ARCTIC CAT '04 F7 EFI FIRECAT UPDATE:

Bill DiFranco (AKA "looneytune" on the internet who previously provided his '03 F7 for evaluation for DynoTechResearch) swapped his sled for an '04. Then he came to the dyno with his '04 F7 bone stock and with two ECU's reprogrammed by Arctic Cat—one for 1000' dragracing (92 octane) and another for 500' dragracing (with 100+ octane). The 1000' box is what Bill has been using for both dragracing (asphalt and grass) and trail riding this winter. Now that Bill is a certified DynoTechResearch junkie, it was difficult for him to ride his reprogrammed ECU without knowing exactly what dyno numbers he was pulling, including (very importantly) what RPM the HP peak was occurring.

On the dyno, the F7's convoluted cooling system (reverse flow like modern NASCAR engines—with cool water entering the heads first, then exiting out the bottom of the engine) makes tying into the SuperFlow engine cooling tower difficult, so we instead used Bill's dragracing cooling system (a 12v pump which circulates cool water through the engine between rounds) to maintain consistent engine coolant temperature between dyno runs (*consistent pipe center section temp, consistent coolant temp and clean consistent temp intake air is critical for repeatability)*.

Bill has an aftermarket adjustable fuel pressure regulator (mounted on the in-tank EFI pump) and inline liquid filled fuel pressure gauge purchased from APC. He has been using that to try to tweak fuel management on his 1000' box on his sled which was too rich cruising on the trail, but also seemed lean on transition (*note that the 1000' program is created for accelerating from a dead stop for 10 seconds, so trail manners are not considered).* It required a few in-tank fuel regulator adjustments to get back to what we think is bone stock fuel pressure (@ 44 psi). We installed a stock '04 ECU on the sled and the following data closely matched our '03 baseline power numbers with super-safe BSFC of close to.80 lb/hphr.

2004 F7 EFI STOCK

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel B lb/hr	BMEP psi	AirTmp degF
5300	61.4	61.9	0.92	56.8	107.6	32
5400	61.1	62.7	0.92	57.5	106.9	32
5500	62.1	65.1	0.89	57.9	109.1	31
5600	64.2	68.5	0.85	57.9	112.7	31
5700	67.8	73.6	0.81	58.6	118.9	32
5800	69.6	76.9	0.81	61.2	122.1	32
5900	69.6	78.2	0.77	60.1	122.1	32
6000	71.4	81.6	0.75	60.7	125.2	32
6100	73.1	84.9	0.74	62.9	128.2	31
6200	74.4	87.8	0.74	64.3	130.5	31
6300	75.4	90.4	0.74	66.8	132.3	31
6400	77.8	94.8	0.72	67.9	136.5	31
6500	78.9	97.6	0.71	68.1	138.4	31
6600	79.8	100.3	0.71	69.4	140.2	31

6700	82.3	105.1	0.66	69.1	144.3	32
6800	84.4	109.3	0.64	69.2	148.1	32
6900	85.4	112.2	0.64	71.2	149.7	32
7000	85.5	113.9	0.64	72.1	149.9	32
7100	85.4	115.4	0.63	72.8	149.7	32
7200	86.2	118.1	0.63	74.5	151.1	32
7300	91.6	127.3	0.74	94.1	160.6	32
7400	92.2	129.9	0.76	98.7	162.1	30
7500	92.7	132.4	0.75	99.5	162.9	30
7600	92.6	134.2	0.78	104.5	162.9	29
7700	91.3	133.9	0.81	106.4	160.3	31
7800	87.9	130.5	0.82	106.8	154.3	31
7900	84.8	127.6	0.83	105.8	148.8	31
8000	80.7	122.9	0.82	100.5	141.6	31
8100	72.8	112.2	0.88	98.2	127.7	31

During our dyno runs, we could observe Bill's inline fuel pressure gauge from the control room. It was interesting to note that as soon as we reached high revs (around the torque peak, just after exhaust valves opened) the pressure would drop about 4 psi. This would probably be due to either 1) the inline pressure gauge fittings were restrictive or 2) the injectors are open long enough at 25-30 degrees F air temp to slightly outpace the fuel pump. If it is the latter, that would be no problem. Certainly high rev fuel pressure drop would be compensated for by added pulse width. One DTR subscriber is currently testing various size inline restrictors to reduce top end fuel flow and raise EGT's and HP without affecting midrange, which seems like a reasonable and inexpensive way to increase HP for short runs on premium or better gas.

For comparison, we dropped the fuel pressure 10% with the APC regulator. While HP was increased, dropping the fuel pressure results in a wholesale reduction in fuel flow, even in those part throttle and midrange areas where mixtures are extremely lean stock, and possibly dangerous if reduced. The more I think about it the more I like that restrictor deal which should only lean out top end fuel flow.

