Arctic Cat F7/ F8 EFI big bore from Bikeman

Running a boring bar through a 350cc F7 cylinder, renickasiling and turning it into a 400cc “F8 800” twin is almost guaranteed to deliver some extra airflow CFM and HP. There’s been great discussion online regarding cast aftermarket cylinders vs bored stock vs bored stock and ported cylinders.

The replacement cast cylinder D&D F8 setup tested earlier in DTR gave us 160+ HP and great midrange torque with the stock single pipe on what has proven to be a safe calibration with 92 octane gas. Adding twin D&D twin pipes only added a few HP and too many dB (newer versions are said to have a quieter can instead of glasspacks) to this F8’s impressive stock single pipe/ muffler output.

Bill DeFranco AKA LooneyTune purchased a set of F8 cylinders/ pistons/ heads from Bikeman (www.bikemanperformance.com) for 1/8th and ¼ mile asphalt dragracing. Please understand that while we show a half dozen dyno runs this is truly a compilation of 12 hours of intensive dyno testing/ tweaking (dyno runs A through X, some not saved), maybe 30 dyno runs that would allow us to ultimately tune LT’s sled into a very powerful ¼ mile rocket (note: we did about as many tuning runs on the D&D F8 to dial in to perfection). Any big bore/mod/etc really needs to be verified and tuned on a fully instrumented dyno—there are many independent and non-independent dyno testers besides me who can measure A/F ratio and help fine-tune these things to optimal performance (maybe I can sell banner ads to independent dyno tuning shops, and we can form some sort of co-op to exchange dyno info…). My biased opinion is that any stock or modded Firecat will benefit greatly by being dyno tuned on an instrumented engine dyno. Not that a stock F6 or F7 is slow out of the box, but the many we have tuned with reduced fuel and added timing are incredible performers, with 100% reliability so far.

After dyno tuning Bill’s F8 for a few hours, we noted a continual strange drop in HP just as exhaust valves snapped open. HP dropped, airflow flatlined and the result was a goofy looking dip in the power curve. We saw the same phenomenon in the D&D F8, but didn’t really notice it while we were testing because it was so incredibly powerful on top end. We figured it was due to the raised exhaust port—not a huge increase in port timing over stock but maybe enough to cause some confusion in the pipe/ cylinders at 7200 just as the valves open. D&D and Bikeman have both seen this dip on the dyno but report that since the engine accelerates through this midrange so quickly, it is not noticeable. Stock ported F8's might make a bit less HP on top end, but don't have that strange dip when valves open.

Here is LT's stock pipe F8, tuned as we like for max pump gas HP. Note that to feed adequate fuel to this F8 engine w/ stock pipe Bill used: Stock 04 square box (longest pulse width), triangle injectors (highest fuel flow), and methanol switch turned on. With fuel pressure set at 42 PSI (utilizing an APC fuel regulator) this gave us barely enough midrange fuel flow to support the added midrange airflow of this Bikeman F8 setup. Bill had a three degree offset key for all of these tests (no effect on A/F ratio but lowers BSFC). Also note that if you view the SFD you will see an "oil pressure" column, which is actually our EFI rail fuel pressure.

04F8LTD 154.9 HP

04F8LTD stock single pipe, tuned to perfection with pump gas

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6100	75.2	87.4	0.716	61.2	189.1	14.14	42.7	51
6200	76.9	90.7	0.696	61.8	191.4	14.18	42.7	51
6300	79.4	95.3	0.677	63.1	195.1	14.15	42.6	51
6400	81.3	99.1	0.657	63.6	198.3	14.27	42.6	51
6500	84.2	104.2	0.636	64.9	204.5	14.42	42.6	51
6600	85.3	107.2	0.618	64.8	208.3	14.71	42.6	51
6700	86.4	110.2	0.615	66.3	211.1	14.57	42.6	51
6800	88.9	115.1	0.605	68.1	216.7	14.57	42.5	52
6900	91.5	120.2	0.599	70.4	224.9	14.62	42.5	52
7000	94.1	125.4	0.584	71.7	229.4	14.65	42.5	51
7100	96.1	129.7	0.579	73.4	232.4	14.49	42.4	52
7200	86.7	118.8	0.727	84.4	231.3	12.54	42.2	52
7300	86.8	120.6	0.722	85.1	231.5	12.45	42.2	52
7400	87.9	123.8	0.718	86.9	232.8	12.26	42.2	52
7500	99.3	141.8	0.765	106.2	257.4	11.13	41.8	51
7600	100.1	144.8	0.763	108.1	259.5	10.99	41.4	51
7700	101.1	148.1	0.758	109.8	264.5	11.03	41.8	51
7800	101.1	149.9	0.768	112.7	266.9	10.84	41.7	51
7900	101.5	152.6	0.734	109.6	269.8	11.27	41.8	51
8000	101.5	154.6	0.721	108.9	271.9	11.43	41.8	51
8100	100.5	154.9	0.716	108.6	272.7	11.49	41.8	51
8200	97.5	152.2	0.711	105.8	274.7	11.89	41.8	51

