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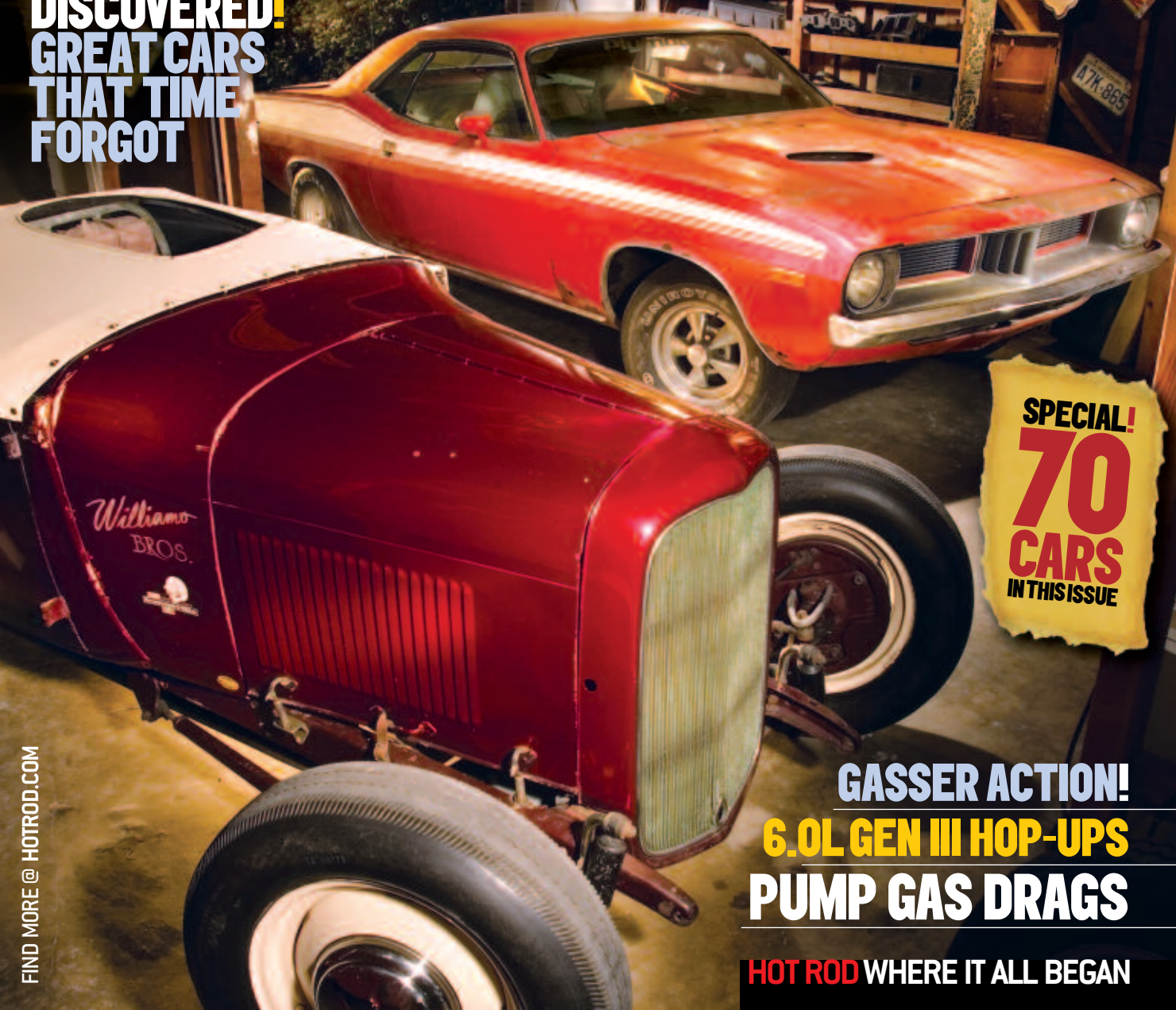
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HOPPING GM'S 6.0L LS-SERIES SMALL-BLOCK



Pick up 74 hp and 53 lb-ft on a 6.0L Truck Engine With Basic Bolt-Ons and a Computer Tune-Up.