2004 F7 EFI REDUCE FUEL PRESSURE 10%

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel B lb/hr	BMEP psi	AirTmp degF
5300	60.2	60.7	0.89	53.7	105.5	35
5400	61.5	63.2	0.85	53.7	107.8	35
5500	63.1	66.2	0.81	52.9	110.4	35
5600	64.1	68.2	0.78	53.1	112.4	34
5700	66.1	71.8	0.75	53.7	116.1	34
5800	68.4	75.6	0.73	54.8	120.1	34
5900	70.4	79.1	0.71	56.1	123.6	34
6000	71.1	81.1	0.69	55.9	124.7	34
6100	72.1	83.8	0.66	55.3	126.5	35

6200	73.4	86.7	0.66	56.8	128.8	35
6300	75.7	90.8	0.64	58.2	132.8	35
6400	75.8	92.4	0.64	59.1	133.1	35
6500	78.4	97.1	0.64	61.9	137.6	34
6600	79.8	100.2	0.63	62.7	140.1	34
6700	81.6	104.1	0.63	65.3	143.2	34
6800	81.4	105.4	0.63	66.1	142.8	34
6900	83.9	110.2	0.63	68.7	147.1	35
7000	83.7	111.5	0.62	68.7	146.5	36
7100	85.4	115.5	0.62	71.3	149.7	35
7200	85.2	116.8	0.62	71.8	149.4	35
7300	85.7	119.1	0.62	73.4	150.2	35
7400	93.2	131.4	0.71	93.4	163.5	35
7500	93.5	133.6	0.72	95.6	164.2	35
7600	94.3	136.5	0.72	97.6	165.4	35
7700	93.1	136.6	0.74	100.3	163.3	35
7800	90.9	135.1	0.74	99.2	159.4	35
7900	88.7	133.5	0.75	99.3	155.7	34
8000	85.4	130.1	0.75	97.3	149.9	34

After increasing the fuel pressure back to stock, Bill installed the factory reprogrammed "1000' ECU". This is a stock ECU, reprogrammed for stock dragracing on 93 octane pump gas. Those who opt for this reprogramming by the Cat race shop lose their factory engine warranty, which Bill was happy to lose in exchange for six more HP. This reprogramming dropped the fuel flow to below 100 lb/hr, and resulted in incredible (for a bone stock 700cc twin) high-test pump gas performance with (proven safe this year for Bill to trail ride/ lakerace on 93 octane) .70 lb/hphr BSFC.

2004 F7 EFI, FACTORY 1000' ECU PROGRAMMING

EngSpd	STPTrq	STPPwr	BSFC	Fuel B	BMEP	AirTmp
RPM	Clb-ft	CHp	lb/hph	lb/hr	psi	degF
6000	71.8	82.1	0.88	72.1	125.9	32
6100	72.7	84.4	0.86	72.3	127.3	32
6200	74.7	88.1	0.83	72.9	130.9	32
6300	77.1	92.4	0.81	74.2	135.1	32
6400	78.1	95.1	0.77	72.9	136.9	32
6500	80.1	99.1	0.76	75.1	140.2	33
6600	81.8	102.8	0.74	75.6	143.2	33
6700	83.5	106.5	0.71	74.1	146.2	33
6800	84.4	109.3	0.66	71.6	147.8	33
6900	85.7	112.6	0.62	69.7	150.2	32
7000	86.9	115.8	0.59	67.6	152.4	32
7100	86.7	117.2	0.58	67.5	152.1	32
7200	86.7	118.9	0.58	68.9	152.2	32
7300	88.5	123.1	0.62	75.8	155.2	32
7400	91.1	128.4	0.64	82.1	159.8	32

7500	95.6	136.5	0.69	93.4	167.5	32
7600	96.4	139.5	0.69	96.1	168.6	34
7700	95.1	139.4	0.71	97.9	166.3	34
7800	92.2	136.9	0.73	99.8	161.2	34
7900	90.2	135.7	0.72	97.7	158.1	33
8000	89.6	136.5	0.71	95.3	156.9	33
8100	82.9	127.9	0.72	91.1	145.3	32

Cat factory sponsored "stock" dragracers are said to qualify for special 500' 100+ octane factory recalibration. Bill had with him such an ECU, but it apparently provided only less fuel flow for extra HP. We expected more—rumors of 150+ HP "stock class" F7 grassracers made us believe that fuel flow reduced from the 1000' box PLUS advanced ignition timing would give us the 150+ HP whispered about by Cat "insiders". Advancing ignition lead reduces EGT and shoves HP peak to a lower RPM. Conversely, simply leaning out mixture for hotter EGT raises HP peak to higher revs. Comparing power curves between the 1000' and 500' ECU's, it appears as though this particular 500' 100 octane drag box ONLY reduces fuel flow with a reasonably increase in HP. We suspect that there may be way more HP available with this box if timing is advanced to maximum output. Could it be that only the select few factory favorite racers, who are said to be able to run several tenths quicker than the others, get the "good" boxes with the gobs of ignition lead necessary to create the 150 dragracing HP that this engine may be capable of producing? Later on, we plan to do mechanical tweaking of ignition timing to see if the factory race people are perhaps saving something for the "chosen few". Here's this particular Arctic Cat Factory 500' drag box numbers—but there may be more to come.

