Crossfire/ M 1000 pipe shootout

We purchased Y pipes and single pipes from BMP, D&D, SLP, and Speedwerx to test and compare on a stock Crossfire/ M 1000 with stock muffler.

Mike Kehl and his son Ryan (son and grandson of former local Cat dealer Fran Kehl) brought this 2007 Crossfire 1000 to be the "mule" for this single pipe shootout. With several thousand trail miles, this one is well-broken in, with the engine never having been touched. The ECU had been "reflashed" in 2008, perhaps done by AC to help reduce power and warranty issues. Compared to the new stocker we tested for the AmSnow Shootout this year, fuel flow appears identical, but power and torque are a bit lower indicating reduced timing compared to 2010 model year programming. After the reflash, the Kehls reported much worse fuel mileage, another indication that timing may have been backed off. Furthermore, we never got one click of deto on our detophones all day, even thought there were times when we dipped low into the mid .50's BSFC.

For this test session we used 8% ethanol 93 octane gas and a Power Commander V tuner to try to make A/F ratio and BSFC safe and as equal as we could for each component tested. We had originally planned to use the Power Commander Autotune to dial in fuel flow, but we were getting inconsistent wideband A/F readings. Our proctoscope-like wide band tube that we insert in the muffler outlet apparently was getting reversion of some outside air causing too-lean readings. So fuel flow adjustments were made manually, based upon our mechanical fuel and airflow readings to create WOT PCV maps for each combo, and added to the DTR map database available to our members.

The Crossfire 1000 ECU senses pipe center section temperature, and retards the timing initially to help achieve the 960F+ pipe temp that it seeks. Today, we unplugged the pipe temp probe, causing the ECU to default to 960F and deliver max timing regardless of pipe temperature. In place of the stock probe, I use a combination temperature probe and pressure fitting that the dyno uses to measure and record pipe temperature and average backpressure. This was used on the stock, SLP, and BMP pipes but when Ryan removed my probe from the BMP single pipe, the threads were galled, (we should have been using anti-seize lube!) and my pressure/ temp fitting was destroyed. So for testing the D&D and Speedwerx exhausts, intuition had to be used to ensure that the pipes were at our target 1000F plus at the HP peaks, shown as "Exhaust 1" on the data. All tests were done with 120 degree F coolant temp, 12-15 seconds at WOT.

The day of our Pipe Shootout was awful EFI tuning weather—beginning in the AM in the high 20's F then as the day went on it warmed up to nearly 40 F, with light rain and high humidity that saps HP from EFI sleds. So today we made use of the new DTR air refrigeration system to provide constant 20 degreeF dry air to the sled's intake, ensuring equal, excellent air all day long. The actual density altitude outside in the afternoon was +350 ft, but the sled enjoyed –1400 ft air from AM to PM!

Our plan was to test each company's Y pipe with the stock pipe, then test each company's tuned pipe in conjunction with its own Y pipe, all with the stock muffler.

Beginning with the stock exhaust, we created this stock baseline:

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	ExhPrs	Exh_1
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	psig	deg F
6500	134.3	108.5	0.683	91.8	11.2	224	2.1	932
6600	145.1	115.4	0.667	96.9	10.9	232	2.2	944
6700	152.1	119.2	0.661	100.7	10.7	236	2.9	954
6800	156.6	120.9	0.653	102.4	10.7	240	3.2	965
6900	159.9	121.7	0.646	103.6	10.7	242	3.3	976
7000	162.5	121.9	0.640	104.2	10.7	244	3.3	985
7100	164.9	122.0	0.626	103.5	10.9	246	3.1	996
7200	166.6	121.5	0.610	101.9	11.1	247	3.2	1008
7300	167.1	120.2	0.597	99.9	11.3	247	3.0	1024
7400	166.4	118.1	0.592	98.7	11.5	247	3.1	1040
7500	163.3	114.3	0.596	97.5	11.6	247	3.1	1056
7600	156.3	108.0	0.619	97.0	11.6	245	3.2	1067
7700	145.0	98.9	0.668	97.1	11.4	243	3.0	1070

We installed the SLP Y pipe with the stock pipe, and in three dyno runs created this test and PCV map—an incredible 12 hp and 10 lb/ft increase for the cost of a Y pipe and EFI tuner with safe fueling. DO NOT TRY THIS WITHOUT ADDED FUEL! You will add, say, 15 observed HP to the stock 167 HP and fixed stock 100 lb/hr EFI fuel flow, the BSFC would be .54—a sure recipe for disaster on trail-quality pump gas if held at WOT for more than a few seconds!

