SSI (Speed Shop Inc) Arctic Cat turbo upgrades

www.speedshopinc.com Jim Czekala

Erich Long is on his own now with a new corporation doing high performance sled, motorcycle, and quad business as SSI in New Richmond, WI.

Recently we tested some SSI bolt-on upgrades for the Arctic Cat four-stroke turbo engines. This is Oneida Lake [NY] madman Ron Nard's stock/ stock turbo Crossfire 1100 lakeracer that we would test with SSI 230 and 260 horsepower reflashes. Ron had purchased the sled from an AC dealer, used, with a SSI 230 reflash with a hermaphrodite exhaust system—one other Cat tuner's 2.5" turbo outlet pipe and another Cat tuner's 2.5" quiet muffler. As we would see during the dyno test session, it's sometimes not wise to mix and match exhaust components.

Ron had purchased a 260HP reflash from SSI for his ECU (can be toggled, as an option, from 230 to 260hp) along with an SSI full 3" diameter turbine outlet pipe and a large, fairly quiet 3" muffler to maximize pump gas performance for running on the trails/ lake racing. We would do baseline testing on his current setup, then try the 260HP pump gas reflash and higher flowing SSI exhaust system.

Now that we have an $11,000 (if purchased new—this one, happily, was found on RaceJunk.com for a fraction of that) Zeltex 101C octane tester, we can be assured that our pump gas dyno testing is meaningful. In the past, some sled tuners have deceived themselves (and me) by having, intentionally or otherwise, race gas mixed in with the pump gas in the tank in order to make max HP with no clicks of deto. Now the Zeltex tester helps the tuners and us by assuring that the fuel being used for testing is proper. On this day, Ron's 91 octane ethanol-free fuel measured at 91.6 R+M/2, with less than 1% ethanol. Interestingly, we tested the RVP of this 91 octane non-ethanol fuel and it was about 6 psi, meaning it was summer blend. Winter blend pump gas RVP is 10-12 psi to allow for cold starting at sub-zero F temperature. It's probable that since the higher priced non-ethanol fuel is mostly purchased for lawnmowers, outboard boat motors, generators and snowmobiles the comparative volume is low, this 91 was left over from last summer/ fall. There's no problem using lower volatility summer blend and in fact it may make more HP than winter blend if there is more energy in it, in a given volume.

Tuning for max HP on true pump gas on a pressurecharged engine like the Cat 1100 turbo is a balancing act—with proprietary software that was developed by a fellow out west for tuning boosted Suzuki Hayabusa motorcycles (they use the same ECU as the AC 1100 turbo), fuel flow, airflow [boost pressure/ backpressure], and ignition timing can be jockeyed about to create as much HP as possible without detonation. The ECU's can also be reprogrammed to try to recognize and deal with deto at high revs—something the factory programming doesn't do. Lean mixtures and advanced timing with lower boost can make as much HP as rich mixtures and retarded timing and higher boost. Which is best? Sean Ray (Delphi Calibration and Hentges Racing engineer) says that they usually achieve auto manufacturers' target TQ/ HP on boosted engines with higher boost, and less timing lead—ostensibly to increase A-B heat energy rise with lower peak temperature, but with more molecules of air being expanded to move the pistons. And airflow is also best increased by reducing backpressure along with moderate boost pressure increases—simply cranking up the boost without reducing backpressure invites deto because

those nasty nitroglycerin-like active radical end gases that can autoignite from the heat of compression need lots of airflow to be evacuated safely from the combustion chambers during the exhaust stroke! DynoTech tech editor/ advisor Kevin Cameron has written several great explanations of detonation and deto avoidance that can be found on this website—check the scanned printed stuff at the bottom [there's a treasure trove of old but very pertinent technical info there]. Almost all of the 37 scanned issues have a "TCD" article [The Cellar Dweller—surely a takeoff on KC's monthly Cycle World magazine column "TDC", the abbreviation for Top Dead Center] that should be read and reread.

