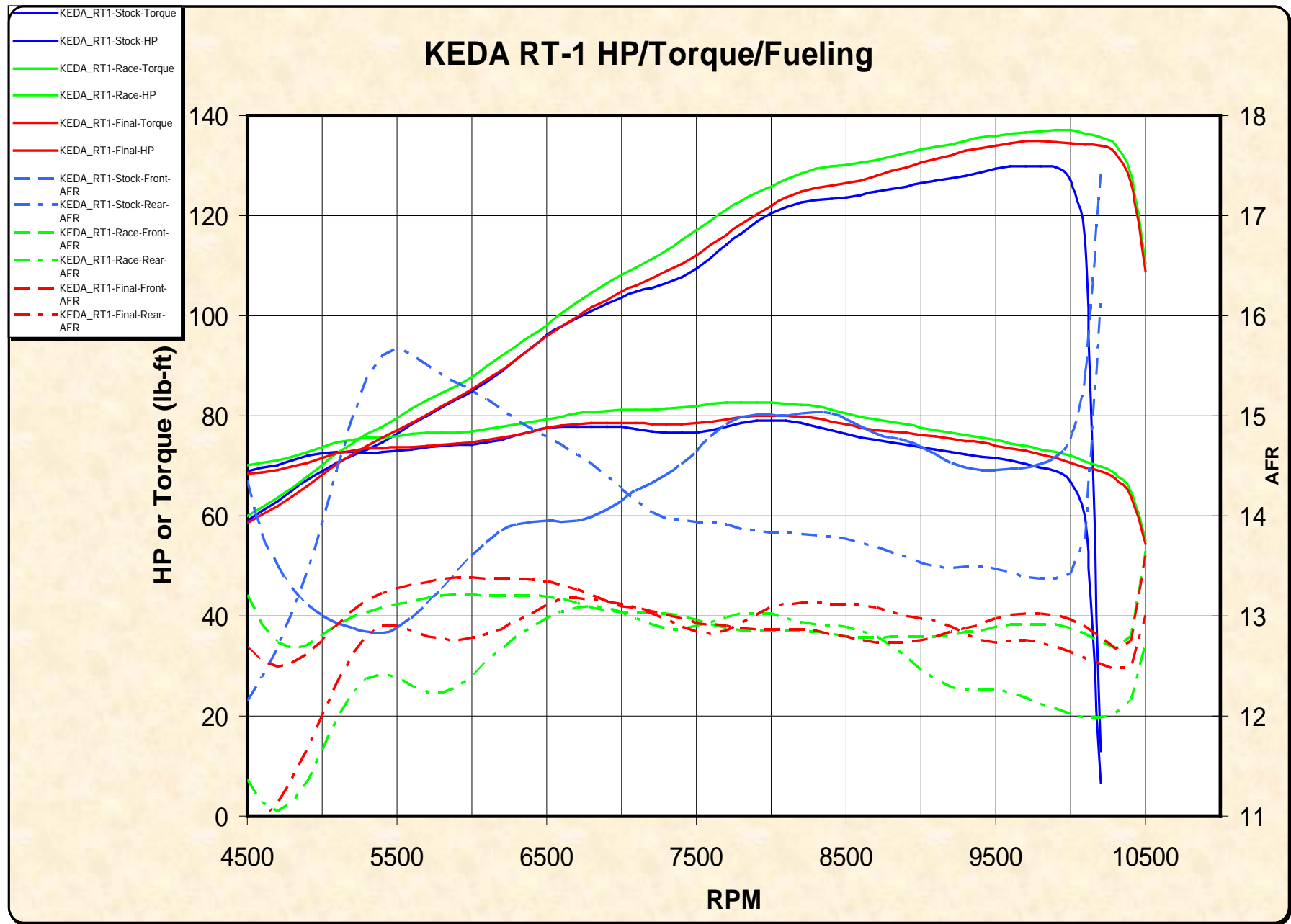


Figure 43 – KEDA RT-3 Torque and HP

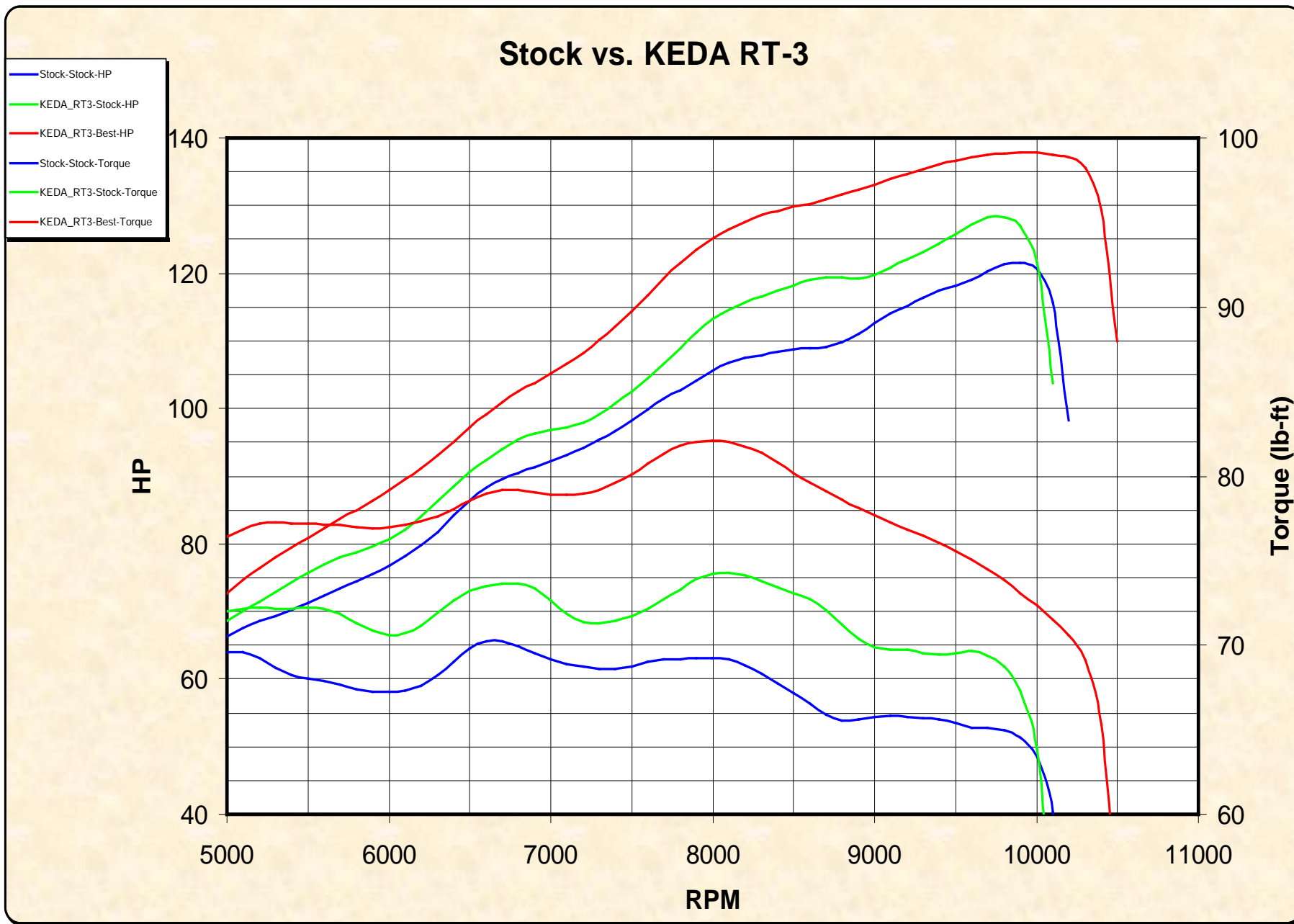


Figure 44 – Stock vs KEDA RT-3

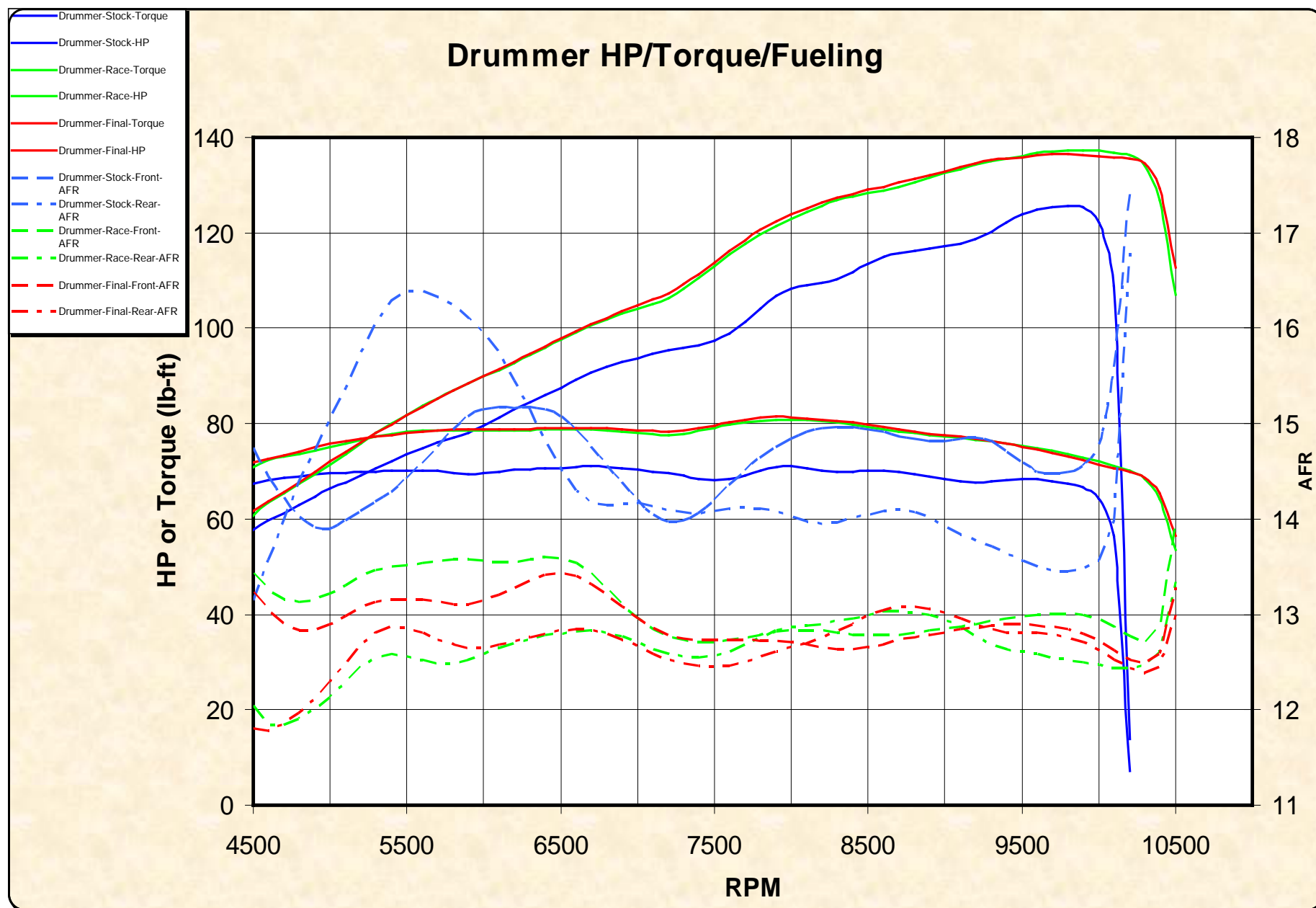


Figure 45 – Drummer Torque and HP

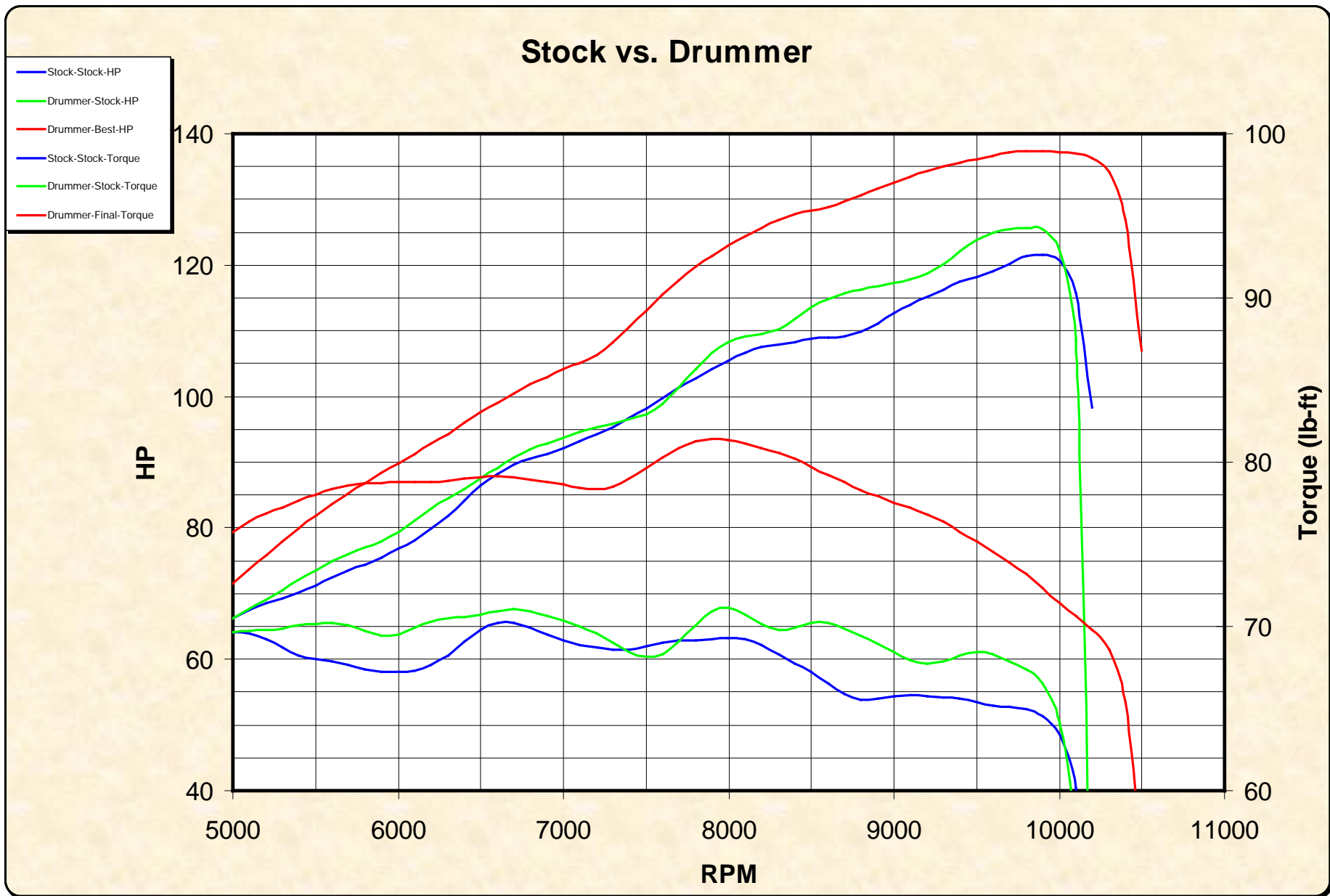


Figure 46 – Stock vs Drummer

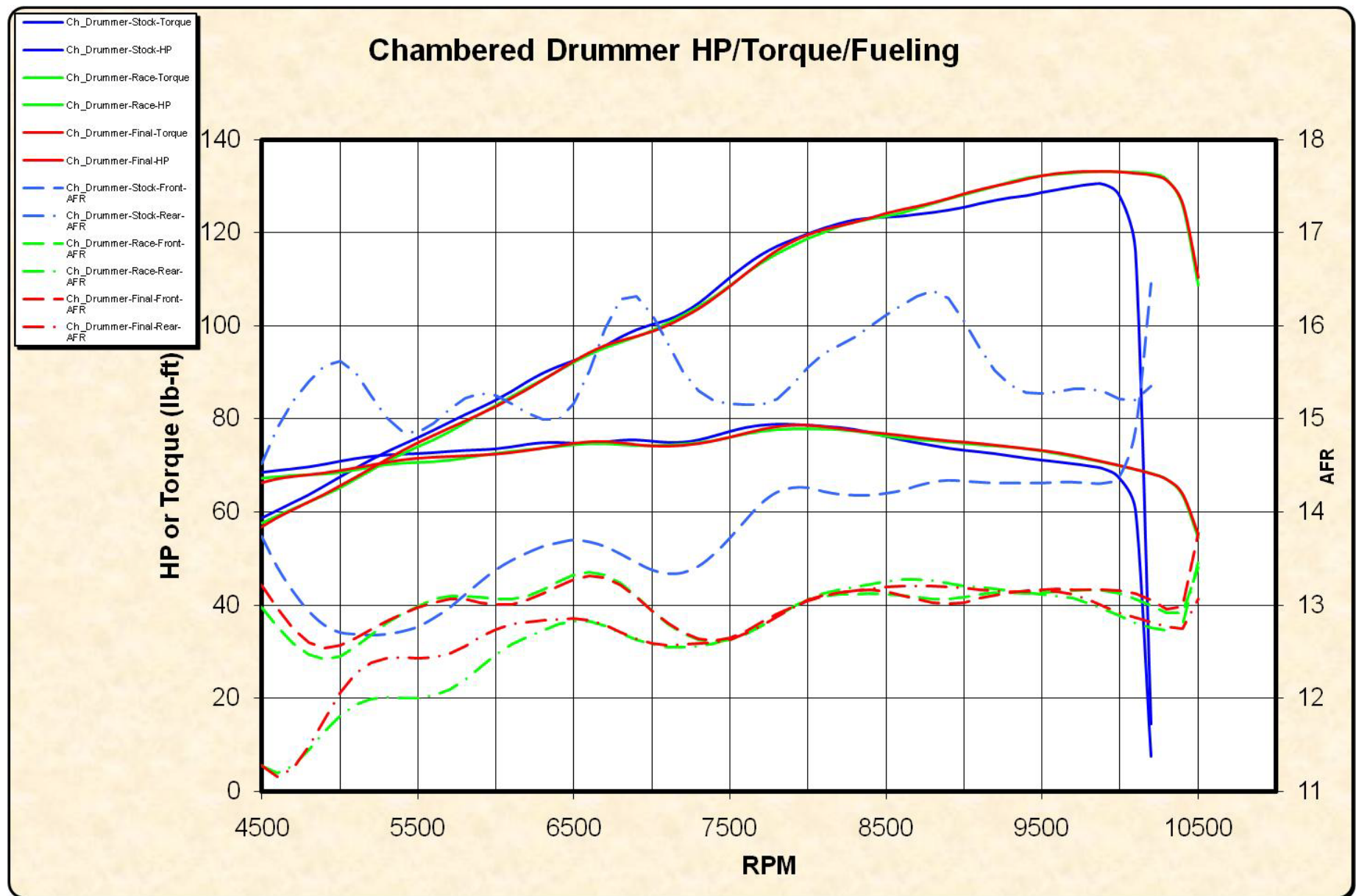


Figure 47 – Chambered Drummer Torque and HP

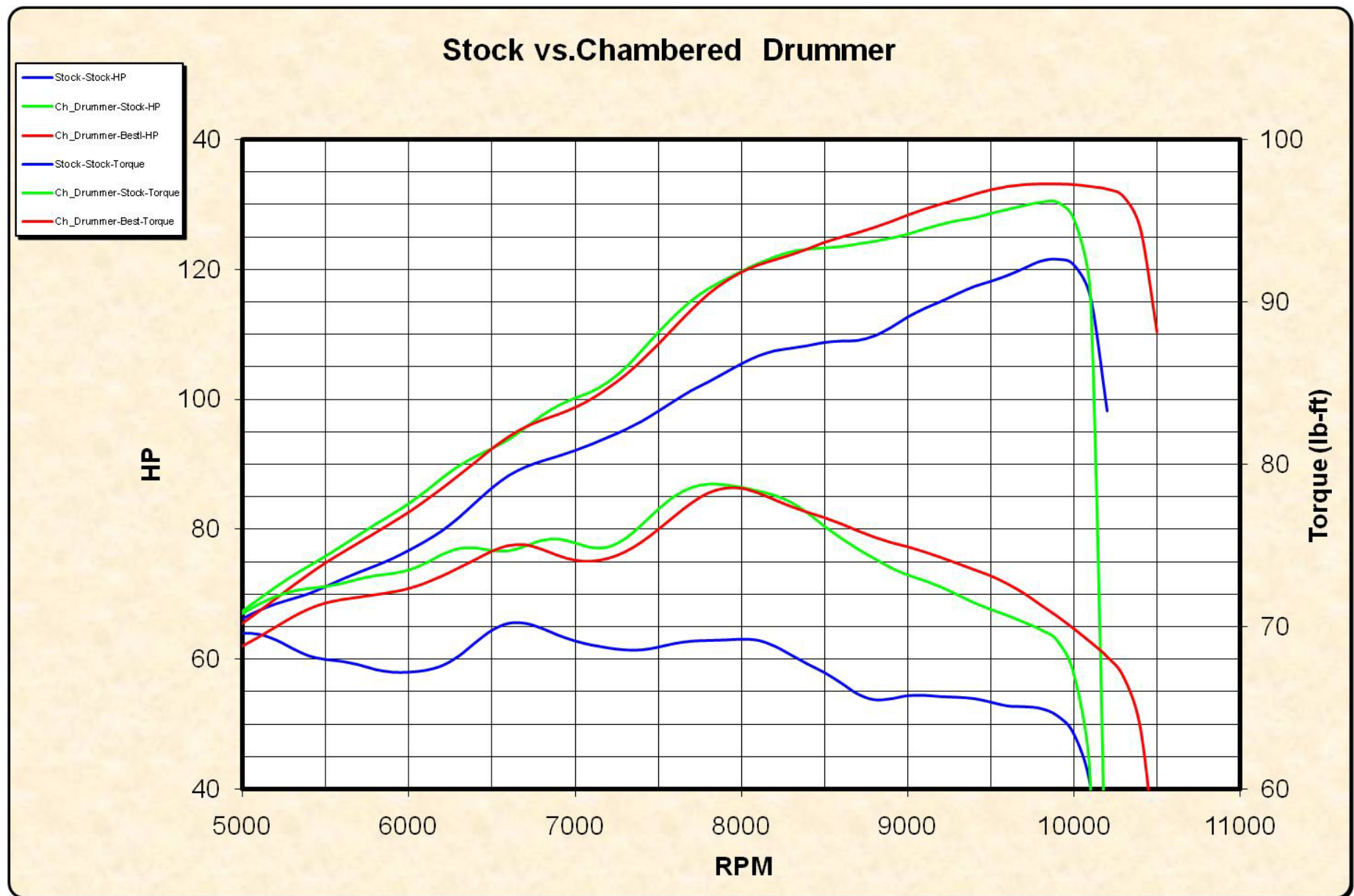