2004 F7 EFI, FACTORY 500' DRAG PROGRAMMING

EngSpd RPM	STPTrq Clb-ft	STPPwr CHp	BSFC lb/hph	Fuel B lb/hr	BMEP psi	AirTmp degF
6000	71.8	82.1	0.88	71.9	125.6	33
6100	73.4	85.2	0.82	69.7	128.4	33
6200	74.6	88.1	0.82	71.4	130.5	33
6300	76.5	91.7	0.81	73.2	133.9	33
6400	77.8	94.8	0.78	73.7	136.1	34
6500	80.3	99.4	0.75	73.8	140.6	33
6600	81.8	102.8	0.74	75.8	143.2	33
6700	82.8	105.6	0.71	74.9	145.1	32
6800	84.6	109.5	0.66	71.9	148.3	32
6900	85.6	112.5	0.62	69.1	149.9	33
7000	86.6	115.4	0.58	66.6	151.7	33
7100	86.1	116.3	0.58	67.4	150.6	33
7200	86.6	118.8	0.59	69.8	151.7	33
7300	88.7	123.2	0.61	74.1	155.2	33
7400	92.9	130.9	0.64	83.1	162.6	33
7500	96.3	137.5	0.65	88.6	168.6	33

7600	97.5	141.1	0.65	90.6	170.7	33
7700	96.7	141.8	0.66	92.4	169.3	33
7800	94.3	140.1	0.68	94.9	165.2	32
7900	94.2	141.7	0.66	92.8	164.9	33
8000	92.1	140.3	0.65	89.9	161.2	33
8100	89.2	137.3	0.64	87.3	155.7	34

Bill and I did two final tests to satisfy F7 owners who thought about closed hood vs open hood dyno runs, and the possible ram-air effect at high vehicle speed.

All previous dyno runs were made with hood-open, with rubber bellows hose attatched to the stock airbox opening, stretched out to connect to the open hood air inlet. We had a high precision 0-15" water pressure Magnehelic vacuum gauge plumbed inside the stock airbox. On all hood-open runs, we registered a maximum of 2.75 inches of water negative pressure at peak revs. *(this is the slight amount of vacuum required to suck Pepsi 2 ¾" up a straw—definitely efficient and not HP robbing)*. 24" of [sea] water = one PSI pressure. Extremely impressive for a stock quiet cold airbox at 140 HP. My own opinion is that drilling holes in the airbox to eliminate this miniscule restriction would instead reduce HP by introducing less dense, power robbing hot underhood air into the airbox. Maybe we can get Bill to document the temperature rise in his box if he opens those slide valves he has installed (they were closed for all tests).

Finally, we mounted our flexible blower duct (12" diameter, fed from a 7.5HP roof mounted squirrel cage blower) with its 80 mph exit velocity directly in front of the hood scoop. The subsequent dyno run with the blower ramming air into the hood "scoop" at 80 mph showed a slight drop in vacuum, to about 2.50 inches of water negative pressure and no change in HP. But, since the effect of air pressure increases as the square of velocity, it would be interesting to see if there is more of an effect on airbox vacuum at 120 mph. It is conceivable that this very slight negative airbox pressure could drop close to zero at 120 mph, but it is not very conceivable that pounds of pressure per square inch "boost" could be created with this hood inlet. Pro Stock bike racers are said to be thrilled when their fairing-mounted air scoops add one PSI airbox pressure at 180 MPH (they measure this with onboard data acquisition systems). How about duct-daping the F7 hood scoop opening at the rear of the scoop to try to "pack" air? Or, consider the fact that NASCAR racers duct their sealed air intakes to the high pressure area at the *base of the windshield* for best performance. Maybe someone should try duct-taping the front openings of the scoop, and leaving the rear opening open then measure the airbox pressure. These are a few things that I'm sure Bill will try—since if it adds ¼ MPH on top end that could mean creeping by a less adventuresome pal on a similarly tuned F7, and well worth the effort.

Next, Bill will be receiving a big bore kit from APC in a week or two—they have his cylinders and head now, so that will be next on the dyno. It will come with an adjustable pulse width extender that will provide extra fuel (though it would appear that stock '04 ECU fuel has plenty of fuel for even the best big bore F7). Tuning this sort of device is not easy, but I saw APC's F7 big bore run at the AmSnow Shootout, and the tuning they have come up with looks dandy. We're hoping that an eight percent displacement increase will give us eight percent more airflow and HP, which would put Bill over 150 HP with stock timing and .70 lb/hphr. That would be outstanding. APC told Bill that the Vforce reeds that add very little HP to stock F7's increase power with the big bore. We will find out shortly.