RK Tek Arctic Cat ProCross 800/ 925 Big Bore **Jim Czekala**

This new 2012 Arctic Cat ProCross 800 was modified for trail use for an **anonymous** trail rider ("Rider X") who wanted to have fun with his pals who ride stock Arctic Cat Z1 turbo sleds. Rider X sent the stock cylinders to Kelsey at RK Tek for conversion to higher HP 925cc big bore. He was hoping to achieve the 180HP RK Tek advertises for this package with stock exhaust. After this dyno session, Rider X was very pleased.

The RK Tek (www.2strokeheads.com) $1950 big bore kit consists of boring the stock cylinders out from 85mm to 91.5mm and fitting them with proprietary tight-fitting forged pistons. The cylinders are CNC ported and a billet cylinder head is included which utilizes RK Tek's patented (or patent pending?) high turbulence, textured squish bands. Some day, we hope to do a back to back test of two sets of identically contoured combustion chambers—one set with plain squish bands and another with the RK Tek textured squish band surface. But for today, we had the complete package.

Rider X and his dealer's technician ("Tech X") who came to help during the tuning session arrived with a most conservative tune—lots of Boodocker fuel added at WOT from midrange to top end. Also, conservative 1.5 degree advance timing key was fitted. But Rider X desired reasonable power with good reliability for running on the 91 octane gas for trails and long lake blasts for a mile or more. But remember that stock bore timing curves are designed to create maximum cylinder pressure at about 18-20 degrees ATC for best power. By adding a whopping 6.5 mm to the cylinder bores, the flame front has a much longer distance to travel, at about 60'/second to consume the contents of the combustion chambers. Leaving timing stock will ensure that the peak pressure will arrive much later than the 20 degrees ATC that engines like, losing lots of potential torque and HP, sending unutilized energy out the pipe. So cranking the flywheel clockwise a few extra degrees can pay big dividends with overbored engines! Also Dale Roes and Glenn Hall had left us a new D&D stamped ProCross 800 single pipe and Y pipe for testing on this big engine. Rider X and Tech X would be glad they did!

For this tuning session, we tested this new engine with 91 octane gas, and coolant temp at 120 degrees F+ with stock thermostat in place. We had our excellent copper tube deto sensor attached to the engine which allows us to hear every slight click of deto if and when we step over the line. Two or three clicks and we stop and retune—no harm, no foul or damage. But eight clicks and usually the engines seize (yes I've allowed eight clicks a few times and we've paid the price). Listen, react quickly to clicks, retune and maximum power can be made on whatever octane we use, with no stuck pistons along the way.

Today, we did hear some light midrange deto that we easily eliminated with tweaking of the Boondocker to add fuel there. Good big bores like this can pack lots of extra air into the engines in the midrange, effectively increasing compression ratio there—proper midrange fuel tuning is a must.

Here is test 1. Our baseline initially concerned Rider X becaue it was lower HP than stock, but once he saw how overfueled it was with the super-safe Boondocker tune, confidence returned. Note that volumetric efficiency peaked at 115% at a low 7500 RPM meaning great midrange cylinder filling and torque will be there. All we need from here is tuning! Here it is—ultra-safe fuel, stock exhaust and 1.5 degree key.

