The Ultimate Chevrolet LS Cylinder Head Test - Speed Parts Testing

We Test A Dyno Room Full Of New Chevy LS Cathedral-Port Heads.

By Richard Holdener, Photography by Richard Holdener
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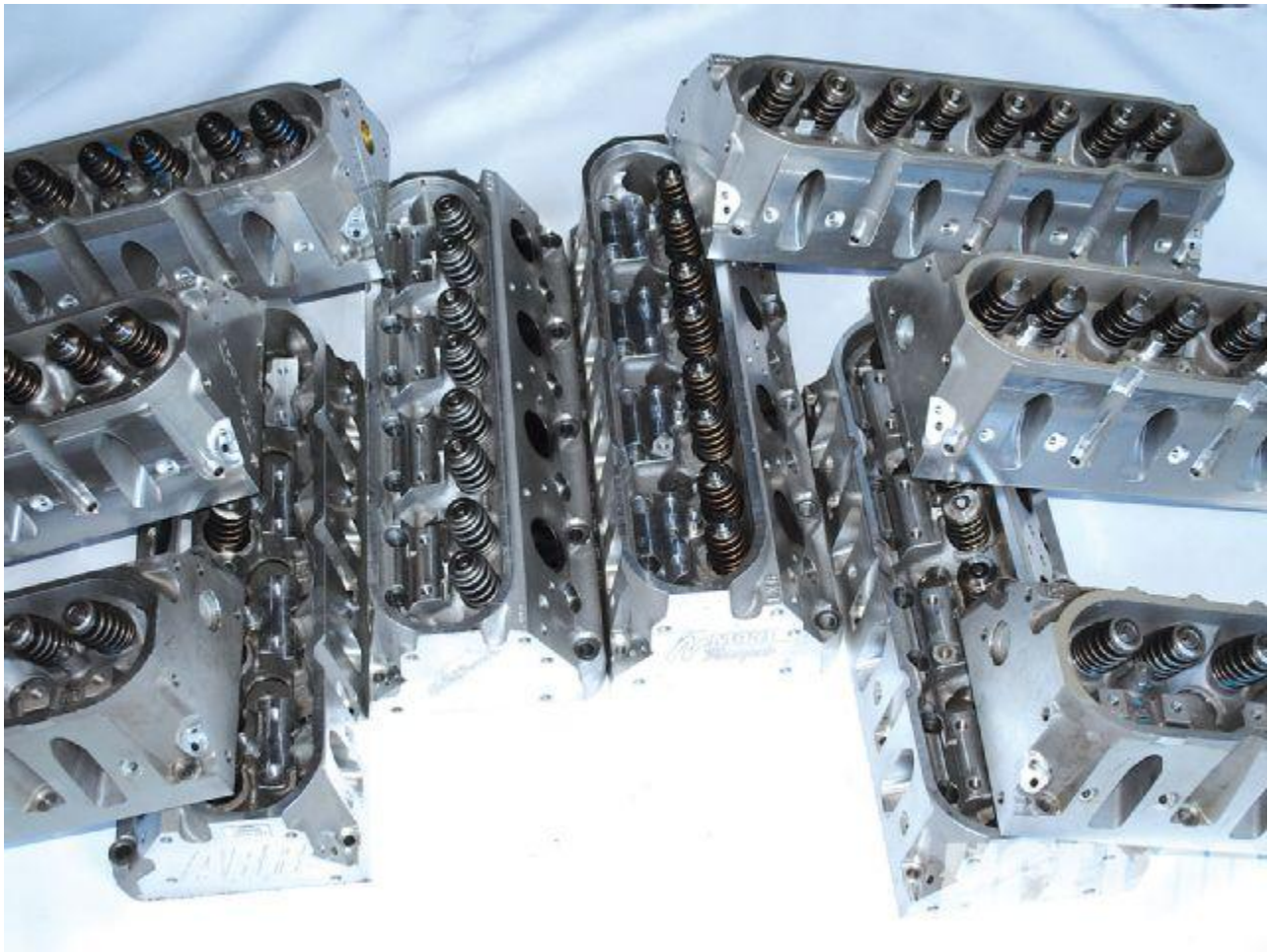

Like most ideas, this one started out with a simple statement: "Hey, let's test a few LS heads." From that innocent phrase came what would become the granddaddy of all LS cylinder head tests. Sure, we could have tossed them all on the airflow bench, provided some fancy flow numbers, and called it a day, but did we stop there? Not hardly. We here at HOT ROD are all about taking things to the next level, so we decided to add port-volume measurements and dyno testing to our already very long LS to-do list.