By Marlan Davis

Photography: Marlan Davis, Ken Duttweiler, and Ed Taylor

GM Parts Research Assistance: Ken Casey, Burt Chevrolet

General Motors' LS-series small-block engines have been in production for over a decade, but it's only been within the last few years that they have really hit critical mass among average hot rodders, who are now finding them to respond superlatively to traditional hot rod power adders. One engine builder that's jumped on the LS bandwagon is Duttweiler Performance, renowned for its hard-running, high-tech, EFI turbo Buick V-6 and classic Chevy V-8 engines. When HOT ROD decided to evaluate the current state of bolt-on LS hop-ups, Duttweiler was our first choice. Its sophisticated Froude F24 dyno controlled by state-of-the-art Digalog Benchmark software enables true wide-band pulls, so the facility provided the perfect opportunity for evaluating a late-model engine under simulated street-driving conditions—and proprietor Ken Duttweiler is totally at home with modern PC laptop tuning software.

All we needed was a representative motor. The all-aluminum Gen III LS1 and LS6 engines displace 5.7 liters (346 ci). Unfortunately, their cast-in-place engine liners make overboring difficult. Although their improved liner design makes them a more viable rebuild candidate, the late LS2 6.0L (364ci) all-aluminum cores are still relatively rare. That left the most bang for the buck: a 6.0L truck engine. Not only are the truck engines much more plentiful than the LS1/LS6 engines that are found only in selected high-perf rear-wheel-drive cars, but in the past most have been based on easily rebuildable iron blocks (max overbore 0.030 inch). Besides, a stock-bore 6.0 nets you 19 ci over the 5.7L car engines.

The best of the iron-block,

aluminum-headed 6.0L truck engines was RPO LQ9, which General Motors Performance Parts (GMPP) also sold as a complete crate assembly that included just about everything from throttle body to flexplate. GM shipped us one for test-mule service. PN 19156262 was rated at 345 hp and 380 lb-ft (SAE net) with 10.08:1 advertised compression and heads similar to the vaunted Corvette LS6, except for larger combustion chambers (making them more suitable for a blower, if you're going that route).

Although this crate engine has recently been discontinued, some local dealers may still have a few. Mr. Goodwrench service replacement long-blocks are also still available, and there are also lots of cores in the wrecking yard: The 345hp, 6.0L LQ9 was installed in selected '02-'06 Cadillac SUVs and '04-and-later Chevy Silverado SS pickups. Look for a 6.0L block with the No. 317, LS6-like head castings. Some 325hp, 6.0L LQ4s also got these heads. Allegedly, the main difference between the two engines is the LQ4's half-point-lower 9.41:1 compression ratio.

BASELINE

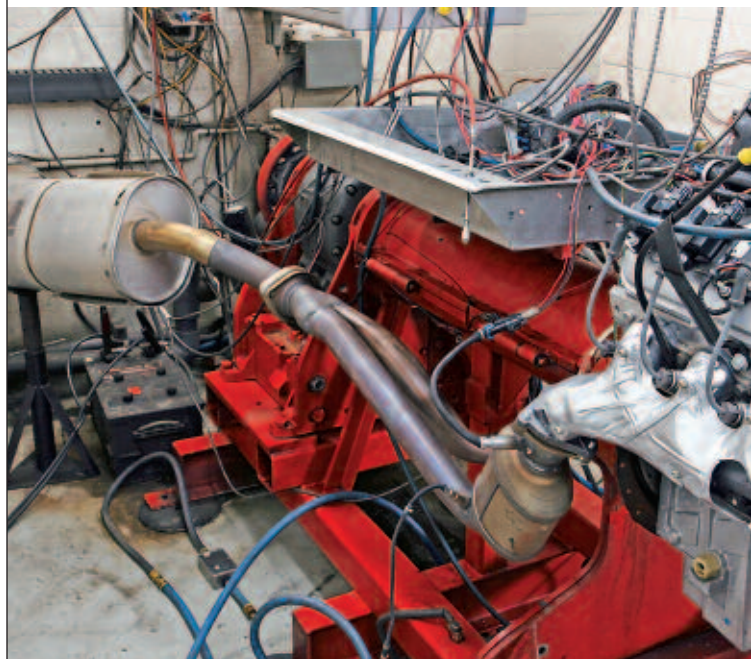
The crate engine was installed on Duttweiler's dyno set up the way it would be in a production truck, less the factory airbox but with the factory exhaust system and accessories. Running off the stock computer using the truck fuel and spark calibration, the engine produced 355 hp and 396 lb-ft of torque, as measured with the standard temperature and pressure-correction factor. GM claims 345 hp and 380 lb-ft, as rated by the more conservative "net" correction factor.