TEST 1

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s	VolEff
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	%
6600	127.6	101.6	0.687	84.7	12.24	226.5	108.2
6700	130.5	102.3	0.667	84.2	12.57	231.1	108.7
6800	133.8	103.4	0.687	89.0	12.13	235.8	109.2
6900	136.9	104.2	0.698	92.6	11.93	241.2	110.0
7000	139.2	104.4	0.702	94.6	11.99	247.9	111.4
7100	141.2	104.5	0.717	98.0	11.83	253.4	112.2
7200	143.5	104.7	0.726	100.9	11.65	256.7	112.1
7300	144.3	103.8	0.782	109.4	11.09	264.9	114.0
7400	146.8	104.2	0.792	112.7	10.97	270.0	114.5
7500	148.4	103.9	0.815	117.3	10.73	274.8	115.0
7600	149.6	103.4	0.841	122.0	10.44	278.4	114.9
7700	152.2	103.8	0.833	122.9	10.41	279.6	113.9
7800	152.8	102.9	0.855	126.8	10.17	281.6	113.1
7900	154.3	102.6	0.861	129.0	10.05	283.2	112.2
8000	154.4	101.4	0.871	130.7	9.97	284.4	111.3
8100	153.9	99.8	0.894	133.6	9.77	284.9	110.0
8200	154.1	98.7	0.894	133.8	9.75	285.0	108.6
8300	152.9	96.8	0.879	130.6	10.00	285.3	107.4
8400	151.5	94.7	0.866	127.5	10.22	284.7	105.8

The first thing we did was drop our mid-top end WOT fuel by 13 numbers. This is from intuition from having Boondocker tuned many 100s of EFI sleds. In the early days, we used to drop 2 at a time but now it's done quickly like this dropping peak fuel flow from 134 to 114 lb/hr:

TEST 2 REDUCE BOONDOCKER NUMBERS BY 13

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM
6500	127.3	102.9	0.645	79.8	12.66	220.6
6600	126.1	100.4	0.635	78.0	13.13	223.8
6700	129.4	101.5	0.613	77.3	13.52	228.4
6800	133.9	103.4	0.618	80.6	13.23	233.0
6900	136.7	104.0	0.632	84.3	12.97	238.8
7000	139.5	104.7	0.643	87.6	12.81	245.2
7100	142.9	105.7	0.651	90.9	12.58	249.9
7200	144.9	105.7	0.661	93.6	12.41	253.8
7300	145.7	104.8	0.696	99.2	11.99	259.7
7400	144.4	102.5	0.737	104.0	11.75	267.0
7500	146.9	102.8	0.733	105.3	11.76	270.6
7600	150.9	104.3	0.729	107.6	11.72	275.6
7700	153.5	104.7	0.727	109.2	11.63	277.6
7800	159.1	107.1	0.717	111.9	11.49	280.8

7900	161.5	107.4	0.711	112.6	11.52	283.3
8000	165.3	108.5	0.702	113.9	11.48	285.8
8100	171.2	111.0	0.677	113.8	11.51	286.2
8200	172.8	110.6	0.675	114.6	11.49	287.6
8300	176.7	111.8	0.660	114.6	11.50	287.8
8400	173.2	108.3	0.659	112.2	11.73	287.5
8500	166.7	103.0	0.673	110.4	11.90	287.0

Now our A/F ratio was in the range that we like for sea level riding on pump gas, but BSFC was still high. That along with the midrange sag in the HP curve usually means that we need more ignition timing advance. So we left fuel alone, and Tech X removed the 1.5 degree advance key and installed a .040" advance key to try to get peak combustion chamber pressure closer to 20 degrees ATC. Now we fitted the pipe with the dyno instrumentation that registers pipe center section temperature and pressure. This sensor replaces the stock sensor (creates max timing at about 900F). When we disconnect the stock pipe center section probe, the ECU defaults to max timing. Rider X and Tech X had surmised that if this 2012 stock muffler were a bit "loose" for Billy Howard's stock 800, the 925cc top end's added airflow CFM could create optimal conditions. To generalize, 4 psi seems to most often a best average pipe pressure for best torque and HP. Too low, and too much charge/ air mix can be allowed to short-circuit out the exhaust making only extra EGT and no power. Too high, and often deto-producing active radicals can be packed back into the combustion chambers creating havoc. But today, the stock 800 muffler seems just right!