This is part one of a series that will thoroughly test all the available LS heads we can get our hands on. We're starting here with the LS1/LS2/LS6 cathedral-port versions. We plan on following up this adventure by testing both LS3 and LS7 heads, but for now, let's get back to the killer cathedrals.

Knowing we will be running a plethora of performance heads that exceed 300 cfm (enough flow to easily support more than 600 hp), we needed something more than your run-of-the-mill LS1 crate motor. To that end, we assembled a 408 stroker that offers more cubes, more cam, and more compression than a stock LS1, LS2, or even LS6. The 408 has a 4.00-inch forged-steel crank, matching connecting rods, and forged, dish-top pistons from Probe Racing. Wanting to tax the flow capacity of the cylinder heads, we installed an aggressive hydraulic roller cam from Comp Cams. The LSR cathedral-port profile offers 0.624 lift (with 1.7:1 rocker ratio), 239/247 duration (at 0.050), and a 114-degree lobe-separation angle. The lift was slightly higher with the 1.72 roller rockers run on most of the heads.

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The test motor consisted of a 408 stroker equipped with a forged-steel 4.00-inch stroker c

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The record time for a head swap (running to running) was 37 minutes. Perhaps the most impr

Prior to the dyno test, all heads were subjected to port and combustion chamber volume mea

Each of the cylinder heads was run using the same set of 17/8-inch headers from American Racing and tuned using the Fast XFI/XIM management system. The air/fuel was dialed in to 13.0:1 at peak power rpm, and every head ran best with 30 degrees of total timing. Sweeps were made with more and less timing (4 degrees in each direction), but all we managed to do was lose power. Naturally, variables such as air and water temperatures were also kept consistent between runs. Each set of heads was run from 3,000 rpm to 6,700 rpm (some slightly higher if the power curve continued to climb). We gathered not only the peak power numbers but also the average horsepower and torque production from 3,000 to 6,500 rpm and torque production measured at 4,000 rpm (to give an indication of the torque lower in the rev range). In addition to the dyno results, every head was run on the flow bench and tested for combustion chamber and intake port volume. Per our instructions, the manufacturers supplied their heads with 64cc chambers (our measurement only verified that we had no high-compression ringers) and sufficient spring pressure to allow for the 0.624-lift cam and 7,000-rpm potential.

While every LS owner will naturally be looking for us to declare a winner, the reality is a bit more complex. First and foremost, we discovered that the manufacturers had sufficient confidence in their products that they were willing to subject them to such an ordeal. In any contest, there will be perceived winners and losers, but the results of any dyno tests are application specific. Our combination of displacement, cam timing, and intake may have favored one or more cylinder head configuration over another. Tested on a different application, the results would certainly be different. On many of the heads, the results varied by only a couple of horsepower. In the grand scheme, that's insignificant.

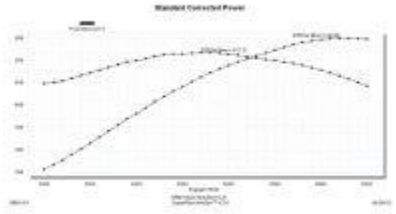
The dyno graphs provided with each head test compare them with the stock head curve. Let the Internet bickering begin.

Test 1
Stock LS1

Retail price: N/A
Intake valve size: 2.0
Exhaust valve size: 1.55
Intake port volume: 205 cc
Exhaust port volume: 70 cc

Chamber volume: 68 cc
Peak power: 549.6 hp at 6,200 rpm
Peak torque: 517.2 lb-ft at 4,800 rpm
Average horsepower (3,000-6,500): 442.1 hp
Average torque (3,000-6,500): 488.7 lb-ft
Torque at 4,000 rpm: 499.8 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	32	24
0.100	64	55
0.200	137	106
0.300	190	141
0.400	216	179
0.500	228	193
0.600	238	203
0.650	242	204
0.700	**244**	**206**



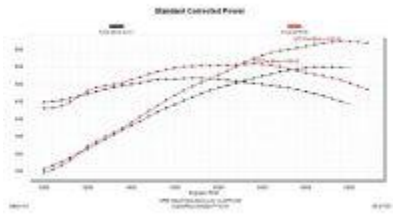
The stock LS1 heads (241 castings) were run on the 408 to establish a baseline. They have 68cc combustion chambers, so the compression was slightly lower than the test heads, but much of the power difference can be attributed to the fact that the stock heads offered peak flow numbers of 244 cfm. Though down in flow considerably compared with the aftermarket heads, they represented a significant step up the performance ladder compared with traditional small-block castings (the stock LS1 heads flow 40 cfm more than even the legendary fuelie heads of the late '60s). The 241 castings feature 205cc intake ports, 70cc exhaust ports, and a 2.0/1.55 valve combination. The hot factory heads would be the LS6 (243 castings), but even the stock LS1 heads can be made to flow well with proper porting.