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	ExhPrs	Exh_1
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	psig	deg F
6500	143.1	115.2	0.673	96.1	11.3	249	2.8	964
6600	154.9	122.8	0.653	100.9	11.1	252	2.9	977
6700	164.5	128.4	0.636	104.4	11.1	255	3.2	988
6800	170.7	131.4	0.627	106.8	11.0	258	3.3	1002
6900	174.6	132.4	0.616	107.3	11.1	260	3.4	1016
7000	177.2	132.5	0.612	108.1	11.1	261	3.3	1028
7100	178.6	131.7	0.61	108.7	11.1	262	3.3	1036
7200	178.9	130.1	0.611	109.0	11.1	262	3.6	1031
7300	177.9	127.5	0.616	109.4	11.1	262	3.5	1023
7400	173.1	122.4	0.637	109.9	10.9	260	3.5	1030
7500	164.0	114.4	0.670	109.6	10.8	253	3.3	1040

Next we removed the stock pipe, and installed the SLP tuned pipe on the SLP Y pipe. This took several more dyno runs to create a good pump gas trail map for the SLP setup. We also had a SLP muffler, which we tested later and it flowed exactly the same CFM as the excellent stock muffler, and about matched the stock muffler's HP. Here's the SLP Y and single pipe with the stock muffler:

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	ExhPrs	Exh_1
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	psig	deg F
6500	131.2	106.0	0.719	94.2	10.9	225	2.6	909
6600	145.1	115.4	0.692	100.2	10.8	237	2.9	925
6700	155.3	121.8	0.677	105.0	10.7	245	2.8	938

6800	162.4	125.4	0.668	108.2	10.6	251	3.4	952
6900	167.2	127.3	0.657	109.6	10.6	255	3.6	964
7000	171.3	128.5	0.641	109.7	10.8	258	3.7	976
7100	174.9	129.4	0.622	108.6	11.0	261	3.6	992
7200	177.9	129.7	0.611	108.4	11.1	263	4.0	1008
7300	180.2	129.6	0.609	109.4	11.1	264	3.8	1026
7400	181.2	128.6	0.607	109.9	11.1	266	3.8	1036
7500	180.8	126.6	0.614	110.8	11.0	266	3.6	1053
7600	178.5	123.4	0.618	110.0	11.1	267	3.6	1060
7700	173.0	118.0	0.637	109.9	11.0	265	3.5	1063
7800	164.2	110.5	0.658	107.7	11.1	262	3.4	1069
7900	151.9	101.0	0.701	106.2	11.0	256	2.9	1066

Here is the BMP Y pipe with the stock single pipe, tuned to around .60 lb/hphr BSFC. In retrospect, we had the PCV tuning a bit leaner on this Y pipe compared to the others, as evidenced by the higher overrev HP, due to the hotter pipe temp. This Y pipe had, by a tiny margin, the lowest overall airflow of the aftermarket Y pipes tested but our slightly leaner tuning of the PCV overcame some of that.

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	ExhPrs	Exh_1
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	psig	deg F
6500	137.5	111.1	0.693	95.0	11.0	229	3.1	949
6600	150.4	119.6	0.666	99.8	11.0	239	2.9	962
6700	159.7	125.2	0.649	103.3	10.9	246	3.1	976
6800	165.3	127.7	0.636	104.8	10.9	250	3.1	988
6900	169.5	129.0	0.626	105.8	11.0	253	3.2	1000
7000	172.6	129.5	0.617	106.3	11.0	255	3.3	1015
7100	175.0	129.5	0.612	106.8	11.0	257	3.4	1029
7200	176.6	128.8	0.605	106.5	11.1	259	3.4	1043
7300	177.1	127.4	0.602	106.4	11.2	259	3.2	1057
7400	176.1	125.0	0.612	107.4	11.1	260	3.4	1071
7500	171.3	120.0	0.632	107.9	10.9	258	3.3	1082
7600	158.0	109.2	0.684	107.8	10.6	250	3.2	1075

The combination of the BMP Ypipe and BMP single pipe created a very high airflow curve and HP curve almost identical to the SLP combo. Both would be good candidates for on-off-on throttle trail riding where midrange performance is very desirable. High HP with high airflow CFM is a good attribute for trail riders. The BMP package came with exhaust valve spacers that are said to increase midrange airflow and HP before valves open. We did not install them here, but all data shown on graphs is with valves wide open.