TEST 3 INCREASE TIMING ADVANCE

EngSpd RPM	STPPwr CHp	STPTrq Clb-ft	BSFA_B lb/hph	FulA_B lbs/hr	AFRA_B Ratio	Air_1s SCFM	Exh_1 deg F	ExhPrs Psig
6500	126	101.8	0.647	79.7	12.55	218.7	771	2.2
6600	126.6	100.7	0.636	78.9	12.83	221.2	786	2.0
6700	129.6	101.6	0.619	78.5	13.15	225.5	799	2.0
6800	133.9	103.4	0.628	82.5	12.83	231.1	814	2.2
6900	138.5	105.4	0.632	85.8	12.63	236.8	827	2.5
7000	141.0	105.8	0.633	87.6	12.66	242.3	834	2.5
7100	142.4	105.3	0.648	90.6	12.53	248.1	840	2.6
7200	144.5	105.4	0.652	92.5	12.48	252.2	845	2.7
7300	147.4	106.0	0.688	99.7	11.93	260.0	855	2.9
7400	150.3	106.7	0.695	102.7	11.79	264.5	863	3.0
7500	155.2	108.7	0.699	106.7	11.61	270.6	881	3.4
7600	160.7	111.1	0.686	108.6	11.62	275.7	900	3.6
7700	163.8	111.7	0.676	109.0	11.64	277.2	907	3.6
7800	168.1	113.2	0.670	111.0	11.57	280.4	926	3.7
7900	172.6	114.7	0.650	110.6	11.69	282.3	942	3.8
8000	173.9	114.2	0.650	111.5	11.64	283.5	948	3.9
8100	177.0	114.8	0.649	113.4	11.51	285.0	965	3.9
8200	181.7	116.4	0.633	113.6	11.52	285.8	979	3.9
8300	180.9	114.5	0.631	112.8	11.60	285.8	988	3.9
8400	176.4	110.3	0.645	112.3	11.59	284.3	995	3.8
8500	165.4	102.2	0.673	110.1	11.70	281.5	1000	3.5
8600	139.8	85.4	0.770	106.4	11.69	271.7	994	3.0

Rider X was now pleased, since we were exceeding the 180HP RKTek advertises for this big bore with safe click-free fuel flow on his 91 octane gas. But next Tech X installed the D&D ProCross 800 single pipe and this created way more midrange torque and HP, and a bunch more on top end but with a bit less overrev power. Note also the airflow was a bit lower, and pipe pressure dropped as a result. But the 925 engine was way happier with this pipe!

TEST 4 ADD D&D SINGLE PIPE

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s	Exh_1	ExhPrs
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	deg F	Psig
6600	126.0	100.3	0.645	79.6	12.27	213.5	780	2.0
6700	128.5	100.7	0.623	78.4	12.63	216.3	794	2.0
6800	131.5	101.6	0.635	81.9	12.34	220.7	806	2.2
6900	134.3	102.2	0.650	85.6	12.16	227.2	817	2.4
7000	137.8	103.4	0.661	89.4	11.95	233.4	828	2.5
7100	140.3	103.8	0.663	91.3	11.95	238.3	836	2.5
7200	142.9	104.3	0.672	94.3	11.77	242.5	845	2.6
7300	145.5	104.7	0.704	100.6	11.36	249.6	854	2.7
7400	151.3	107.4	0.708	105.1	11.16	256.4	869	2.9
7500	160.3	112.2	0.689	108.6	11.15	264.4	896	3.3
7600	166.1	114.8	0.675	110.3	11.13	268.1	913	3.3
7700	170.8	116.5	0.662	111.2	11.21	272.5	936	3.3
7800	174.8	117.7	0.650	111.8	11.30	275.9	953	3.4
7900	180.2	119.8	0.638	113.1	11.29	279.2	970	3.5
8000	183.8	120.7	0.631	114.3	11.26	281.2	982	3.5
8100	187.2	121.3	0.620	114.5	11.30	282.6	998	3.6
8200	187.3	120.0	0.617	114.0	11.38	283.5	1008	3.7
8300	171.6	108.6	0.676	114.5	11.23	280.8	1010	3.7
8400	154.5	96.6	0.731	111.4	11.43	278.3	1001	3.5

Next we installed the production D&D 800 Y pipe, and this made us more HP by raising the peak HP RPM. Airflow was just a bit higher, and center section Ex temp was also just a bit higher. Not only was peak HP increased, the HP curve was broadened and overrev HP improved. 190 HP and not one click!