> A 6.0L block has its displacement cast into the front driver side of the block below the water pump. The LS6-like LQ9 truck heads are cast No. 317 and were also used on some late LQ4 engines.



> For dyno interface purposes a cable-driven GM 75mm throttle body (center) was substituted for the crate motor's drive-by-wire (DBW) unit (left). The LS2 and FAST intakes require a larger 90mm throttle body with a different mounting bolt pattern; Duttweiler used FAST's 90mm billet throttle body (right).



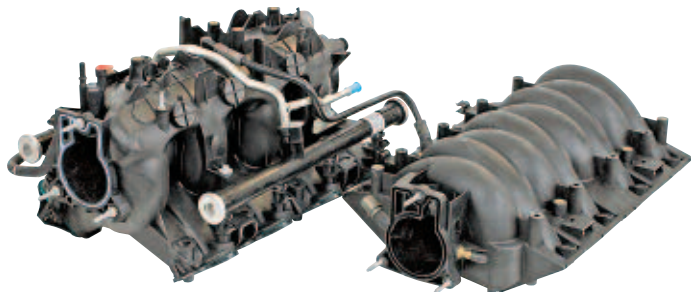
> As run with the baseline stock trim, the LQ9 exhaust manifolds dump into the stock truck dual catalytic converters, a single Y-pipe, and a big single muffler.

INTAKE MANIFOLDS

A commonly held belief is that a short-runner, car-style intake manifold should outperform a poky long-runner truck intake. On a truck engine, switching to a car-style, short-runner intake is not a straight bolt-on. You must install a passenger-car front accessory dress to clear the lower-mounted throttle body. Fortunately, Duttweiler had a complete Camaro drive setup handy.

With the accessory drives switched over, Duttweiler tested the original stepped-floor LS1 intake (stock on '97-'01 Corvettes and '98-'01 F-cars), the flat-floor LS6 manifold (also used on most LS1 builds from late '01 and up), and the Generation IV LS2 intake. Compared to the LQ9 truck long-runner design, the LS1 intake lost 9 hp and 11 lb-ft. The LS6 intake was a hair better, but certainly not enough to justify the complexity of the changeover unless you had a hood-clearance issue. As for the LS2 configuration—fahgetaboutit! Despite a larger 90mm throttle body, when compared to the best headers/cats/truck intake configuration the LS2 manifold was down nearly 8 hp and 7 lb-ft at the peak and 6.7 hp and 9 lb-ft on average.

FAST's short-runner, car-style LSX intake is a popular bolt-on. And for good reason: In our tests, equipped with the 90mm throttle body, it raised the power and torque peak outputs to 419.8 hp and 440 lb-ft respectively, a gain of 11.5 hp and 6.9 lb-ft over the truck intake's headers-with-cats configuration. Although this hot rod manifold was down (just slightly) on torque below 2,800 rpm as well as in under-3,200-rpm horsepower production, it more than made up for it in the midrange and top end, to the tune of raising average 1,600- to 5,700-rpm output about 6 hp and 10 lb-ft. Power output above its 5,400-rpm power peak also fell off less precipitously. This manifold should be worth even more when coupled with a high-performance camshaft.



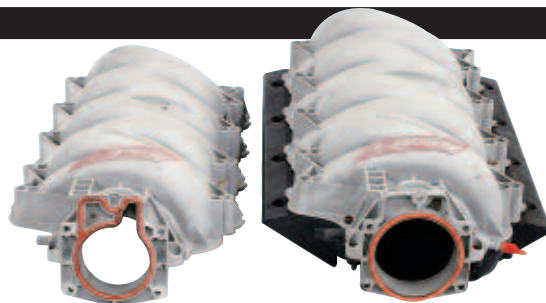
> Here's the long-runner LQ9 truck-style intake (left) compared to the car-style intake on the right.



