D&D F1200 two-stroke twin w/ Boondocker custom drag turbo system

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D&D Motorsports' F1200 turbo grass dragracer was brought to DTR by Dale, Glenn and Scooter for verification of the seemingly lean A/F ratio (14-1-ish) indicated by the wideband unit on the sled and perhaps tune for more power. It had been dialed in initially by D&D's Glenn Hall on Glenn's Dynojet track dyno and made great power there but A/F showed lean. Field testing has been promising, with sub-four second 500' ETs reported even with the indicated lean mixture. Our initial dyno testing here verified Glenn's wideband readings—the four injectors delivered 240 lb/hr at 60 psi fuel pressure, and our own wideband on the SuperFlow dyno read lean as well. Our first full dyno run netted an incredible 454 CHP (all testing was done with nitrogen blanketed VP Import gas which is 120 motor octane).

We had attempted to obtain mechanical A/F readings for verification, using the two fuel flowmeters (one measuring gross flow from pump to rail and the other subtracting bypassed fuel back to tank) and a 4" diameter airflow meter fitted to the large compressor inlet of the oversize Garrett ball bearing race turbo. The airflow meter has aluminum air straighteners fitted above and below the air turbine wheel. These are 4" diameter aluminum foil honeycomb-shaped discs, maybe ¼" thick. Unfortunately, we discovered just after the 454 CHP dyno test (Glenn seemed bummed that the HP was *that* low) that the lower air straightener had gotten sucked out of the meter by the huge turbo (possibly helped by a lean part throttle sneeze), which totally ingested it, destroying the compressor wheel while it was quisinarting the air straightener into fine confetti that lodged mostly in the top of the intercooler along with the much heavier chunks of aluminum compressor wheel blades. Intercoolers not only drop intake charge temp dramatically, but also make dandy filters to prevent compressor wheel and dyno air straightener shrapnel from wreaking havoc on the engine.

A call to Boondocker resulted in a replacement cartridge arriving the following morning. The cartridge is a complete ball bearing center section, and new-looking turbine and compressor wheels (usually sold as exchange).

It took Glenn and D&D technician Scooter only an hour to fit the replacement unit to the turbo, orient it appropriately, and have the sled running again. This time with no airflowmeter, we spent several hours tweaking fuel flow with the Boondocker controller. We seemed to be tapped out at 240 lb/hr, well shy of what would be needed to achieve the 500 HP that the D&D crew were striving for. Fortunately, there were two extra injectors fitted to the airbox (for an unutilized N2O system). Glenn tapped the two supplemental turbo fuel injector wires into the fifth and sixth injectors, driving them with the Boondocker EFI turbo controller.

Further tweaking with six injectors firing finally created dark exhaust smoke and over-rich mixture, and burbling misfire at our preset boost pressure of about 22 psi measured at the intercooler outlet tank. But now we had the 300 lb/hr fuel flow necessary to support over 500 HP. All we needed was more air. So Glenn bumped boost up to about 26 psi, and we made 496 CHP, and A/F was still fat (even though the wideband indicated lean as the result of light misfire sending unburned fuel and unused O2 past the O2 sensor, fooling it). One more tweak of the wastegate (brought boost up to 29 psi and created this delightful dyno test. This was exactly four seconds at WOT including initial load time at 7200 before the test began.

D&D F1200 W/ BOONDOCKER RACE TURBO SYSTEM

EngSpd	STPTrq	STPPwr	BSFA-B	FulA-B	FuelP	BOOST	LAMAF1	AirDen
RPM	Clb-ft	CHp	lb/hph	lb/hr	psig	IN HG	Ratio	lb/cFt
7200	355.0	486.7	0.67	303.6	61.4	58.5	12.0	0.071
7300	352.8	490.4	0.66	300.3	61.4	58.6	11.8	0.070
7400	348.9	491.6	0.64	294.5	61.5	58.6	11.6	0.070
7500	351.7	502.2	0.64	299.2	61.4	58.6	11.5	0.070
7600	351.7	508.9	0.62	294.5	61.2	58.2	12.9	0.070
7700	348.2	510.5	0.63	301.0	61.1	58.3	12.9	0.071
7800	345.3	512.8	0.63	300.5	60.9	58.1	12.3	0.070
7900	341.5	513.6	0.62	298.7	60.9	58.1	12.1	0.070
8000	341.2	519.7	0.62	300.3	60.7	58.4	12.0	0.070
8100	345.9	533.4	0.61	303.1	60.8	58.0	11.7	0.070
8200	342.1	534.0	0.61	303.1	60.9	57.7	11.2	0.070
8300	338.5	534.9	0.61	302.5	60.9	57.8	11.2	0.070
8400	335.9	537.3	0.61	304.7	60.9	57.6	11.1	0.070
8500	326.3	528.2	0.63	307.7	60.8	57.5	12.9	0.070
8600	306.1	501.2	0.69	323.0	60.7	57.9	12.4	0.070