TEST 5 ADD D&D Y PIPE

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s	Exh_1	ExhPrs
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	deg F	Psig
6500	122.9	99.3	0.658	79.2	11.94	206.6	764	2.0
6600	125.5	99.8	0.631	77.6	12.39	210.0	786	1.9
6700	126.8	99.4	0.622	77.3	12.58	212.5	793	2.1
6800	128.5	99.2	0.645	81.3	12.23	217.3	802	2.2
6900	132.9	101.2	0.650	84.8	12.12	224.4	814	2.3
7000	138.2	103.7	0.643	87.3	12.17	232.0	828	2.4
7100	141.5	104.6	0.647	90.0	12.11	238.0	840	2.5
7200	143.7	104.8	0.647	91.4	12.12	242.0	847	2.5
7300	145.3	104.5	0.672	96.0	11.85	248.6	855	2.6
7400	157.6	111.8	0.669	103.8	11.46	259.8	893	3.1
7500	160.2	112.2	0.674	106.4	11.40	265.0	910	3.2
7600	165.4	114.3	0.657	107.2	11.48	268.8	933	3.5

7700	171.1	116.7	0.649	109.5	11.42	273.3	956	3.5
7800	174.0	117.2	0.642	110.3	11.44	275.6	964	3.5
7900	180.7	120.1	0.622	110.9	11.55	279.8	987	3.5
8000	184.7	121.2	0.612	111.6	11.57	282.1	1004	3.6
8100	186.9	121.2	0.607	112.1	11.57	283.3	1009	3.7
8200	188.2	120.5	0.610	113.4	11.51	285.0	1023	3.8
8300	190.5	120.5	0.600	113.0	11.60	286.4	1032	3.8
8400	187.9	117.5	0.596	110.7	11.84	286.3	1045	3.9
8500	155.8	96.2	0.703	108.3	11.77	278.6	1037	3.7

Time to quit? Greedy RKTek Kelsey was up early (Utah time) anxiously watching this test session on the DynoCams and as expected (and his argument was not unreasonable) since Billy Howard's stocker was deto-free with 91 octane at .55 lb/hphr he suggested to Rider X by Iphone-- why couldn't this engine be the same? So we dropped the WOT fuel by 5 Boondocker numbers from lower RPM to High RPM. To be extra safe, I increased the dyno acceleration rate by 200 rpm/sec for a quick blast just so I could be sure the fuel flow numbers were where we wanted them, but power was lower due to the too-fast accel rate. This dropped our BSFC into the mid .50s where we wanted them (test 6). Next I slowed the acceleration rate back to normal and test 7 gave us BSFC like Kelsey wanted it, with zero clicks of deto on top end. We had a click or two in the low RPM WOT area around 7200-7400 but we drove through it. We could have used a few more steps in the Boondocker to tweak this even better (8100 was the highest step here but we could have used a step at 8500). Once again, incredible power on 91 octane gas!