Test 2
AFR 245

Retail price: $2,699
Intake valve size: 2.160
Exhaust valve size: 1.6

Intake port volume: 244 cc
Exhaust port volume: 87 cc
Chamber volume: 64 cc
Peak power: 622.1 hp at 6,400 rpm
Peak torque: 558.3 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 474.9 hp
Average torque (3,000-6,500): 519.7 lb-ft
Torque at 4,000 rpm: 511.7 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	27
0.100	68	55
0.200	152	117
0.300	225	176
0.400	278	214
0.500	318	230
0.600	343	241
0.650	**352**	240
0.700	341	**242**



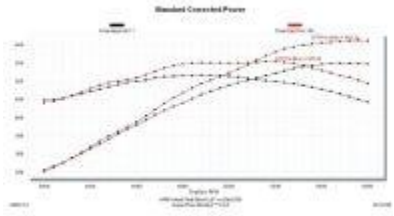
The new Air Flow Research (AFR) 245 heads offer impressive flow numbers, registering 352 cfm at 0.650 lift. Second in size only to the LS3 Mast heads, the AFR 245s featured massive 2.160-inch intake valves combined with the apparently industry standard 1.60 exhaust valve. In truth, the 245 heads were probably better suited to a bigger-bore motor and possibly an even wilder engine combination, but they nonetheless performed well on our milder 408. The peak torque production of 558 lb-ft was equaled by TFS and Texas Speed and bettered only by the Mast LS3 heads.

Test 3
Dart Pro 1 CNC 250

Retail price: $2,796
Intake valve size: 2.08
Exhaust valve size: 1.60

Intake port volume: 249 cc
Exhaust port volume: 94 cc
Chamber volume: 64 cc
Peak power: 613.2 hp at 6,400 rpm
Peak torque: 554.6 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 473.9 hp
Average torque (3,000-6,500): 519.5 lb-ft
Torque at 4,000 rpm: 509.8 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	37	24
0.100	70	54
0.200	144	110
0.300	216	157
0.400	265	196
0.500	304	225
0.600	318	235
0.650	**322**	238
0.700	317	**240**

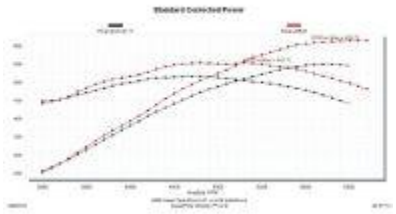


As it comes from Dart, the name Pro 1 is synonymous with power. Measuring 250 cc, the Pro 1 LS heads feature the largest port volumes of any of the cathedral-port heads (eclipsed only by the Mast rectangular-port LS3 heads). The Dart Pro 1 heads offered enough peak intake flow to easily support more than 600 hp with 2.08/1.60 valves. Despite a significant increase in port volume, the Dart head offers an additional 10 lb-ft over the stock head at 4,000 rpm. The critical element in power production is obviously not port volume but the airflow increase in relation to port volume. Interestingly, the AFR heads flowed more on the bench, yet the Dart units with larger ports and less flow made nearly equal power.

Test 4
LPE Edelbrock

Retail price: $2,995
Intake valve size: 2.10
Exhaust valve size: 1.60
Intake port volume: 234 cc
Exhaust port volume: 84 cc
Chamber volume: 64 cc
Peak power: 615.7 hp at 6,600 rpm
Peak torque: 553.7 lb-ft at 5,300 rpm
Average horsepower (3,000-6,500): 474.9 hp
Average torque (3,000-6,500): 520.9 lb-ft
Torque at 4,000 rpm: 516.7 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	32	24
0.100	63	53
0.200	129	110
0.300	191	160
0.400	245	196
0.500	284	213
0.600	318	222
0.650	**321**	225
0.700	305	**227**