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	ExhPrs	Exh_1
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	psig	deg F
6500	135.2	109.3	0.710	96.0	10.9	228	2.3	846
6600	147.6	117.4	0.695	102.4	10.6	238	2.3	866
6700	156.8	123.0	0.682	106.9	10.5	246	2.5	881

6800	162.7	125.7	0.675	109.8	10.5	251	2.8	895
6900	167.3	127.3	0.667	111.6	10.5	255	2.7	912
7000	171.3	128.5	0.651	111.4	10.6	258	2.8	928
7100	175.0	129.5	0.636	111.4	10.7	261	2.6	948
7200	178.1	129.9	0.619	110.1	10.9	263	2.5	966
7300	180.2	129.6	0.611	110.1	11.0	264	2.7	984
7400	181.6	128.9	0.609	110.5	11.0	266	3.1	1000
7500	181.8	127.3	0.615	111.7	10.9	267	3.1	1017
7600	180.6	124.8	0.618	111.6	11.0	268	3.0	1030
7700	174.9	119.3	0.636	111.3	11.0	268	3.1	1038
7800	146.6	98.7	0.752	110.2	10.5	252	2.6	1019

Now we have the Speedwerx Y pipe fitted with the stock muffler. This on nearly matches the airflow and HP of the SLP Y pipe, and we have a good safe PCV tune to match.

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	AirInT	FulPrA
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	degF	psig
6500	140.1	113.2	0.679	94.8	11.3	233	23.0	43.5
6600	152.8	121.6	0.650	99.1	11.2	243	22.7	43.5
6700	161.7	126.7	0.640	103.2	11.0	249	22.5	43.4
6800	167.5	129.3	0.633	105.7	11.0	253	22.3	43.4
6900	171.5	130.5	0.621	106.2	11.1	257	22.2	43.4
7000	174.6	131.0	0.617	107.5	11.0	259	22.0	43.4
7100	176.8	130.8	0.608	107.2	11.2	261	21.9	43.4
7200	177.8	129.7	0.604	107.3	11.2	262	21.7	43.4
7300	177.2	127.5	0.612	108.2	11.1	263	21.6	43.4
7400	173.5	123.2	0.634	109.8	10.9	262	21.5	43.4
7500	165.0	115.6	0.666	109.8	10.8	259	21.4	43.3
7600	150.3	103.9	0.732	109.8	10.5	253	21.3	43.4

Now we removed the stock pipe, and installed the Speedwerx single pipe. This SW single pipe is a bit shorter than the SLP and BMP singles, and adds a few top end, higher RPM HP in exchange for a bit less midrange torque and HP. Once again, we have a dandy PCV tune for this combination.

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	LamAF1	AirInT	FulPrA
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	Ratio	degF	Psig
6500	135.1	109.1	0.683	91.9	10.8		23.3	43.5
6600	144.3	114.8	0.694	99.8	10.5		23.1	43.4
6700	150.3	117.8	0.689	103.2	10.4		23.0	43.3
6800	157.3	121.5	0.672	105.4	10.4		22.8	43.3
6900	162.4	123.6	0.656	106.2	10.5		22.7	43.3
7000	167.6	125.7	0.638	106.7	10.7		22.5	43.3
7100	171.7	127.0	0.628	107.5	10.7		22.4	43.3
7200	175.1	127.8	0.617	107.8	10.8		22.3	43.3
7300	178.0	128.0	0.612	108.6	10.8		22.2	43.3
7400	180.4	128.0	0.608	109.5	10.8		22.1	43.2
7500	182.3	127.7	0.612	111.3	10.7		22.0	43.2

7600	183.3	126.7	0.610	111.7	10.7		21.9	43.2
7700	183.6	125.3	0.610	111.9	10.7		21.8	43.2
7800	182.4	122.8	0.599	109.1	10.9		21.8	43.3
7900	169.6	112.8	0.635	107.5	10.8		21.6	43.3

We installed the D&D Y pipe with the stock muffler, along with three supplied stamped steel spacers beneath the big donut that effectively lengthened the D&D Y pipe to match the others. This one had a large goober of weld slag on the seam of the otherwise smooth inside crotch of the Y, which could have obstructed airflow a bit.

EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	AirInT	FulPrA
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	degF	Psig
6500	136.8	110.5	0.704	95.9	10.9	229	23.1	43.5
6600	150.3	119.6	0.675	101.0	10.9	239	23.0	43.4
6700	161.2	126.4	0.651	104.5	10.8	247	22.8	43.4
6800	167.9	129.7	0.638	106.7	10.8	251	22.7	43.3
6900	172.4	131.2	0.629	108.1	10.8	255	22.6	43.3
7000	175.4	131.6	0.619	108.2	10.9	257	22.5	43.3
7100	177.4	131.2	0.611	108.0	11.0	259	22.4	43.3
7200	178.0	129.9	0.609	108.1	11.0	260	22.3	43.3
7300	177.6	127.8	0.616	109.1	10.9	261	22.2	43.3
7400	174.1	123.5	0.632	109.7	10.8	260	22.2	43.4
7500	163.1	114.2	0.680	110.6	10.6	256	22.1	43.3
7600	145.5	100.6	0.756	109.8	10.3	247	22.0	43.3

The D&D single pipe replaced the stock pipe, and with the D&D Ypipe it produced the highest HP of everything we tested here, but with lower midrange torque and HP. Also note that the D&D pipe makes it's power with less airflow than the others, which due to what is probably higher exhaust backpressure, is partially responsible for the high top end HP.

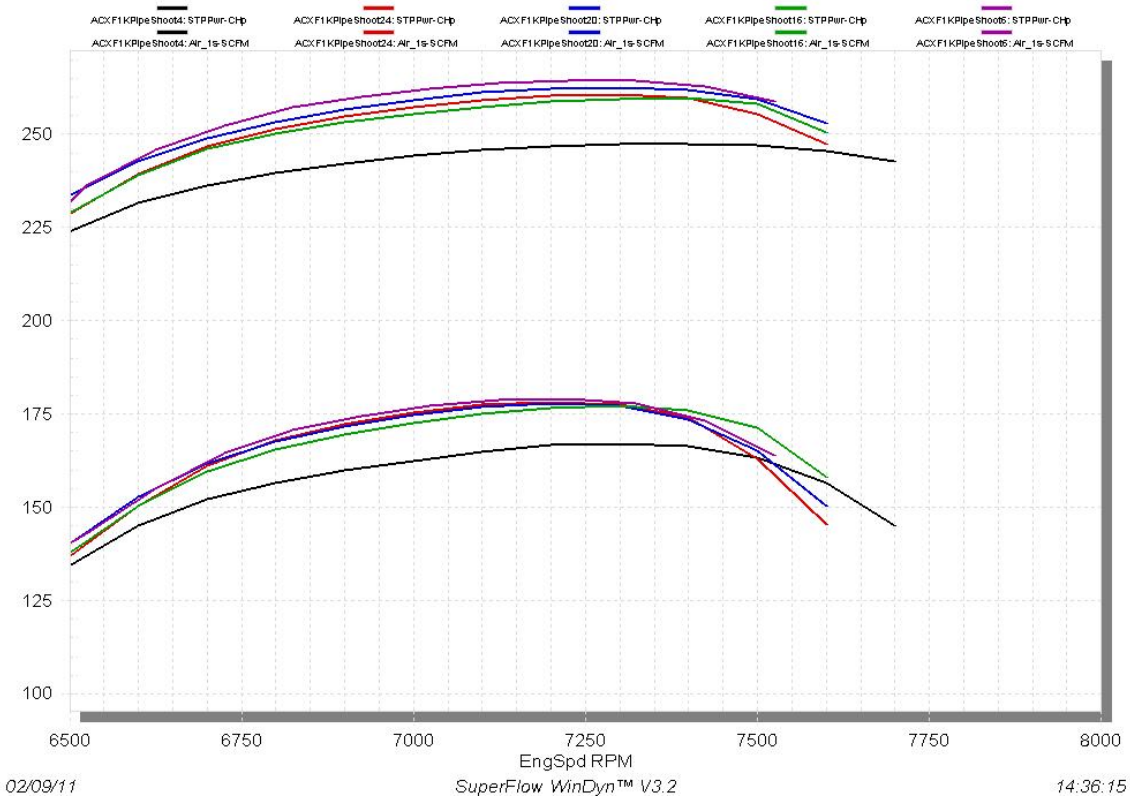
EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	AirInT	Air_1s	FulPrA
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	degF	SCFM	psig
6500	136.1	109.9	0.707	96.2	10.4	19.8	220	43.4
6600	141.0	112.2	0.702	98.9	10.4	19.8	225	43.3
6700	145.8	114.3	0.700	102.0	10.3	19.7	230	43.3
6800	150.4	116.1	0.701	105.3	10.2	19.7	234	43.3
6900	154.0	117.2	0.691	106.4	10.2	19.6	237	43.2
7000	160.2	120.2	0.671	107.5	10.3	19.6	243	43.3
7100	165.0	122.1	0.651	107.4	10.5	19.5	246	43.3
7200	169.3	123.5	0.641	108.5	10.5	19.5	250	43.3
7300	173.1	124.6	0.630	109.1	10.6	19.4	253	43.2
7400	176.7	125.4	0.626	110.6	10.6	19.4	255	43.2
7500	180.1	126.1	0.623	112.2	10.5	19.4	257	43.2
7600	183.3	126.7	0.616	112.9	10.5	19.3	259	43.2
7700	186.0	126.9	0.604	112.3	10.6	19.3	261	43.2
7800	187.8	126.5	0.600	112.7	10.6	19.3	262	43.2
7900	181.2	120.5	0.590	107.0	11.1	19.3	259	43.3