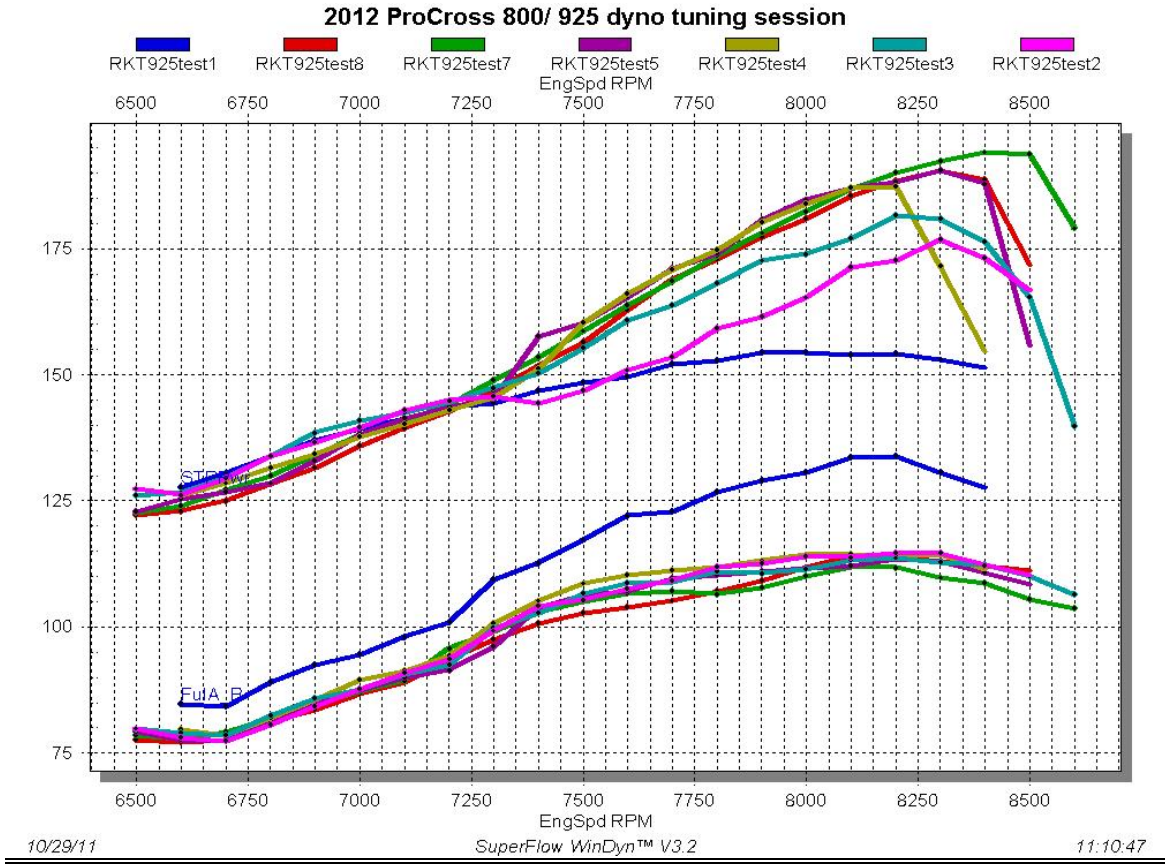
TEST 7 LEAN OUT BOONDOCKER TUNING

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s	Exh_1	ExhPrs
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	deg F	psig
6500	122.7	99.1	0.654	78.5	12.08	207.0	785	2.0
6600	124.0	98.7	0.640	77.7	12.35	209.8	806	2.4
6700	127.1	99.7	0.635	79.1	12.31	212.7	822	2.3
6800	130.0	100.4	0.642	81.8	12.15	217.2	835	2.4
6900	134.1	102.0	0.644	84.8	12.05	223.2	853	2.4
7000	138.1	103.6	0.643	87.2	12.04	229.5	868	2.5
7100	141.0	104.3	0.645	89.4	12.00	234.3	880	2.5
7200	144.2	105.2	0.675	95.8	11.64	243.4	907	2.8
7300	148.9	107.1	0.676	99.1	11.56	250.1	934	3.0
7400	153.5	109.0	0.680	102.9	11.46	257.6	960	3.3
7500	158.6	111.1	0.671	105.0	11.48	263.2	982	3.4
7600	163.7	113.1	0.660	106.5	11.51	267.9	1002	3.7
7700	168.6	115.0	0.643	107.1	11.62	271.7	1021	3.7
7800	173.6	116.9	0.621	106.5	11.84	275.4	1041	3.7
7900	178.1	118.4	0.613	107.8	11.80	277.9	1057	3.7
8000	182.4	119.7	0.611	110.1	11.65	280.3	1073	3.7
8100	186.8	121.2	0.605	111.8	11.56	282.2	1085	3.8
8200	190.1	121.7	0.594	111.8	11.64	284.1	1092	3.9
8300	192.3	121.7	0.576	109.7	11.93	286.0	1100	3.9
8400	194.0	121.3	0.565	108.6	12.14	288.0	1109	3.9
8500	193.6	119.6	0.550	105.5	12.53	288.8	1121	4.3
8600	179.0	109.3	0.584	103.6	12.58	284.8	1116	3.7