Figure 48 – Stock vs Chambered Drummer

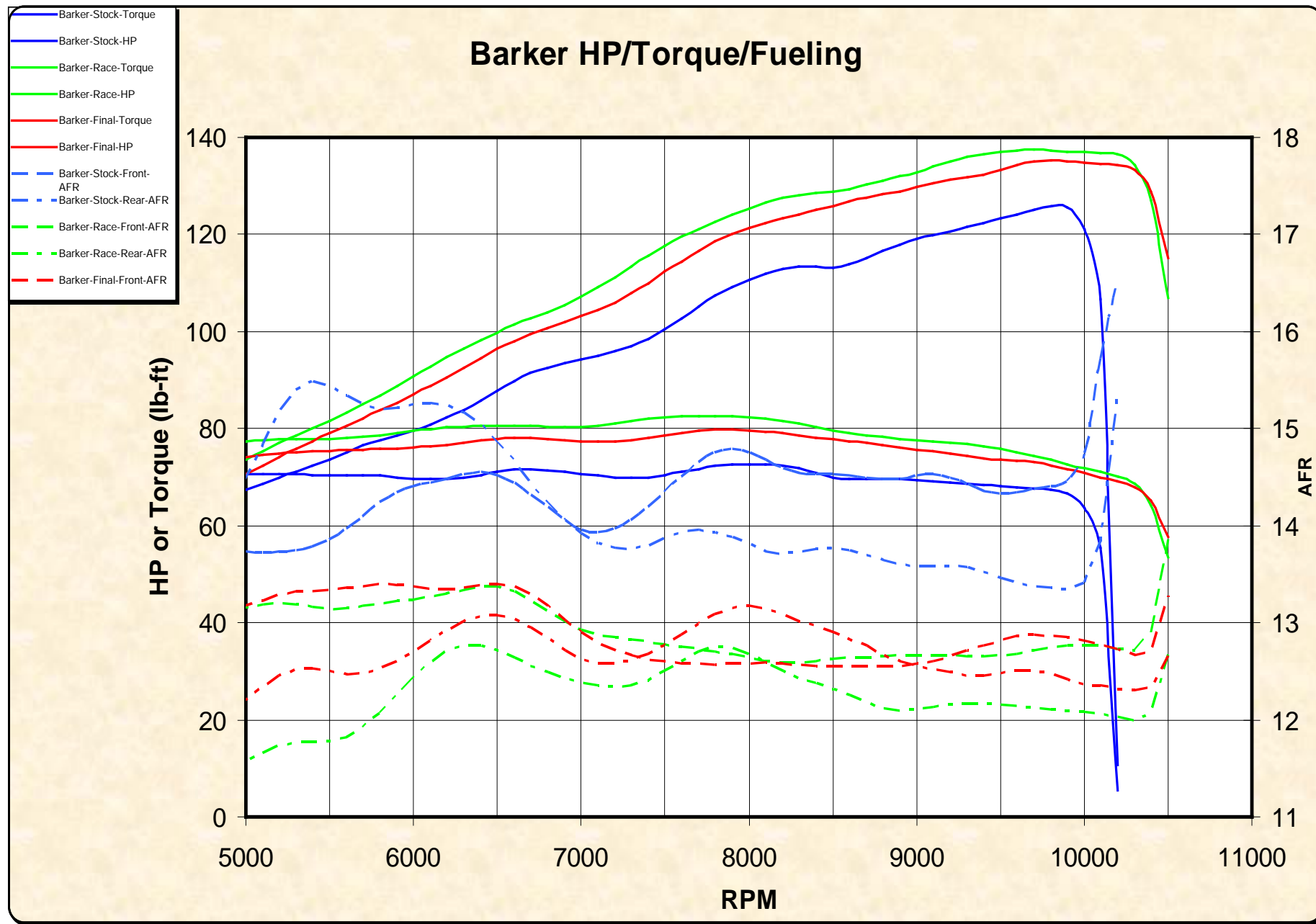


Figure 49 – Barker Torque and HP

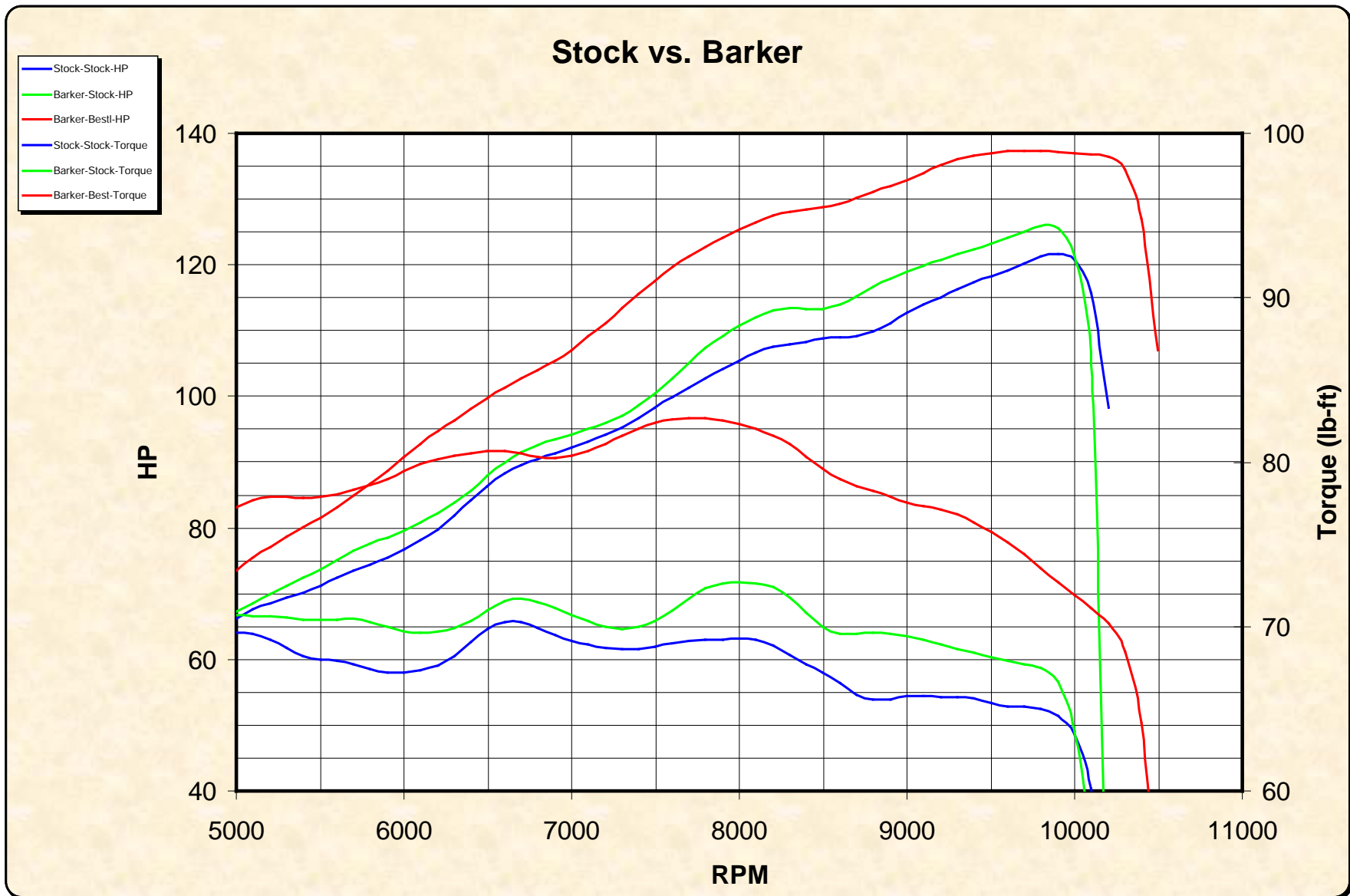


Figure 48 – Stock vs Barker

Conclusions

The intention of this report is to provide the objective data so that the reader can make his own conclusions. However, I will provide some general conclusions based on the experiences obtained during the testing and the subsequent data analysis.