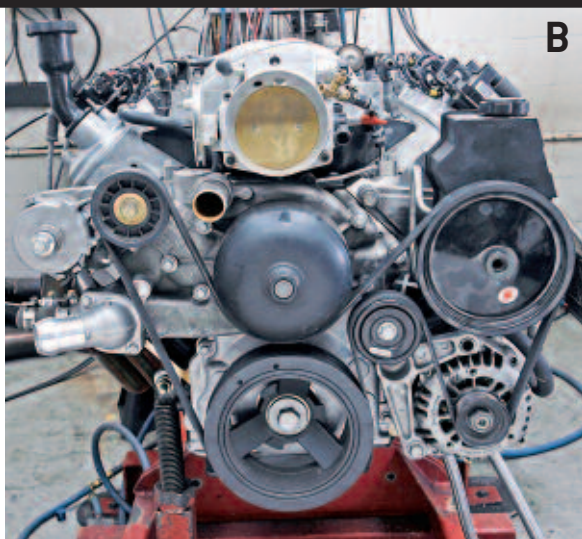
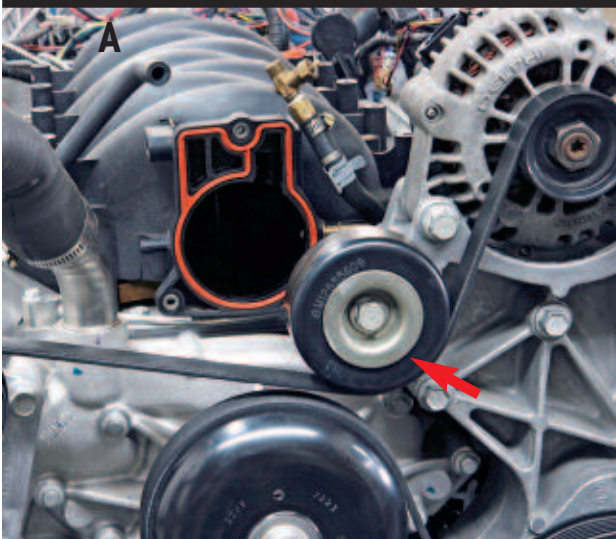
> An LS1 intake (left) has a humped floor, while the LS6's floor is flat (right). Swapping from LS1 to LS6 usually requires modification to the water crossover tubes that run under the intake.



> Both the LS1 and LS6 intakes use three-bolt 75mm throttle bodies (top). The LS2 is machined for a four-bolt 90mm throttle body (bottom). The LS2's design was reportedly compromised to reduce production costs. Duttweiler's tests seemed to bear this out—the intake was way down on power and torque despite the bigger throttle body. Stay away from it.



> FAST's LSX intake is available in two versions: one with a small throttle body mounting flange (left) for LS1/LS6 and truck 75mm throttle bodies, and another with a large 90mm LS2 throttle body flange (right). Duttweiler says the big flange works best in nearly all cases. On the LQ9 it raised overall output to 420 hp and 440 lb-ft.



A > The car intake's lower throttle body mount interferes with the LQ9's idler pulley (A, arrow), even with a 75mm throttle body. Installing a complete Camaro front accessory dress, including brackets, water pump, harmonic damper (with integral crank drive pulley), and power-steering pump, cleared even the LS2 and FAST intake's 90mm throttle bodies (B).

HIGH-RATIO ROCKER ARMS

Stock LS-series engines already have roller-fulcrum 1.7:1-ratio rocker arms (with roller fulcrums but not roller tips). Although a step up from the old-school small-block's 1.5:1 stamped rockers, unlike those legacy V-8s (except for the LT4), LS-series engines have a non-adjustable net-lash valvetrain. More radical cams require a means of adjusting the valvetrain, but even if you don't want to tear apart the engine to install a new cam, moving up to higher-ratio rocker arms is potentially worth some power—and is a quick and simple bolt-on with Crane's adjustable 1.8:1 full roller rocker arm kit. Stiffer pushrods are also included in the Crane kit, as experience has shown that the stock soft pushrods are one of the LS-series engine's weak links for performance usage.

Moving up from 1.7:1 to 1.8:1 is worth some more valve lift—in the LQ9's case, about a 0.027-inch increase to 0.494/0.507. But according to Crane, the average overall improvement is more than the raw numbers indicate because the rockers incorporate quick-lift technology. By positioning the pushrod cup lower in the rocker than stock, Crane effectively increases the rocker ratio during the early and late lift cycle as the rocker arm moves through its prescribed arc. As tested here, the Crane rockers helped the engine produce the highest numbers seen in this initial test series: 429 hp and 449 lb-ft.



> Axing the stock net-lash 1.7:1 rockers (right) for a Crane bolt-on adjustable kit that includes beefy new $\frac{3}{8}$ -inch pushrods, guideplates, screw-in rocker studs, and its famous fully rollerized (tip and fulcrum) gold aluminum 1.8:1 rocker arms (left and center) was worth 9 hp and 9 lb-ft—not quite Crane's claimed 20 hp, but then again the engine still had the stock mild cam.