Rider X opted to detune this package by adding even more fuel to make it ultra-safe so he could terrorize his Z1 riding pals without fear of knock light coming on. We added just a bit more midrange WOT fuel to eliminate the midrange knock we heard on the prior test. Now this engine has excellent deto protection with the stock ECU pulling timing/ adding fuel as clicks are noticed. Here we added the fuel back and even a bit extra, and got the pipe CS hot—perhaps as hot as it might get blasting across a lake at 120 mph. Note that the stock quiet muffler registered an ideal 4.0 psi backpressure!

TEST 8 ADD FUEL AGAIN, ULTRA-SAFE

EngSpd	STPPwr	STPTrq	BSFA_B	FulA_B	AFRA_B	Air_1s	Exh_1	ExhPrs
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	deg F	psig
6500	122.1	98.6	0.650	77.6	12.13	205.5	776	2.0
6600	123.0	97.8	0.641	77.2	12.40	209.1	803	2.2
6700	125.0	98.0	0.634	77.6	12.52	212.3	818	2.2
6800	128.2	99.0	0.647	81.3	12.22	217.0	835	2.3
6900	131.6	100.2	0.647	83.5	12.17	222.2	846	2.4
7000	135.9	101.9	0.651	86.8	12.07	228.9	867	2.5
7100	139.4	103.1	0.650	89.0	12.10	235.0	884	2.6
7200	142.8	104.2	0.667	93.6	11.88	242.9	905	2.9
7300	146.9	105.7	0.675	97.4	11.75	250.0	926	3.1
7400	151.8	107.7	0.675	100.7	11.65	256.3	948	3.3
7500	156.5	109.6	0.667	102.7	11.61	260.5	964	3.5
7600	162.9	112.6	0.648	103.9	11.73	266.3	988	3.7
7700	168.9	115.2	0.632	105.2	11.77	270.4	1008	3.7
7800	173.0	116.5	0.629	107.1	11.73	274.6	1023	3.7
7900	177.2	117.8	0.625	109.2	11.64	277.5	1038	3.8
8000	181.0	118.8	0.626	111.8	11.45	279.7	1047	3.9
8100	185.5	120.3	0.624	114.2	11.29	281.6	1057	3.8
8200	188.4	120.7	0.612	113.8	11.40	283.6	1063	3.9
8300	190.6	120.6	0.600	112.9	11.57	285.5	1068	4.0
8400	188.6	117.9	0.602	112.1	11.61	284.4	1069	3.8
8500	171.6	106.1	0.656	111.3	11.43	277.9	1049	3.5


2012 ProCross 800/ 925 dyno tuning session
RKT925test1
RKT925test8
RKT925test7
RKT925test5
RKT925test4
RKT925test3
RKT925test2
EngSpd RPM
6500
6750
7000
7250
7500
7750
8000
8250
8500
175
150
125
100
75
FulA_B
10/29/11
SuperFlow WinDyn™ V3.2
11:10:47

Tech X and Rider X, pleased with what they have created.