We depend on our copper detotube bolted to the cylinder head that sends the sometimes violent sound of detonation into the dyno control room to help us protect our engines from damage during tuning for max HP. Normal combustion flame speed is smooth—travelling across the combustion chambers at @60 feet/ sec, creating peak cylinder pressure at 15-20 degrees ATC. But the second flame front created by detonation [after the plug fires] travels across the combustion chamber at the local speed of sound which creates peak pressure way too early, and a loud "snap" that's easily audible as the vibration travels from inside the engine, down the copper tube and into the control room.

During our SSI dyno session, we never heard one click of deto—even when running the more powerful 260HP flash on the too-tight mismatched 2.5" muffler and turbo outlet pipe. And with the final setup of SSI 260HP reflash and high-flowing SSI 3" exhaust, we did four back to back lengthy dyno runs with hot engine/ hot intake components and there were zero clicks—not even light knock at peak torque. We have included those final four hot tests, showing how airflow coincides with HP—as turbo compressor and intake components gain heat, airflow from the turbo through the engine drops slightly along with HP. On the second and third dyno test it made 261 HP, and on the fourth with hot everything it was just shy of 260, but still zero clicks of deto. A/F ratio similarly enrichens as temps rise, creating additional deto protection for Ron while he does "hot laps" on Oneida Lake.

Our graphic comparisons also include test data from the new 2015 ZR9000 that we used in the most recent American Snowmobiler/ DTR Shootout.

Here's the stock 1100 turbo, with stock intercooler and SSI 230 flash and airflow restricting mismatched 2.5" turbine outlet pipe and 2.5" muffler. The un-named turbine outlet pipe had one nasty-looking "clamshell" weld where a pair of short mandrel bends didn't quite match up, so the fabricator cheated to make things fit by sanding a few degrees of angle on the inside radius of the joint. And it's difficult to know if those stainless welds were backpurged with argon—critical to prevent airflow-reducing internal slag. The questionable fitment and/ or possible internal weld slag may have been the culprit. We used our dyno wideband O2 sensor with a long tube inserted as far as possible, colonoscopy-style, into each muffler's outlet to give us A/F readings.

TEST 2 w/ 230 flash and mismatched exhaust

EngSpd	STPPwr	STPTrq	LamAF1	BoostP	Air_1s	ElpsTm
RPM	CHp	Clb-ft	Ratio	psig	SCFM	Secnds
6000	146.8	128.5	12.14	10.5	194.7	0.34
6100	147.7	127.2	12.31	10.5	195.1	1.15
6200	149.5	126.7	12.35	10.6	197.2	1.41

6300	151.7	126.5	12.46	10.7	201.7	1.80
6400	155.1	127.2	12.51	10.9	205.2	2.13
6500	158.7	128.2	12.44	11.1	209.3	2.48
6600	162.3	129.1	12.27	11.6	215.8	2.80
6700	166.5	130.5	12.09	12.6	224.5	3.08
6800	172.9	133.5	11.96	13.9	235.7	3.38
6900	181.1	137.8	11.93	15.0	246.2	3.65
7000	189.0	141.8	11.96	15.8	254.3	3.87
7100	198.6	146.9	12.04	16.4	263.1	4.16
7200	206.8	150.8	12.09	16.7	269.1	4.45
7300	213.6	153.7	12.10	16.6	273.7	4.87
7400	216.3	153.5	12.03	16.4	275.9	5.60
7500	218.1	152.7	12.00	16.3	276.2	5.81
7600	218.2	150.8	11.93	16.2	276.8	6.10
7700	217.0	148.0	11.81	16.1	277.5	6.46
7800	216.7	145.9	11.71	16.0	278.1	6.81
7900	216.2	143.7	11.62	15.9	279.0	7.21
8000	216.3	142.0	11.55	15.8	279.8	7.52
8100	216.2	140.2	11.47	15.8	280.8	7.84
8200	215.1	137.8	11.32	15.7	281.6	8.24
8300	213.2	134.9	11.05	15.6	282.1	8.68
8400	212.1	132.6	10.90	15.6	282.8	8.98
8500	204.2	126.1	11.17	15.6	270.0	9.61

Here's the 260HP reflash with the same restrictive 2.5" exhaust system. Note the great air conditions on this day gave us a negative correction factor!