D&D co owner Dale Roes suggested that, with the Arctic Cat EFI diagnostic software we look at the timing curve of the Crossfire 1000 as revs climb. Since they have tuned their pipe to make max power at higher revs where the stock timing curve drops steeply, they recommend a 2 degree advance key ($20) to compensate for that. Here is the D&D pipe combo with 2 degrees added ignition timing (not shown of the graphs).

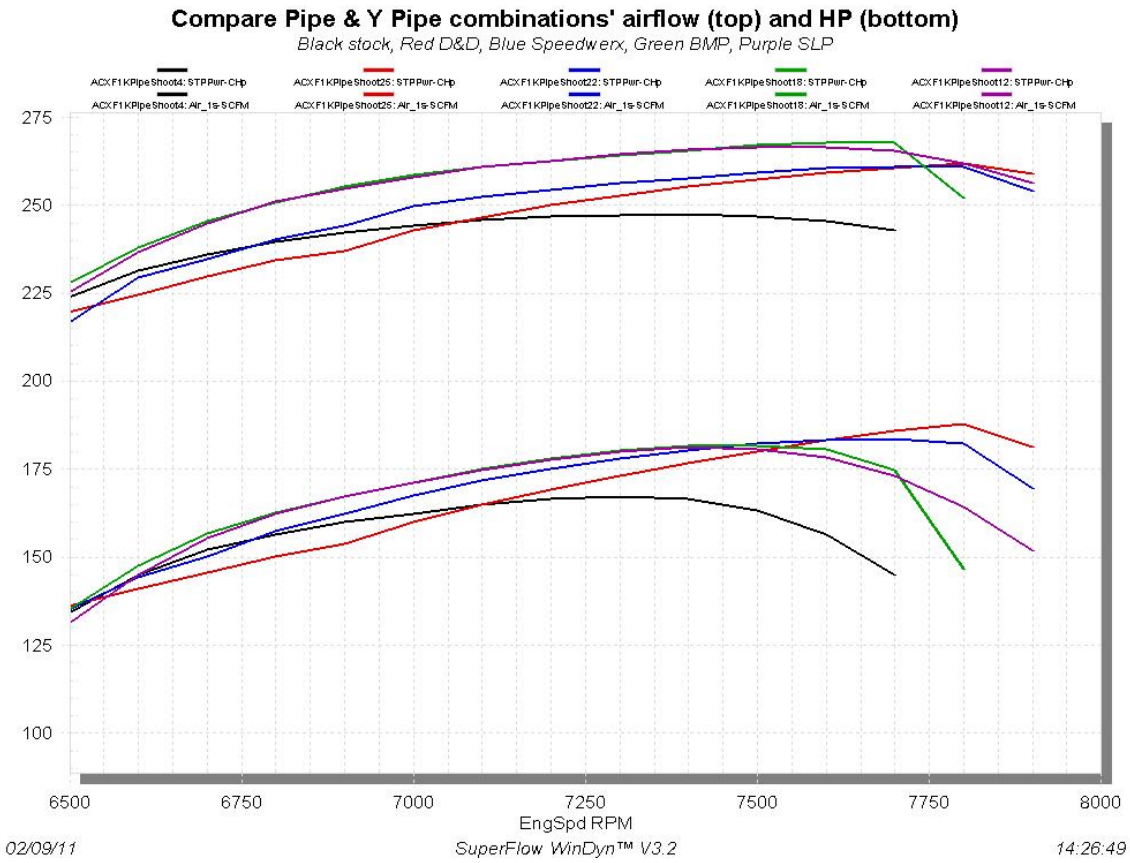
EngSpd	STPPwr	STPTrq	BSFCAB	FulAB	AFRAB	Air_1s	AirInT
RPM	CHp	Clb-ft	lb/hph	lbs/hr	Ratio	SCFM	degF
6500	127.5	103.0	0.683	86.6	10.8	205	22.6
6600	135.3	107.7	0.707	95.2	10.5	217	22.5
6700	144.3	113.1	0.703	101.0	10.3	227	22.4
6800	152.4	117.7	0.688	104.5	10.3	235	22.4
6900	159.5	121.4	0.668	106.0	10.4	240	22.3
7000	165.2	123.9	0.652	107.1	10.5	245	22.2
7100	169.6	125.4	0.638	107.8	10.6	249	22.2
7200	173.5	126.6	0.621	107.4	10.7	252	22.1
7300	177.3	127.6	0.610	107.7	10.8	254	22.0
7400	180.8	128.3	0.608	109.4	10.7	257	22.0
7500	183.6	128.6	0.605	110.6	10.7	258	22.0
7600	185.8	128.4	0.602	111.5	10.7	260	21.9
7700	187.9	128.1	0.597	111.6	10.7	262	21.9
7800	189.0	127.3	0.585	110.1	10.9	263	21.8
7900	186.8	124.2	0.576	107.2	11.3	264	21.8

Compare Y pipes' airflow SCFM (top) and HP (bottom) with stock pipe

Black stock, Red D&D, Blue Speedwerx, Green BMP, Purple SLP



02/09/11 *SuperFlow WinDyn™ V3.2* *14:36:15*