OIL AND OIL PANS

Up to this point all the tests had been conducted using the stock GM deep-sump truck oil pan and the 5W-30 factory oil (yes, GM delivers the crate engine with oil). It is felt in the enthusiast community that the truck pan is a rather crude design; its deep sump often presents ground-clearance issues when installed in a low-to-the-ground classic hot rod. Could another pan do better? Duttweiler had two he wanted to try—a factory LS2 Corvette pan and a new Moroso retrofit design—but to maintain consistency during the cam swaps, the 5W-30 GM factory oil was replaced by some of Duttweiler's normal in-shop Lucas 10W-30 oil supply and the engine rebaselined, still with the 6-quart truck oil pan and standard truck windage tray. With the slightly heavier oil, the engine was down a tad: 2.2 hp and 4.1 lb-ft at the peaks, 2.9 hp and 4.7 lb-ft on average.

Reputedly, the '05 and later LS2 Corvette oil pan with its sophisticated internal baffling is better for a handling application than the truck pan; its shallow sump is also more adaptable to older rear-steer chassis. (Do not confuse this pan with the '04 and earlier LS1/LS6 Corvette pan that had side kick-out wings and doesn't fit anything besides a Corvette.) The Moroso pan is specifically designed to clear most classic musclecar chassis, with the exception of early '62-'67 Chevy IIs. In actual testing, neither of these pans proved superior to the truck pan on a stationary engine dyno. However, these tests retained the stock truck full-length windage tray; results may differ with a tray optimized for the other pans.

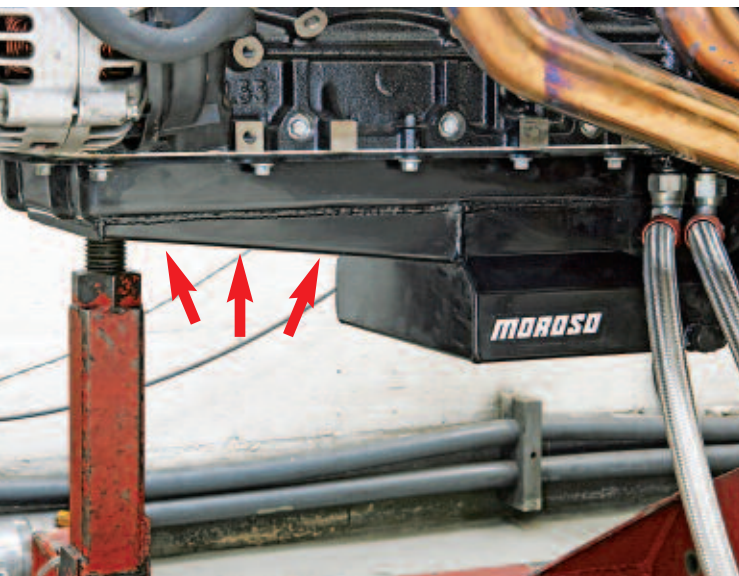


> The LQ9's deep-sump 6-quart oil pan (PN 12579273, use with pickup screen PN 12563961) relies on sump depth rather than internal baffling to manage windage and oil slosh. On a stationary engine dyno, it made as much power as the more sophisticated pans tested here.

> Right: This 6-quart pan (PN 12598186) and pickup (PN 12558750) come stock on '05-and-up LS2 Corvettes. The shallow sump extends farther to the rear, with internal baffling



to manage oil under high lateral acceleration conditions. It should fit front-steer cars (such as old Chevelles) but won't clear a rear-steer chassis like the '67-'69 Camaro. > Left: Moroso's retrofit 6-quart pan (PN 20141, use with pickup PN 24050) fits all classic musclecars set up for a rear-sump pan. It made at least as much power as the GM pans. Its subtle front slope (arrows) aids oil drain back to the sump.



NEXT UP

As the engine now stands, the highest recorded numbers were with the Dynatech headers, high-flow cats, recalibrated computer, stock truck oil pan, 5W-30 oil, and Crane 1.8:1 rockers. Compared to the initial stock baseline configuration, Duttweiler had gained nearly 74 hp and 53 lb-ft with bolt-ons and tuning. In the ultimate configuration so far, the engine was making almost 430 hp and 450 lb-ft at the peaks. It churned out over 400 hp from 4,700 rpm on up, with over 400 lb-ft of torque from 2,900 through 5,600. Of all the changes, adding the headers and tuning the computer garnered the most improvement, although the FAST intake and 1.8:1 rockers should really come into their own when coupled with big cams and higher-flowing heads. Big cams? High-flow heads? Come back next month. We're just getting started.