Next we decided to assess the valve opening timing—was it opening too late or too early? Or, just right for the pipe temp? We installed an extra set of valves in the cylinders, and allowed the original valves to operate normally while laying on the engine, this fooling the ECU. We locked the valves closed for a full dyno run (quitting as the power began to tail off early), then we locked them open for another run. Theoretically, where the HP curves cross would be the ideal valve opening RPM for that pipe temp! To be safe for midrange A/F ratio, we jacked up base fuel pressure 3 psi higher before we did this valve closed/ valve open test in case midrange airflow CFM increased. This would show that with this port timing and pipe temp, 7600 would be the ideal valve opening RPM (just about where stock F6 EV's open). It would have been interesting to see how the HP curve would be with an F6 EFI ECU, which should give us @15 lb/ft more (!) midrange torque at 7300. Please use the SuperFlow Windyne software download to compare:

04F8LTF `144.5HP lock EV closed

04F8LTF lock exhaust valves closed

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6200	79.4	93.7	0.707	64.4	194.7	13.84	45.2	56
6300	80.7	96.8	0.687	64.7	196.1	13.87	45.2	56
6400	84.8	103.3	0.657	66.1	201.7	13.99	45.1	57
6500	84.9	105.1	0.647	66.1	203.4	14.09	45.1	57
6600	89.4	112.4	0.635	69.3	212.1	14.01	45.1	57
6700	89.2	113.8	0.631	69.7	213.5	14.02	45.1	56
6800	92.8	120.2	0.613	71.8	222.6	14.19	45.2	54
6900	94.6	124.2	0.599	72.5	226.8	14.32	45.1	55
7000	96.8	129.1	0.595	74.6	230.8	14.16	45.1	57
7100	99.2	134.1	0.585	76.2	234.8	14.11	45.2	57
7200	101.7	139.5	0.679	91.9	241.4	12.02	44.5	58
7300	102.1	141.7	0.727	100.1	246.8	11.29	44.5	57
7400	101.5	143.1	0.747	103.9	249.1	10.97	44.4	57
7500	101.1	144.3	0.754	105.8	250.5	10.84	44.4	57
7600	99.8	144.5	0.786	110.3	255.2	10.59	44.3	57
7700	97.1	142.4	0.811	112.1	256.6	10.48	44.3	57
7800	92.2	137.1	0.858	114.3	259.1	10.38	44.2	56

04F8LTG 152.5HP lock EV open

04F8LTG lock exhaust valves open

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6600	76.8	96.5	0.809	75.7	207.9	12.57	45.1	57
6700	76.7	97.8	0.781	74.1	207.2	12.81	45.1	57
6800	77.4	100.2	0.758	73.7	208.2	12.93	45.1	57

6900	79.1	103.8	0.739	74.5	210.3	12.92	45.2	57
7000	77.9	103.8	0.718	72.4	217.1	13.73	45.2	56
7100	78.4	106.1	0.697	71.8	217.5	13.87	45.2	56
7200	80.4	110.2	0.671	71.7	219.2	13.99	45.1	56
7300	83.3	115.7	0.645	72.5	222.1	14.02	45.1	56
7400	98.5	138.7	0.787	106.1	255.1	11.11	44.4	56
7500	98.8	141.2	0.801	110.1	259.4	10.81	44.3	55
7600	98.5	142.6	0.796	110.5	259.8	10.76	44.3	55
7700	99.6	146.1	0.805	114.4	264.4	10.58	44.2	55
7800	99.1	147.1	0.818	116.8	267.2	10.47	43.7	56
7900	99.5	149.6	0.789	114.8	269.4	10.74	44.2	56
8000	99.9	152.2	0.737	109.1	274.5	11.52	44.3	55
8100	98.9	152.5	0.721	106.9	276.3	11.83	44.4	56
8200	95.5	149.1	0.735	106.6	278.3	11.95	44.4	55

Next, we installed Bill's 1000' dragace ECU (setup by AC for 700cc stock dragracing) and we added 2 more psi fuel pressure to help to safely enrichen fuel flow. Note that added HP was due to reduced fuel flow and added ignition timing that would make this a short run drag spec. But please note the post-EV-opening midrange bog did not appear with the 1000' box (could the valves have already been open at 6700?).

04F8LTN 160.3HP stock single pipe ¼ mile drag spec.

