SkiDoo 4Tek 1200 w/ custom lakeracer turbocharger system

Here is a completely stock preproduction SkiDoo 4Tec with boost added. This was purchased from SkiDoo by Greg Bennett to be transformed into some sort of winter lake racer.

Being most familiar with Aerochargers (he uses a model 66 on his Polaris 930cc twin), Greg fitted a model 66 to a custom stainless tube header. Exhaust dumps out the side of the sled with a straight unmuffled pipe. Compressed air is ducted through a large front mounted air-air intercooler (Greg is contemplating a more efficient liquid-air intercooler from www.Bellintercoolers.com). The stock throttle body is retained, and the stock airbox is used with some reinforcing.

Though DynoJet/ Power Commander is said to be working on a timing/ fuel controller like they sell for most EFI bikes and Yamaha 4 stroke sleds, nothing is yet available. So Greg installed two supplemental injectors in the aluminum pipe between the intercooler and airbox (he's used this system on boosted boat engines with good success). These injectors are controlled by an electronic device that measurers RPM and boost, and is adjusted to turn on at the desired RPM/ boost level, with pulse width rate increase adjusted to match boost/ airflow rise. With the supplemental injectors, the stock ECU is retained. Since the stock ECU assumes all is normal, the three stock injectors were delivering about 60 lb/hr, and the fuel necessary to support the higher HP is added accordingly. And since the ECU is stock, the stock timing curve is retained.

On Greg's two-stroke Polaris 930cc twin lakeracer the model 66 turbo has its' tongue hanging out at 320 HP and 540 CFM airflow. Greg was hoping that the 4tek's lower BSAC would allow 400+ HP with that same airflow, and he was correct. After some tweaking of static/ boosted fuel pressure here is where Greg began his quest for 400 HP, with a 15 psi starting boost level. All testing was done with VP Import fuel which is 120 motor octane. Glenn Hall uses this fuel with excellent reliability in all of the D&D/ Boondocker turbo F1xxx race sleds he tunes. During this tuning session we had Sean Ray's copper tubing deto listening device hooked to the engine, and Greg wore the Harbor Freight headphones, listening for knock inside the engine. Thankfully all was quiet during the 20 or so dyno tests.

14 psi boost .50 plus BSFC

EngSpd	STPTrq	STPPwr	BSFC B	Fuel B	A/F B	BOOST	Air 2
RPM	Clb-ft	CHp	lb/hph	lb/hr	Ratio	IN HG	scfm
7100	189.4	256.1	0.501	120.6	10.34	20.7	272
7200	204.6	280.4	0.507	133.6	10.19	23.8	297
7300	207.8	288.9	0.550	149.5	9.93	26.6	324
7400	218.0	307.2	0.527	152.3	9.98	27.5	332
7500	219.9	314.1	0.526	155.4	9.79	27.4	332
7600	213.6	309.1	0.522	151.7	10.11	28.1	335
7700	216.8	317.8	0.527	157.8	9.77	28.1	337
7800	212.5	315.6	0.515	153.3	10.15	27.3	340
7900	209.9	315.7	0.516	153.5	10.18	27.7	341

8000	210.2	320.2	0.519	156.3	10.04	27.5	343
8100	206.9	319.0	0.521	156.3	10.18	27.9	348
8200	207.3	323.7	0.523	159.2	10.07	27.7	350
8300	203.3	321.3	0.525	158.7	10.07	27.6	349
8400	204.0	326.3	0.516	158.3	10.34	28.0	358

We began adjusting boost upwards very gradually, and made sure fuel was more than adequate. Here is a test at 21 psi boost, and when we ran past the 8500 rev limiter (where the stock injectors shut off) the fuel flow leaned out by that 60 lb/hr the stock injectors were delivering. HP immediately climbed to 400 plus but BSFC was very lean, OK for a few seconds but overreving this engine with large supplemental injectors could be bad on the lake. After this dyno run, we set the dyno computer to take the last reading at 8500 then stop the test. Also here I've included our wide band LM1 A/F ratio readings. Notice how different they are from the mechanical dyno readings. I'm suspecting that for some reason on this engine the airflow numbers are lower than actual, since it's unusual to get clean runs like this with no misfire at A/F much richer than 10/1. Also note that the LM1 was too slow to pick up the drop in fuel flow when the stock injectors closed at 8500.