“HP Tuners is the second tier. If you don't modify the existing factory package, there's not much need for it. But the minute you make some changes, then it really comes into its own.” —Ken Duttweiler

DYNO RESULTS OVERALL SUMMARY									
TEST	UNIT	MAX OUTPUT @ RPM	MAX CHANGE		AVERAGE 1,600-5,700 RPM	AVERAGE CHANGE		AVERAGE 1,600-3,600	AVERAGE 3,700-5,700
			FROM BASELINE	FROM PREVIOUS		FROM BASELINE	FROM PREVIOUS		
A	LB-FT	396.3 @ 4,000			372.9			372.4	373.4
	HP	355.2 @ 5,300			258.7			185.7	331.7
B	LB-FT	421.7 @ 3,900	25.4	25.4	394.4	21.5	21.5	391.3	397.5
	HP	379.2 @ 5,700	24.0	24.0	274.5	15.8	15.8	195.8	353.1
C	LB-FT	433.0 @ 4,300-4,400	36.7	11.3	402.5	29.5	8.0	391.1	413.8
	HP	398.4 @ 5,300	43.2	19.2	281.9	23.2	7.4	195.7	368.1
D	LB-FT	440.3 @ 4,400	44.0	7.3	405.9	32.9	3.4	390.3	421.4
	HP	408.0 @ 5,300	52.8	9.6	285.3	26.6	3.4	195.5	375.1
E	LB-FT	433.2 @ 4,400	36.9	-7.1	402.1	29.1	-3.8	386.7	417.4
	HP	408.3 @ 5,400	53.1	0.3	282.7	24.0	-2.6	193.4	371.9
F	LB-FT	422.2 @ 4,300-4,400	25.9	-11.0	397.8	24.9	-4.3	387.6	408.0
	HP	399.1 @ 5,400	43.9	-9.2	278.6	19.9	-4.1	193.7	363.4
G	LB-FT	433.3 @ 4,500	37.0	11.1	404.3	31.4	6.5	389.8	418.8
	HP	411.1 @ 5,300-5,400	55.9	12.0	284.1	25.4	5.5	194.9	373.2
H	LB-FT	416.2 @ 4,300-4,400	19.9	-17.1	393.0	20.1	-11.3	381.0	405.1
	HP	400.5 @ 5,500	45.3	-10.6	275.9	17.2	-8.2	190.7	361.2
I	LB-FT	440.1 @ 4,600	43.8	23.9	405.1	32.1	12.0	385.5	424.7
	HP	419.8 @ 5,400	64.6	19.3	286.0	27.3	10.1	193.1	378.9
J	LB-FT	448.9 @ 4,700	52.6	8.8	411.3	38.3	6.2	389.9	432.6
	HP	428.9 @ 5,400	73.7	9.1	290.8	32.1	4.8	195.4	386.2
K	LB-FT	444.8 @ 4,600	48.5	-4.1	406.6	33.7	-4.7	383.5	429.8
	HP	426.7 @ 5,400-5,500	71.5	-2.2	287.9	29.2	-2.9	192.1	383.7
L	LB-FT	443.0 @ 4,600	46.7	-1.8	406.7	33.7	0.0	384.9	428.4
	HP	426.4 @ 5,500	71.2	-0.3	287.6	29.0	-0.3	192.8	382.4
M	LB-FT	442.2 @ 4,600	45.9	-0.8	406.2	33.3	-0.4	384.5	427.9
	HP	426.3 @ 5,400-5,500	71.1	-0.1	287.3	28.7	-0.3	192.7	382.0

THE COSTS SO FAR			
Below are the prices as of April '07 for the major components used in the "Test J" configuration, the highest output achieved during this test series.			
DESCRIPTION	PART NO.	PRICE SOURCE	PRICE
GMIQ9 6.0L engine*	19156262	Scoggin	\$3,749.85
Dynatech headers, cats, and exhaust	115-7343005	Dynatech	\$1,495.00
Flowmaster Super 40 mufflers (2 required)	952545	Summit	\$165.90
HP Tuner VCM Suite	—	HP Tuner	\$499.00
FAST intake	54003	Summit	\$879.95
FAST 90mm throttle-body	54019	Summit	\$529.95
Crane 1.8:1 rockers	144759-16	Summit	\$715.95
		TOTAL	\$8,035.60