04F8LTN install 1000' race ECU, added fuel pressure, 1/4 mile drag spec

EngSpd	STPTrq	STPPwr	BSFC	Fuel A	Air1+2	A/F	Fuel P	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	scfm	Ratio	psig	degF
6700	90.8	115.8	0.672	75.7	219.6	13.28	47.3	59
6800	91.9	119.1	0.644	74.5	223.5	13.73	47.2	59
6900	93.1	122.2	0.602	71.6	229.7	14.69	47.2	59
7000	93.6	124.7	0.578	70.1	233.9	15.27	47.2	59
7100	94.9	128.3	0.547	68.2	239.1	16.05	47.2	59
7200	95.4	130.8	0.648	82.4	242.6	13.48	46.8	59
7300	95.9	133.3	0.672	87.2	244.4	12.83	46.8	59
7400	100.7	141.9	0.671	92.5	252.3	12.49	46.7	60
7500	102.4	146.2	0.671	95.4	256.1	12.29	46.6	60
7600	103.7	150.1	0.678	99.1	261.6	12.11	46.6	59
7700	104.2	152.8	0.681	101.2	263.9	11.94	46.5	60
7800	104.7	155.4	0.686	103.6	266.8	11.79	46.5	60
7900	104.7	157.4	0.664	101.6	268.9	12.12	46.6	60
8000	104.6	159.3	0.628	97.3	273.6	12.87	46.7	59
8100	103.9	160.3	0.611	95.1	275.8	13.28	46.7	59
8200	101.9	159.1	0.605	93.5	278.6	13.64	46.7	60
8300	98.2	155.2	0.612	92.2	280.1	13.89	46.8	60

Going back to the 04 ECU we installed SLP twin pipes. It required 46 psi fuel pressure to deliver adequate midrange fuel flow to keep this reliable. This is critical, especially in the midrange where airflow is higher. This may well may be a reasonably reliable 92 octane pump gas spec for this setup:

04F8LTS 166.0 HP

04F8LTS install SLP twin pipes, pump gas spec

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6900	96.7	127.1	0.673	83.2	241.2	13.27	46.3	57
7000	96.6	128.8	0.646	80.8	241.1	13.66	46.3	58
7100	98.4	133.1	0.636	82.1	245.1	13.67	46.3	59
7200	98.3	134.8	0.632	82.6	245.8	13.62	46.3	59
7300	105.1	145.9	0.768	108.8	264.3	11.12	45.8	59
7400	107.1	150.8	0.761	111.2	270.1	11.11	45.7	59
7500	108.4	154.7	0.771	116.1	276.1	10.91	45.8	58
7600	109.5	158.5	0.774	119.1	280.6	10.79	45.6	59
7700	109.2	160.1	0.766	119.1	283.2	10.89	45.5	59
7800	109.2	162.2	0.767	120.9	287.3	10.88	45.5	58
7900	108.8	163.6	0.757	120.4	290.9	11.06	45.5	58
8000	109.1	166.1	0.711	114.6	294.3	11.76	45.6	59
8100	106.6	164.5	0.708	113.1	297.2	12.04	45.6	59
8200	100.9	157.5	0.729	111.4	300.7	12.36	45.6	59

With the SLP twin pipes fitted, we dropped fuel pressure to lean out A/F ratio and increase HP. This would be a questionable power level for 800cc and pump gas, and may possibly be OK for short runs, but for smart dragracing/ lakeracing 100 octane would be cheap insurance.

04F8LTW 170.1 HP

04F8LTW SLP twins, reduce fuel pressure/ fuel flow for 100 octane (?) drag spec

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6400	88.1	107.4	0.648	68.1	217.9	14.67	43.4	53
6500	89.5	110.7	0.631	68.2	220.7	14.81	43.4	54
6600	91.1	114.5	0.624	69.7	223.8	14.71	43.2	54
6700	91.7	117.1	0.621	70.8	227.4	14.72	43.1	54
6800	92.4	119.7	0.612	71.6	231.5	14.81	43.1	53
6900	94.3	123.9	0.611	73.9	235.3	14.58	42.9	54
7000	95.9	127.8	0.608	75.9	239.1	14.41	42.7	54
7100	96.6	130.6	0.597	76.2	242.1	14.54	42.3	53
7200	96.2	131.9	0.659	84.8	245.5	13.25	41.7	54
7300	96.3	133.9	0.665	87.1	246.3	12.96	41.6	53