TEST 5

EngSpd RPM	STPPwr CHp	STPTrq Clb-ft	LamAF1 Ratio	BoostP psig	DenAlt Feet	Air_1s SCFM	ElpsTm Secnds	STPCor Factor
6000	160.4	140.4	11.76	13.9	-1272	221.0	0.58	0.999
6100	166.0	142.9	11.81	14.6	-1271	227.7	0.94	0.999
6200	173.4	146.9	11.78	15.1	-1271	234.4	1.42	0.999
6300	179.1	149.3	11.75	15.3	-1270	238.4	1.82	0.999
6400	182.8	150.0	11.68	15.4	-1267	242.1	2.13	0.999
6500	185.4	149.8	11.56	15.5	-1267	246.5	2.45	0.999
6600	188.3	149.8	11.45	15.9	-1266	252.2	2.78	0.999
6700	192.3	150.7	11.47	16.6	-1265	259.1	3.09	0.999
6800	197.1	152.3	11.59	17.1	-1265	264.8	3.33	0.999
6900	204.4	155.6	11.86	17.6	-1263	272.1	3.68	0.999
7000	210.6	158.0	12.05	17.8	-1263	277.3	3.97	0.999
7100	215.1	159.1	12.12	17.9	-1263	280.8	4.16	0.999
7200	219.3	159.9	12.19	18.1	-1262	285.7	4.45	0.999
7300	223.9	161.1	12.31	18.2	-1262	289.6	4.97	0.999
7400	226.8	161.0	12.32	18.0	-1262	290.7	5.28	0.999
7500	226.9	158.9	12.25	18.2	-1261	293.3	5.82	0.999
7600	228.2	157.7	12.22	18.2	-1260	294.5	6.16	0.999

7700	229.2	156.4	12.14	18.2	-1260	296.5	6.47	0.999
7800	230.0	154.9	12.02	18.3	-1260	299.3	6.78	0.999
7900	231.2	153.7	11.88	18.7	-1259	303.6	7.16	0.999
8000	233.4	153.2	11.74	19.2	-1258	307.9	7.49	0.999
8100	235.7	152.8	11.59	19.5	-1257	311.7	7.82	0.999
8200	237.4	152.1	11.41	19.7	-1256	315.4	8.20	0.999
8300	239.0	151.2	11.29	19.8	-1255	317.8	8.52	0.999
8400	239.8	149.9	11.25	19.8	-1254	320.2	8.90	0.999
8500	240.8	148.8	11.30	19.8	-1253	321.8	9.20	0.999
8600	241.3	147.4	11.41	19.8	-1252	323.5	9.61	0.999
8700	242.3	146.3	11.48	19.7	-1251	324.8	9.94	0.999
8800	234.6	140.0	12.03	19.8	-1250	326.8	10.64	0.999

Finally, here's the high flowing and fairly quiet SSI 3" full exhaust with the SSI 260HP flash. This is the first of four lengthy WOT dyno tests. Zero clicks of deto were observed even on the final hot coolant/ hot intake system dyno test. Note, too, that the boost is allowed to max out above 8200 and create max HP at 86-8700. Deto is time-dependent and creating HP at higher revs further prevents detonation.