TEST DESCRIPTION

- Letters below correspond to the test designators in the adjacent tables.
- A Stock baseline using factory ECM calibration, 75mm throttle body, truck long-runner intake, 5W-30 oil in truck oil pan, and stock dual catalytic converters, Y-pipe, and muffler
 - B Dynatech headers, 2.5-inch dual exhaust, dual Flowmaster Super 40 mufflers
 - C Optimize ECM spark table
 - D Optimize ECM fuel enrichment table
 - E Add dual Dynatech high-flow catalytic converters
 - F LS1 intake with 75mm throttle body
 - G LS6 intake with 75mm throttle body
 - H LS2 intake with 90mm throttle body
 - I FAST intake with 90mm throttle body
 - J Crane 1.8:1 rocker arms
 - K 10W-30 oil and stock LQ9 oil pan
 - L LS2 Corvette oil pan
 - M Moroso oil pan

BEST TEST DYNO RESULTS

RPM	TEST A		TEST B		TEST D		TEST E		TEST I		TEST J	
	LB-FT	HP	LB-FT	HP	LB-FT	HP	LB-FT	HP	LB-FT	HP	LB-FT	HP
1,600	353.6	107.3	360.0	109.7	359.1	109.6	359.6	109.5	355.3	108.4	356.9	109.0
1,700	354.0	114.1	363.5	117.7	363.2	117.9	362.0	117.1	357.9	116.1	361.1	117.2
1,800	355.7	121.6	367.0	125.8	366.7	125.9	364.6	125.0	360.3	123.7	364.2	125.0
1,900	358.3	129.5	370.3	134.1	369.7	133.9	367.5	133.0	362.7	131.3	366.8	132.7
2,000	361.1	137.7	373.6	142.3	372.5	141.9	370.3	141.1	365.2	139.1	369.2	140.5
2,100	363.8	145.7	376.7	150.7	375.2	149.9	373.1	149.2	368.0	147.0	371.7	148.5
2,200	366.2	153.7	379.8	159.1	377.8	158.1	375.7	157.4	371.0	155.3	374.6	156.7
2,300	368.3	161.5	382.8	167.6	380.4	166.4	378.3	165.6	374.2	163.7	377.8	165.3
2,400	370.1	169.2	385.7	176.2	383.1	174.9	380.7	173.9	377.7	172.5	381.3	174.2
2,500	371.6	176.8	388.7	184.9	385.9	183.6	383.2	182.3	381.2	181.4	385.1	183.3
2,600	372.9	184.4	391.7	193.8	388.9	192.5	385.6	190.8	384.8	190.5	389.0	192.7
2,700	374.2	192.1	394.7	202.9	392.0	201.6	388.2	199.4	388.5	199.8	393.0	202.2
2,800	375.6	200.0	397.8	212.1	395.2	210.8	390.8	208.3	392.1	209.1	397.0	211.8
2,900	377.2	208.0	400.8	221.4	398.6	220.2	393.6	217.3	395.6	218.6	400.9	221.5
3,000	378.9	216.3	403.9	230.8	402.0	229.8	396.6	226.6	399.0	228.1	404.6	231.2
3,100	380.9	224.8	406.9	240.3	405.5	239.5	399.8	236.1	402.4	237.6	408.1	240.9
3,200	383.1	233.5	409.9	249.8	409.1	249.4	403.2	245.8	405.6	247.2	411.4	250.6
3,300	385.5	242.4	412.6	259.4	412.7	259.4	406.6	255.7	408.8	256.8	414.5	260.3
3,400	387.9	251.3	415.1	268.8	416.3	269.5	410.2	265.7	411.9	266.6	417.4	270.1
3,500	390.2	260.2	417.3	278.1	419.9	279.7	413.7	275.8	414.9	276.4	420.3	279.9
3,600	392.3	269.1	419.1	287.3	423.3	290.1	417.2	286.0	417.9	286.4	423.1	289.9
3,700	394.0	277.7	420.5	296.2	426.6	300.4	420.5	296.3	420.9	296.4	425.9	300.0
3,800	395.3	286.1	421.4	304.8	429.8	310.8	423.6	306.4	423.8	306.6	428.8	310.2
3,900	396.1	294.1	421.7	313.0	432.6	321.1	426.4	316.5	426.7	316.8	431.8	320.7
4,000	396.3	301.6	421.5	320.9	435.1	331.3	428.8	326.4	429.6	327.1	434.8	331.2
4,100	395.8	308.8	420.7	328.3	437.2	341.3	430.7	336.0	432.2	337.4	437.8	341.9
4,200	394.7	315.4	419.4	335.3	438.9	350.9	432.1	345.4	434.7	347.7	440.7	352.6
4,300	393.0	321.6	417.5	341.8	439.9	360.2	432.9	354.3	436.8	357.7	443.5	363.2
4,400	390.7	327.3	415.1	347.8	440.3	368.9	433.2	362.9	438.5	367.5	445.8	373.6
4,500	388.0	332.5	412.2	353.3	439.9	377.0	432.8	370.9	439.6	376.8	447.6	383.5
4,600	384.9	337.2	408.9	358.2	438.7	384.3	431.9	378.4	440.1	385.5	448.7	392.9
4,700	381.4	341.5	405.1	362.7	436.6	390.8	430.3	385.3	439.7	393.5	448.9	401.6
4,800	377.6	345.3	401.0	366.5	433.6	396.3	428.0	391.4	438.4	400.7	447.9	409.2
4,900	373.4	348.6	396.4	369.9	429.6	400.8	425.0	396.7	436.1	406.8	445.8	415.8
5,000	368.9	351.3	391.5	372.6	424.7	404.3	421.2	401.1	432.6	411.8	442.3	421.0
5,100	363.9	353.3	386.2	374.9	418.8	406.6	416.6	404.6	428.1	415.6	437.6	425.0
5,200	358.4	354.6	380.5	376.5	412.0	407.8	411.2	406.9	422.5	418.2	431.7	427.5
5,300	352.2	355.2	374.4	377.7	404.5	408.0	404.8	408.2	415.8	419.6	424.7	428.8
5,400	345.3	354.9	368.1	378.4	396.2	407.3	397.4	408.3	408.3	419.8	417.1	428.9
5,500	337.9	353.9	361.6	378.8	387.3	405.6	389.1	407.2	400.0	418.9	409.1	428.4
5,600	330.4	352.6	355.2	379.0	378.1	403.2	379.9	405.0	391.2	417.1	401.1	427.6
5,700	323.7	351.4	349.5	379.2	368.6	400.1	370.0	401.9	382.1	414.7	393.7	427.2