7400	99.9	140.8	0.664	91.2	250.9	12.59	41.2	54
7500	107.6	153.6	0.708	106.2	273.2	11.78	39.9	54
7600	108.7	157.3	0.709	108.9	277.2	11.65	39.7	54
7700	109.9	161.2	0.718	112.9	281.9	11.43	39.3	54
7800	110.3	163.9	0.711	113.6	286.1	11.53	39.2	53
7900	110.6	166.4	0.693	112.5	289.1	11.76	39.3	54
8000	110.8	168.8	0.664	109.3	294.1	12.32	39.6	54
8100	110.3	170.1	0.642	106.5	297.8	12.81	40.1	55
8200	108.4	169.2	0.636	104.9	303.3	13.24	40.1	54
8300	106.9	169.1	0.633	104.3	304.5	13.36	40.1	54
8400	104.1	166.3	0.635	102.9	306.2	13.62	40.1	54
8500	103.1	166.6	0.612	99.4	312.6	14.41	40.6	55

Finally, because LT wanted to assess the value of his Asphalt dragracing nicely crafted Ferrari F1-style hoodscoop (purchased by LT from Ferrari Bros. Plumbing Supply) we removed all of our airflow/ fuel flow regulators/ meters and dropped his scoop-fitted hood down onto the chassis. During dyno test, 80mph air was blown into Bills's F1 style hoodscoop. We're suspecting that because Bill replaced our dyno fuel regulators with his own, rail fuel pressure perhaps dropped a bit, and/ or maybe the packed airbox added a few CFM, and HP climbed accordingly. This is surely on the edge, max HP for ¼ mile drags on 100+ octane:

04F8LTX 172.0 HP

04F8LTX install hood w/ hood scoop, 80 mph air blown into inlet

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel A lb/hr	Air1+2 scfm	A/F Ratio	Fuel P psig	AirTmp degF
6500	90.1	111.5	0	0	0		0	52
6600	91.8	115.3	0	0	0		0	52
6700	93.1	118.8	0	0	0		0	52
6800	93.3	120.8	0	0	0		0	52
6900	94.2	123.8	0	0	0		0	52
7000	96.4	128.4	0	0	0		0	53
7100	97.6	131.9	0	0	0		0	53
7200	94.1	129.1	0	0	0		0	54
7300	93.9	130.5	0	0	0		0	53
7400	95.9	135.1	0	0	0		0	53
7500	107.5	153.5	0	0	0		0	53
7600	108.6	157.2	0	0	0		0	53
7700	110.3	161.6	0	0	0		0	52
7800	110.9	164.7	0	0	0		0	53
7900	111.5	167.7	0	0	0		0	53
8000	110.7	168.6	0	0	0		0	53
8100	111.1	171.2	0	0	0		0	53
8200	110.2	172.1	0	0	0		0	53

8300	108.3	171.2	0	0	0	0	53
8400	105.1	167.9	0	0	0	0	53
8500	102.6	166.1	0	0	0	0	54

EPILOGUE-

Adding 40 HP to an EFI engine like we did here absolutely requires a fully instrumented dyno to tune correctly. I don't think this can be a mail-order deal unless it's set generally pig fat, retarded timing for safety and low HP. Carbed sleds are way more forgiving, but still will benefit greatly from dyno tuning.

Early on during this test session we removed Boyeson Rad Valves from the engine, and installed stock reeds/ cages. This test was not saved to disc, but the net result was less midrange airflow CFM and added HP (better A/F ratio) and added slight top end airflow CFM and added HP.

Also, we tried a Speedwerx F7 single, and it was low on airflow (probably a bit too tight for F8). Whereas this single adds several HP on the F7, we only saw about 1 HP on this F8. Bikeman has a revised (larger outlet) Speedwerx single for us to try sometime.

The SLP twins make great torque and HP but while they are quieter than the D&D twins on Jason's F8, they are still quite a bit louder than stock—OK for the racetrack but loud pipes on the trail is trouble. I understand the D&D now has a canister for their F7/F8 twins. Also since with similar tuning the SLPs added 10 HP to this F8, it would be interesting to see how they would work on the D&D F8 we tested earlier.

Also, as we continue our quest for ultimate F7/F8 performance keep in mind that hand porting done correctly is an art form—not easy to repeat from engine to engine even with experienced grinders at work. Unless ports are modified on CNC equipment, there's no guarantee that every cylinder will be the same. I recall years ago Joe DiSpirito (CyberDyne) built himself a very slick one cylinder crankshaft/ crankcase out of a Polaris triple. His fanatical but excellent idea was to test individually cylinders/ pipes he had modded for 650 triples. I think it drove him crazy trying to match three individual cylinders and three individual pipes.

Every mod engine needs to be dyno'd to tune for optimum performance and to see where the engine stacks up with others like it. A stock pipe F8 can be 135 or 160 HP depending on lots of variations in compression, timing, fuel flow, actual port timing and shape. Everyone should optimize their tuning for the intended use. Using an independent dyno to do that will also let you know what RPM to clutch to and how your combination stacks up with others. If you've got a true 145 HP, there's no sense beating your head against the wall trying to clutch, tune and run with your pal with an "identical" setup and 155 HP.