All of these pipes run on the stock map with the AFVs at 100 ran leaner than I would ever want to run one of MY motorcycles. After seeing these results, I would run a stock pipe only unless I had a proper map or tuned ECM. Perhaps the AFV mechanisms would take care of some of the lean issues, but the Buell ECM compensating mechanism (AFV scaling) is only capable of scaling the entire fueling curve up or down. It is not capable of flattening peaks and raising valleys in the fueling curves.

ALL of the data collected and displayed in this report is Wide Open Throttle (WOT) data only. The frequency response (RPM) of the pipe is well characterized by this type of testing. But the fueling curves that are shown represent ONLY the WOT response. Since the FI maps in the ECM are different for each throttle setting, the fueling matches displayed may not be typical of the fueling response at other throttle settings.

None of these pipes were only a little bit louder than stock. They are all CONSIDERABLY louder, and some even painfully so. We did not get a chance to test the noise reduction inserts made by a few of the manufacturers. That is something that I'd like to re-visit some day. Regardless of the legalities, many of these pipes should probably not be operated on public roads, or at least not in quiet hours or urban environments. I remarked to Erik Buell that I thought this engine seemed louder than its contemporaries (i.e., Ducati, Aprilia V-twins), and he said that he thought it was, but didn't have a good explanation as to why.

Final Comments

Every effort was made to make this report as accurate and objective as possible. There are many things I'd do differently if we had it to do over again. The data isn't perfect, and I'm sure it doesn't answer all questions that you might ask. You may see other raw data on these exhausts from other sources that won't match exactly. This is to be expected, all bikes and dynos are a little bit different. Small differences of 1 to 2 HP are pretty easy to see in multiple dyno runs without changing anything, so it is fairly pointless to debate differences of that magnitude from one pipe to the next. In the end, look only to the curve shapes and the relative performance differences between the exhausts presented here and ignore the absolute values. The absolute values are virtually meaningless when comparing data from different sources.

Revision Information:

7/14/2010- Rev A Initial Release

7/14/2010- Rev B

- Fixed chambered drummer correction factor and all affected tables/plots
- Minor typos
- Fixed MSRP on RT-2 and RT-4 mufflers