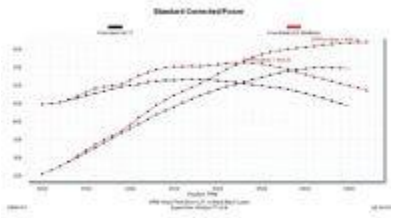


When you think of LS performance, it is hard not to think of the name Lingenfelter. The late John Lingenfelter was not only a great guy, but he was also a serious and extremely capable racer and engine builder. That commitment to quality and performance has carried on, as the gang at Lingenfelter has some impressive offerings for the LS crowd. Though they feature a number of ported heads using factory castings, we chose a set of the company's Edelbrock heads. Starting with as-cast Edelbrock LS1 heads, LPE runs them through its own CNC program to significantly improve the flow and power potential. When completed, the LPE Edelbrock heads feature a 2.10/1.60 valve package, a 235/84cc intake/exhaust port volume, and 64cc combustion chambers. Down at 4,000 rpm, the LPE heads thumped out 516.7 lb-ft and also gained more than 65 hp over the stock LS1 heads.

Test 5
Mast Black Label LS3 (Small Bore)

Retail price: $2,998
Intake valve size: 2.165
Exhaust valve size: 1.60
Intake port volume: 257 cc
Exhaust port volume: 86 cc
Chamber volume: 64 cc
Peak power: 620.1 hp at 6,600 rpm
Peak torque: 563.3 lb-ft at 5,300 rpm
Average horsepower (3,000-6,500): 477.4 hp
Average torque (3,000-6,500): 523.4 lb-ft
Torque at 4,000 rpm: 514.3 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	24
0.100	70	52
0.200	142	110
0.300	215	143
0.400	274	205
0.500	313	225
0.600	342	239
0.650	**352**	247
0.700	335	**250**

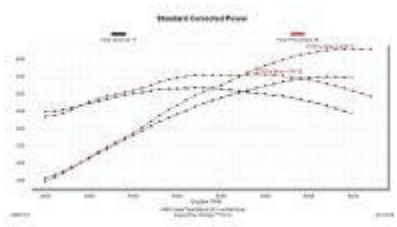


We know this rectangular-port head really doesn't belong in this cathedral-port head test, but we included it for a number of reasons. One was the fact that (just like the cathedral-port heads) this small-bore rectangular-port LS3 head was designed specifically for a 4.030-bore application. As such, the Mast head is a market competitor for the cathedral-port heads, despite the LS3 intake and offset rocker arms required. The second reason is that we wanted to see just how the considerable change in port volume (compared with most of the cathedral-port heads) might affect the low-speed power production. The general consensus is that larger port volumes decrease cylinder filling at lower engine speeds. Were that the case, we'd expect the big ports on the Mast LS3 heads to lose power down low, but that was not the case, as despite intake port volumes of 257 cc and the largest 2.165-inch intake valves, the Mast heads offered the highest peak torque output of 563 lb-ft at 5,300 rpm. The oversized port volumes didn't hinder the average power numbers, either. As we went to press, Mast announced it is introducing a far bigger line of 14 different LS heads, including cathedral ports.

Test 6
ProComp Motorsport LS1

Retail price: $1,875
Intake valve size: 2.055
Exhaust valve size: 1.60
Intake port volume: 219 cc
Exhaust port volume: 79 cc
Chamber volume: 63 cc
Peak power: 629.1 hp at 6,600 rpm
Peak torque: 557.0 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 476.6 hp
Average torque (3,000-6,500): 521.3 lb-ft
Torque at 4,000 rpm: 509.9 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	25
0.100	72	57
0.200	148	113
0.300	203	155
0.400	261	195
0.500	301	213
0.600	**321**	219
0.650	**321**	223
0.700	306	**224**



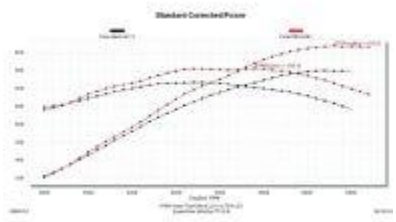
This head test was full of surprises, which is why we go to all the trouble of dyno testing in the first place. Just as surprising as the fact that the big Mast head offered the most torque, the heads with the smallest port volume offered the highest peak power. The CNC-ported LS1 heads from ProComp Motorsport are brand-new. Recognizing that the company's previous head was not a serious player in the LS market, it went to great effort and expense to design a dedicated casting that could stand toe to toe with the best heads on the market-and do so with a substantial cost savings.

Measuring just 219 cc, the intake ports featured 2.055 intake valves. The flow rates checked in at 321 cfm, which was more than enough to support the needs of our test motor. In a strange twist of fate, the small port volume and intake valve actually traded low-speed torque for the extra top-end power (compared with others in the test).