TEST 10

EngSpd RPM	STPPwr CHp	STPTrq Clb-ft	LamAF1 Ratio	BoostP psig	Air_1s SCFM	ElpsTm Secnds
6000	170.4	149.1	11.95	14.1	225.5	0.32
6100	174.4	150.1	11.97	14.8	232.6	0.95
6200	180.0	152.5	11.96	15.4	238.3	1.42
6300	185.0	154.2	11.97	15.5	242.2	1.77
6400	189.1	155.2	11.93	15.6	245.9	2.06
6500	192.8	155.8	11.81	15.8	250.7	2.43
6600	196.5	156.3	11.73	16.0	256.2	2.79
6700	200.2	157.0	11.77	16.4	261.8	3.07
6800	206.2	159.3	12.06	17.3	271.3	3.49
6900	211.7	161.1	12.24	17.6	275.8	3.70
7000	217.7	163.4	12.41	17.9	281.5	3.97
7100	222.9	164.9	12.48	18.1	286.4	4.20
7200	228.4	166.6	12.57	18.5	292.3	4.55
7300	234.7	168.8	12.66	18.3	294.7	5.10
7400	237.5	168.6	12.60	18.2	296.4	5.34
7500	238.6	167.1	12.50	18.4	300.5	5.66
7600	240.0	165.8	12.45	18.5	304.1	6.13
7700	242.7	165.5	12.41	18.3	305.4	6.45
7800	244.1	164.4	12.31	18.4	309.0	6.80
7900	245.9	163.4	12.24	18.8	313.3	7.07
8000	248.9	163.4	12.13	19.4	319.5	7.43
8100	253.6	164.4	11.97	19.9	325.1	7.78
8200	257.8	165.1	11.79	20.2	329.9	8.11
8300	260.6	164.9	11.66	20.4	334.1	8.45

8400	262.5	164.2	11.63	20.5	337.5	8.85
8500	264.3	163.3	11.69	20.5	339.5	9.18
8600	265.1	161.9	11.79	20.4	341.3	9.56
8700	265.5	160.3	11.89	20.4	342.8	9.88