“We’ve picked up 75 hp just messing with the outside of the engine. We expect to gain significantly more when we start throwing cams in it.” — Ken Duttweiler

SOURCES

- BURT CHEVROLET;** Englewood, CO; 800/345-5744 or 303/761-5161; www.burt.com
- CRANE CAMS INC.;** Daytona Beach, FL; 386/252-1151 [general] or 386/258-6174 [tech]; www.cranecams.com
- DUTTWEILER PERFORMANCE;** Saticoy, CA; 805/659-4339
- DYNATECH;** Boonville, IN; 800/848-5850 or 812/897-7651; www.dynatechheaders.com
- FLOWMASTER INC.;** Santa Rosa, CA; 800/544-4761 or 707/544-4761; www.flowmastermufflers.com
- FUEL AIR SPARK TECHNOLOGY (FAST);** Memphis, TN; 877/334-8355 or 901/260-FAST; www.fuelairspark.com
- GM PARTS DIRECT (FLOW CHEVROLET LLC);** Winston-Salem, NC; 336/760-7074; www.gmpartsdirect.com
- GM PERFORMANCE PARTS;** Grand Blanc, MI; 800/577-6888 [nearest dealer]; www.gmperformanceparts.com
- HP TUNERS LLC (VCM SUITE);** Santa Clarita, CA; 661/296-0183; www.hptuners.com
- LUCAS OIL PRODUCTS;** Corona, CA; 800/342-2512 or 951/270-0154; www.lucasoil.com
- MOROSO PERFORMANCE PRODUCTS INC.;** Guilford, CT; 203/453-6571; www.moroso.com
- SCOGGIN-DICKEY PARTS CENTER;** Lubbock, TX; 800/456-0211 [orders] or 806/798-4108 [tech]; www.sdparts.com
- SUMMIT RACING EQUIPMENT;** Tallmadge, OH; 800/230-3030; www.summitracing.com

“If you take the stock motor, put a set of headers on it, and give it a tune-up, you can go up an easy 45 hp.” —Ken Duttweiler