Test 7
TEA LS6

Retail price: $1,320 (porting on customer-supplied head castings)
Intake valve size: 2.055
Exhaust valve size: 1.575
Intake port volume: 226 cc
Exhaust port volume: 78 cc
Chamber volume: 63 cc
Peak power: 618.1 hp at 6,300 rpm
Peak torque: 555.3 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 476.1 hp
Average torque (3,000-6,500): 521.8 lb-ft
Torque at 4,000 rpm: 515.1 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	33	26
0.100	66	60
0.200	144	118
0.300	214	163
0.400	269	199
0.500	310	223
0.600	329	**235**
0.650	**330**	230
0.700	310	231



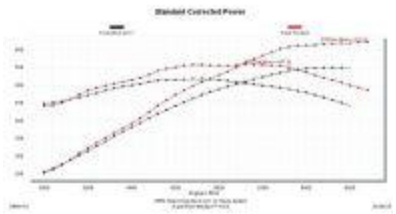
It seems like just about everyone with a grinder offers ported stock LS1/2/6 heads, so naturally we had to choose at least one set for our test. It didn't make much sense to have 20 to 30 sets of ported LS1/2/6 heads, so we decided to pick one

set to represent what was possible with the factory castings. Naturally, we selected the cream of the crop in terms of factory castings-the LS6 head. Our ported LS6 heads came from the flow wizards at Total Engine Airflow. The TEA Stage 2 heads featured the requisite CNC porting, a 2.055/1.575 valve package, and 63cc combustion chambers. As delivered from TEA, the LS6 heads offer 330 cfm combined with impressive midlift flow numbers. It bears mentioning that the ported LS6 head was the lightest of the bunch, which as you know is the same as offering more power. Down just a few horsepower compared with the best of the bunch, porting a set of stock heads is obviously a very cost-effective alternative to purchasing new castings-especially if you already own a set of LS6 heads.

Test 8
Texas Speed 237

Retail price: $2,199
Intake valve size: 2.10
Exhaust valve size: 1.60
Intake port volume: 238 cc
Exhaust port volume: 85 cc
Chamber volume: 64 cc
Peak power: 621.3 hp at 6,700 rpm
Peak torque: 558.4 lb-ft at 5,300 rpm
Average horsepower (3,000-6,500): 477.5 hp
Average torque (3,000-6,500): 523.3 lb-ft
Torque at 4,000 rpm: 514.5 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	27
0.100	72	59
0.200	149	115
0.300	226	176
0.400	281	217
0.500	317	234
0.600	336	242
0.650	345	243
0.700	**351**	**244**



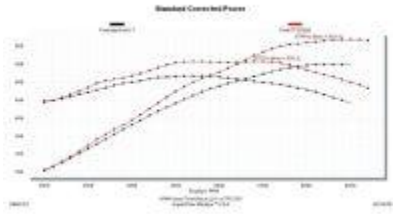
The 237cc Texas Speed heads were dedicated castings that offered not only exceptional flow numbers but also additional head boltholes for use on the aftermarket LSX blocks. If you go looking to make a serious turbo motor with a set of cathedral-port heads, the extra clamping force offered by these extra bolts might be just what you need. The TS heads combined a 2.10/1.60 valve package with a 238/85cc port volume package to maximize airflow. Next to the AFR 245 heads, the TS heads offered the highest 0.500-lift flow numbers. Power production was every bit as impressive, and the average numbers were bettered only by the Trick Flow GenX head.

Test 9
Trick Flow 235

Retail price: $2,550
Intake valve size: 2.08
Exhaust valve size: 1.60
Intake port volume: 234 cc
Exhaust port volume: 80 cc
Chamber volume: 64 cc
Peak power: 619.1 hp at 6,400 rpm
Peak torque: 558.2 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 478.4 hp
Average torque (3,000-6,500): 524.6 lb-ft
Torque at 4,000 rpm: 517.7 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	25
0.100	67	57
0.200	144	113
0.300	221	172
0.400	272	213
0.500	309	230
0.600	**333**	240

0.650	323	240
0.700	315	**244**



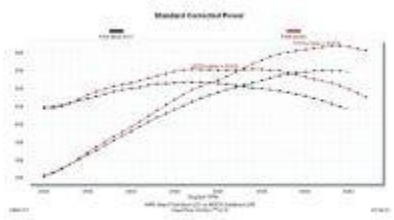
In the past we've exceeded 700 hp with Trick Flow Specialties' 245 heads on a larger 454ci stroker, so we were eager to see how the GenX 235 heads fared on our 408. The heads have a 2.08/1.60 valve package combined with an intake port volume of 235 cc (ours measured 234 cc) and took top torque honors among the cathedral-port heads, though by only 0.1 lb-ft. Is the highest peak power number the most important or is it the best average power production over a given range? The answer depends, which is why we provided both.