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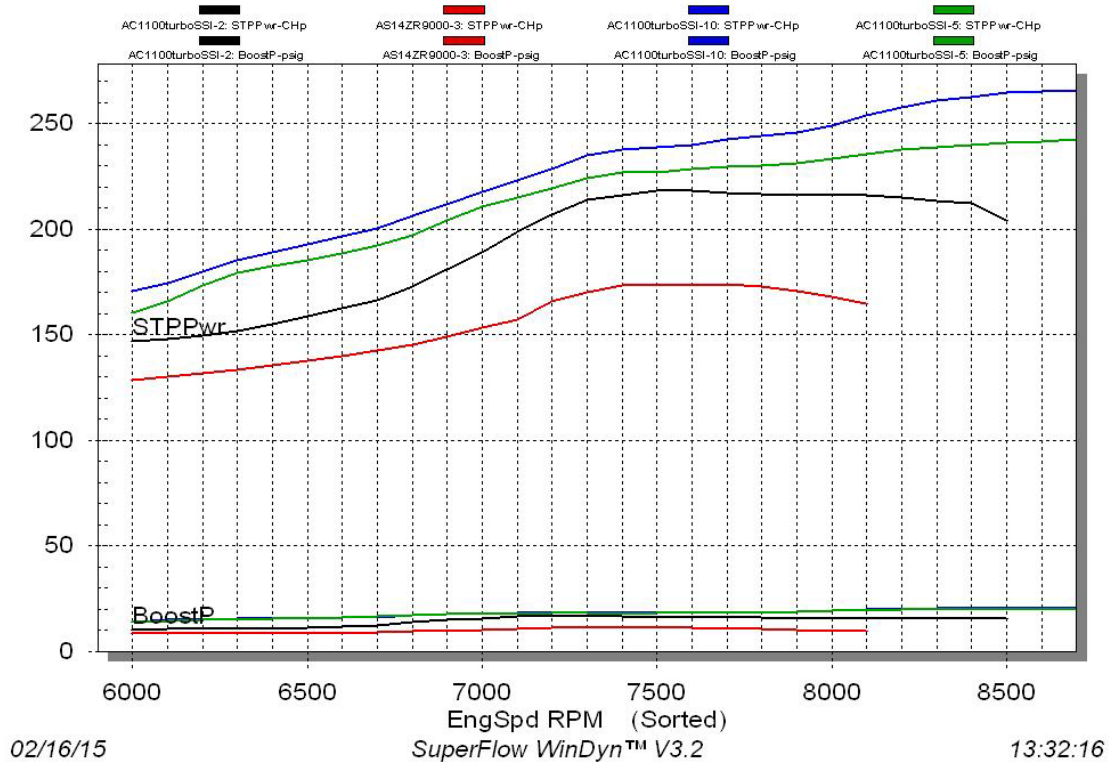
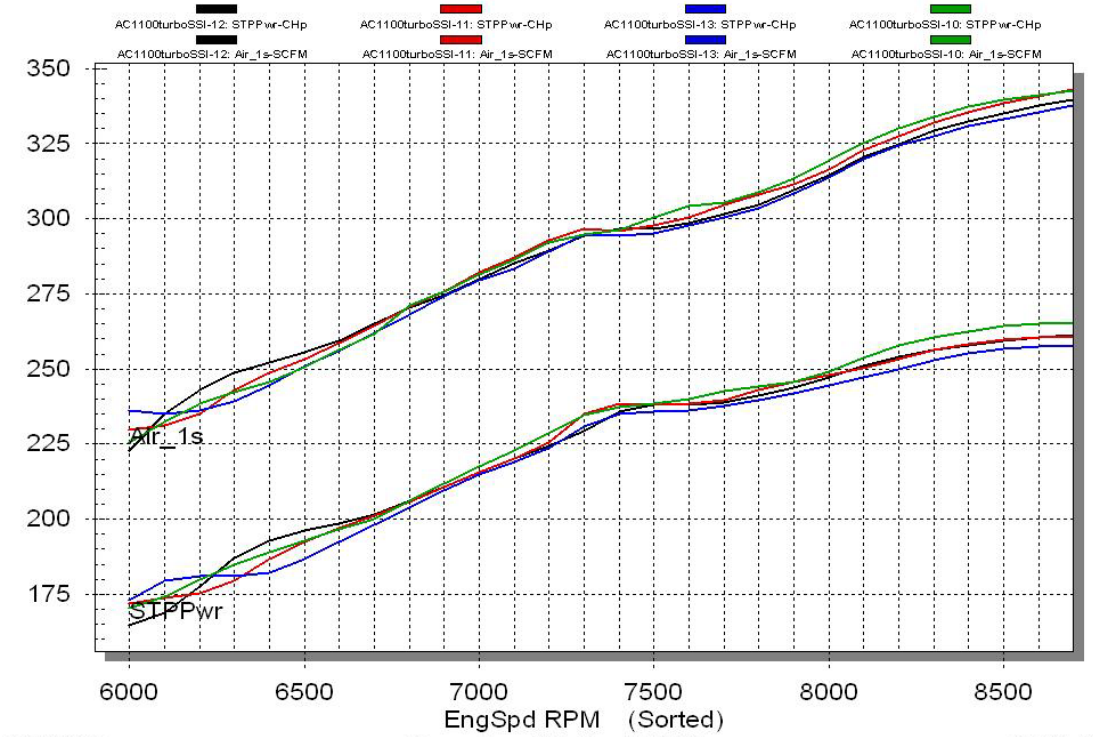
stock AC turbo with SSI 260 flash and 3" header and muffler

red stock, black 230 flash 2.5" mismatch, green 260 flash 2.5" mismatch, blue 260 flash w/ 3" SSI pipe and muffler



HP and Airflow CFM of back to back hot dyno tests

SSI 260hp reflash, SSI 3" full exhaust



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