Since our dyno airflow meter now has parts missing, SCFM data is absent. But we can use our measured fuel flow and wideband (LAMAF1) readings to estimate SCFM. At our HP peak fuel flow is 305 lb/hr. Wideband reads 11/1 (pounds of air per hour vs pounds of fuel per hour), which is probably close to accurate. So 305 x 11 = 3355 lb of air per hour = 55.9 lb of air per minute. I listed air density (pounds in weight per cubic foot) during this test which is .070. Divide 55.9 by .070 = 798 SCFM, about the same as the supercharged big block Chevy boat motor I watched Carl McQuillen dyno tune on Monday (though the Chevy's HP was higher meaning lower BSAC).

Safely tuning a 73 cubic inch engine for 500 plus HP is painstaking, and best done with several observers of important data on the computer screen. Most of the adjustments to fuel were made with dyno set at 7200, throttle stabbed (dyno adjusts load to maintain the desired RPM whether you're making 100 lb/ft or 1000 lb/ft), data is recorded, and the engine is shut down while data is examined. Only when the low RPM WOT numbers appear safe, and no detonation is heard on the deto-phones, do we do rapid sweep tests. Even then, sometimes we can run lean or boost rises excessively, creating knock and tests are aborted.

This was a textbook tuning session, which had the desired outcome, taking perhaps six hours of actual dyno time, not counting parts changing or intercooler cleaning time. Glenn's idea of utilizing those spare nitrous fuel injectors to support more boost-only HP was excellent. While we did experience light midrange deto while searching for adequate fuel, this final test was knock-free, and plugs look dandily tan like you might expect from a well tuned trail sled. How much power did the extra fuel flow and boost add? Our baseline 454 CHP may have been skewed by the probability that the snaggle-toothed compressor wheel was beating and overheating the intake charge while creating the boost desired by the separate wastegate. But even if baseline was really over 500 CHP, 11-1 A/F is way more desirable and reliable than 14 or 15-1.

Those who observed the test session on the DynoCams saw many hours of tweaking/ tuning by an undaunted D&D crew, with some very temporary frustration followed by the excitement of seeing over 500 CHP with a beautiful, flat HP curve with 500 plus from 7500 to 8600 RPM. Apologies to anyone who was offended by a few swear words from the euphoric dyno operator. Also note that this engine's torque peak occurred at 7200 (or maybe even lower had we begun the test earlier). HP peak was at 8400 RPM. Glenn surely won't be "clutching" to his torque peak! All Boondocker settings were recorded, and according to Glenn if the clutches can handle it, boost pressure and fuel flow will remain as is. And beyond that, the huge turbo probably has more airflow remaining to be utilized. It appears as though, if more fuel is made available, that the mechanical strength of the stock lower end (cases, crank, rods, studs) is all that limits max HP. We don't know yet where that limit is as long as deto is avoided.

So this is our new DTR HP record, and it's possible that someone else will better that HP number this year. The One Stop Performance guys from Howell MI are surely capable, and we hope that their canceled tuning session (due to the Syracuse NY rainout) will be rescheduled. Jeff Simon may be inspired to bring a big turbo sled here, as he has discussed in the past. JD Powersports in Rochester NY have a large turbo on a purpose-built Jag lakeracer on their dyno now. Bennett Racing's SkiDoo 4tek turbo is undergoing further development (beyond the 427HP out of the stock engine with a seemingly-tiny 66 Aerocharger). Justin Full Power is wisely concentrating on building lots of 200HP 87 octane 4tek turbo kits, but he's hoping someone contracts for a gonzo HP 4tek lakeracer. And maybe this year our pal Gus Bohne will test the strength of my big dyno driveshaft with some wicked three cylinder boosted two-stroke he's concocting. There's reportedly a D8 Caterpillar in Gus' backyard with a missing turbo. And now other well known NA engine builders are looking to power adders for more HP to enable them to stay "in the hunt". Are port grinders obsolete? There will always be a welcome place and great appreciation for very high powered "all motor" performance. But as we can see here for absolute maximum horsepower it's hard to argue with a few turns of a wastegate controller.

The bar is raised. Records are made to be broken.

Here’s the Big Dog Boondocker race turbo system, with D&D single pipe. Note the separate waste gate and clean stainless steel turbine housing.