Test 10
West Coast Cylinder Head Edelbrock 245

Retail price: $2,385
Intake valve size: 2.08
Exhaust valve size: 1.60
Intake port volume: 243 cc
Exhaust port volume: 88 cc
Chamber volume: 64 cc
Peak power: 618.9 hp at 6,400 rpm
Peak torque: 554.0 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 475.5 hp
Average torque (3,000-6,500): 521.3 lb-ft
Torque at 4,000 rpm: 515.4 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	34	24
0.100	69	54
0.200	146	115
0.300	203	171
0.400	254	210
0.500	300	231
0.600	**325**	238

0.650	323	**240**
0.700	324	**240**



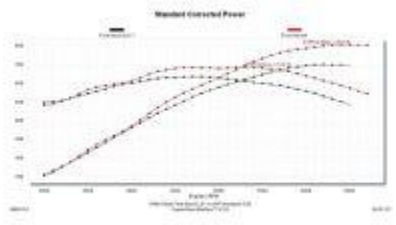
Not by design, we managed to wind up with not one but two different ported Edelbrock LS1 heads. Apparently, they are a popular starting point for serious CNC work. This pair came from the noted cylinder head specialists at West Coast Cylinder Heads. Like the ported heads from LPE, this pair featured 64cc combustion chambers but differed in both intake valve size (2.08 versus 2.10) and port volumes. The CNC program from WCCH produced larger intake and exhaust ports (measuring 243 and 88 cc). The larger ports seemed to improve flow, as the peak intake flow touched 325 cfm. The extra flow made itself known on the dyno as well. With the exception of the stock heads, every head tested produced peak torque either at 5,300 rpm or 5,400 rpm-interesting given the dramatic change in flow and port volumes. We can see why the Edelbrock heads are so popular among head porters.

Test 11
World Products Warhawk 255

Retail price: $2,790
Intake valve size: 2.10
Exhaust valve size: 1.60
Intake port volume: 255 cc
Exhaust port volume: 87 cc
Chamber volume: 64 cc
Peak power: 602.3 hp at 6,500 rpm
Peak torque: 542.2 lb-ft at 5,400 rpm
Average horsepower (3,000-6,500): 466.6 hp
Average torque (3,000-6,500): 512.3 lb-ft
Torque at 4,000 rpm: 506.0 lb-ft

FLOW DATA: CFM (AT 28 INCHES)		
LIFT	**INTAKE**	**EXHAUST**
0.050	35	25
0.100	63	56
0.200	137	115
0.300	200	165
0.400	260	198

0.500	297	214
0.600	313	224
0.650	324	228
0.700	**328**	**233**



The Warhawk heads from World Products are available in both as-cast 235 and 255cc CNC-ported versions. These heads offer a number of desirable features, including a 0.750-inch-thick deck surface to minimize distortion and maximize sealing, a raised valve cover rail to facilitate aftermarket valvetrain components, and Manley stainless steel valves to maximize flow. The CNC porting offered by Kuntz & Kraft on the Warhawk heads produced good flow numbers, peaking at 325 cfm. The World heads relied on a 2.10/1.60 valve combination. The one problem presented by the raised valve cover rail was it prohibited the use of roller rockers without grinding the valve cover rail. Since we didn't want to modify a head we planned on returning, we were forced to run factory rockers in place of the 1.72:1 roller rockers. Previous testing has shown the rockers to be worth 8 to 10 hp, so we figure these numbers are down somewhat from where they would be had we been able to run the roller rockers.

SOURCE

Trick Flow Specialties
1248 Southeast Avenue
Tallmadge
OH 44278
330-630-1555
www.trickflow.com

World Products
51 Trade Zone Court
Ronkonkoma
NY 11779
631-981-1918
www.worldcastings.com

Comp Cams
3406 Democrat Road
Memphis
TN 38118
800-999-0853
www.compcams.com

Dart Machinery
353 Oliver Street
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MI 48084
248-362-1188
http://www.dartheads.com

Edelbrock (Carbs)
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http://www.edelbrock.com

West Coast Racing Cylinder Heads
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CA
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Air Flow Research
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