Surely the best "bang for the buck" is any one of these Y pipes with a fuel controller to add fuel necessary to support the huge increase in airflow and HP. But the greedy riders amongst us will surely opt for adding the tuned pipe that best compliments their needs and riding style. Fast riders/ Lakeracers will likely get better top end acceleration and speeds, especially with fixed Diamond Drive gearing, with the high revving higher peak HP D&D combo. But the ditch-bangers and trail riders may get the best yank out of the corners with BMP and SLP combos. Then, the Speedwerx pipe and Y pipe seems to "split the difference"—for some, a good compromise.

After 25 years of doing this, I often generalize that the two-stroke HP curve is like a pile of clay—a savvy pipe designer can squish the mound of clay about to obtain a higher peak at the expense of the midrange pile and overrev downslope. And the extreme example is making the midrange *and* peak high, and just let the pile drop like a rock after the peak, and figure that the clutch tuners can avoid the cliff. Here we have three distinct and excellent piles of clay. This exercise hopefully will assist our members in deciding which is best for them.

And please, new members, look back at the archives on this website, and see how awful some aftermarket exhausts performed not too many years ago—sometimes worse than stock! Less than stock HP was way too common until those who just fitted and sold loud

pipes with no dyno and no field testing were forced to either step up and test or to abandon this market, hopefully thanks to those consumers who follow DTR and vote with their wallets.