21 psi boost, .60 plus BSFC until stock injectors turn off at 8500

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC B lb/hph	Fuel B lb/hr	A/F B Ratio	LAMAF1 Ratio	BOOST IN HG	Air 2 scfm
7000	225.6	300.6	0.666	187.9	8.45	11.7	30.1	347
7100	225.6	304.9	0.657	187.9	8.45	11.7	30.1	347
7200	243.0	333.1	0.657	205.6	8.43	11.3	33.6	379
7300	249.6	346.9	0.652	212.4	8.49	11.0	36.6	394
7400	255.9	360.6	0.660	223.8	8.45	12.5	41.2	413
7500	252.3	360.3	0.670	226.9	8.36	12.1	41.3	415
7600	249.8	361.4	0.667	226.6	8.55	13.5	41.7	423
7700	250.3	367.0	0.666	229.6	8.50	13.1	41.4	426
7800	250.2	371.6	0.669	233.5	8.48	12.3	41.5	433
7900	243.4	366.2	0.665	228.6	8.76	12.1	41.7	437
8000	243.5	370.8	0.652	227.3	9.06	11.8	42.0	450
8100	245.1	377.9	0.644	228.5	8.99	11.6	42.8	449
8200	241.5	377.0	0.655	231.9	8.97	11.5	42.3	454
8300	242.8	383.7	0.646	232.4	9.08	11.4	42.3	461
8400	243.1	388.9	0.640	233.2	9.19	11.3	42.9	468
8500	235.5	381.1	0.647	231.2	9.34	11.2	42.9	472
8600	250.9	410.8	0.477	184.4	12.13	11.2	43.5	488
8700	251.8	417.1	0.429	167.9	13.46	11.2	44.1	493

We left the boost controller alone, and just leaned out the A/F ratio and set the dyno to quit at 8500. The leaner mixture caused boost to rise just a bit.

22 psi boost, .50 plus BSFC

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC B lb/hph	Fuel B lb/hr	A/F B Ratio	BOOST IN HG	Air 2 scfm
7200	243.2	333.4	0.545	170.3	10.09	36.8	375
7300	265.3	368.8	0.545	188.6	10.00	42.5	412
7400	262.4	369.7	0.540	187.2	10.24	42.0	419
7500	261.5	373.5	0.563	197.2	9.88	42.5	425
7600	259.6	375.7	0.552	194.6	10.11	42.8	430
7700	264.7	388.1	0.551	200.4	9.99	43.1	437
7800	261.8	388.8	0.556	202.6	9.93	43.1	439
7900	258.0	388.0	0.561	204.0	9.92	41.8	442
8000	253.7	386.5	0.562	203.8	10.01	42.0	445
8100	260.6	401.9	0.528	198.7	10.48	43.9	455
8200	261.6	408.4	0.528	202.4	10.38	43.4	459
8300	258.7	408.9	0.516	197.9	10.83	45.0	468
8400	255.5	408.6	0.524	200.7	10.80	43.8	474
8500	253.8	410.7	0.515	198.1	11.06	43.8	478

We did one run with the same boost/ fuel settings, but began the test at light load, allowing boost to rise as the test progresses (unlike the usual turbo dyno methodology of WOT full load at low revs steady-state until boost maxes, then begin the sweep test). This resulted in a cooler intercooler, higher recorded airflow CFM and our best HP of the day. It was time to quit after this.

22 psi boost, .50 plus BSFC, colder intercooler

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC B lb/hph	Fuel B lb/hr	A/F B Ratio	BOOST IN HG	Air 2 scfm
7000	151.2	201.6	0.947	179.3	6.70	19.1	262
7100	162.3	219.3	0.922	190.0	6.84	20.8	284
7200	162.3	222.4	0.909	190.0	6.84	20.8	284
7300	168.0	233.4	0.892	195.5	7.20	21.7	307
7400	168.0	236.7	0.880	195.5	7.20	21.7	307
7500	178.8	255.3	0.848	203.4	7.53	24.1	335
7600	201.7	291.8	0.761	208.6	8.41	25.3	383
7700	228.0	334.3	0.646	203.2	9.56	32.3	424
7800	264.5	392.9	0.539	199.0	10.65	41.0	463
7900	266.6	400.9	0.527	198.7	10.74	41.9	466
8000	272.5	415.1	0.504	196.8	10.87	44.3	467
8100	266.5	411.0	0.516	199.4	10.81	43.9	471
8200	264.0	412.2	0.516	200.1	10.89	43.9	476
8300	267.1	422.1	0.505	200.8	10.87	44.5	477
8400	264.6	423.3	0.507	202.0	11.03	44.9	487
8500	264.0	427.3	0.508	204.3	11.01	44.9	491

Here, we've more than tripled the torque and HP of this bone stock engine, by pumping more air and fuel through it. Boost is way easier on parts than bumping compression, adding revs, or N2O. Engineers say that if you double the HP of an engine with boost, then peak combustion chamber pressure, and compression load on parts, increases by only 20%, with pressure at 90 degrees ATC being many times higher than NA, but still well below peak! And since revs are stock, tension loads on parts is the same as stock. But what about triple the stock HP? Peak pressure 30 or 40% higher than stock? Good fuel and good fuel management are the key to longevity. An engine like this might run for years if treated with proper, adequate fuel and respect. But a few seconds of heavy detonation would change all of that and spoil the party.

Greg Bennett and his sons Greg Jr. and Matt are a greedy lot. I expect that this first dyno session won't be the last for this engine. Other lakeracers talk about 500 plus HP as being "where it's at" now. Next I'm betting we'll see stiffer valve springs, forged lower compression pistons, timing control, and 30 psi boost and 600 CFM from a larger capacity Garrett ball bearing turbo. More to come.