CORVETTE C6.R ENGINE: STATE-OF-THE-ART SMALL-BLOCK V-8

The roots of the GM family tree of V-8 engines reach to the fabled small-block V-8 that was introduced in 1955. The current small-block V-8 shares virtually no components with the original design, yet it retains the longstanding virtues of compact size, simplicity, reliability and high specific output that have made the small-block V-8 the world's most successful production-based racing engine.

When the production LS1, the first of GM's new-generation small-block V-8s, debuted in the fifth-generation Corvette in 1997, it provided a foundation for the Corvette Racing engine program.

"Before the introduction of the LS1 small-block V-8, almost every V-8 engine used for racing dated back to designs that originated in the mid-'50s," said Doug DuchardtMark Kent, director of GM Racing. "The GM small-block V-8 that has been the cornerstone of America's racing industry for more than 50 years is being replaced by derivatives of the LS series of engines. The LS engine family is truly the high-performance small-block V-8 of the future."

The race-prepared engines that power the Corvette C6.R race cars are more powerful than their showroom counterparts, but are still production small-block V-8s at heart. In fact, the heavy-duty blocks and cylinder heads designed by GM Racing engineers for Corvette Racing are based on the design of the production parts.

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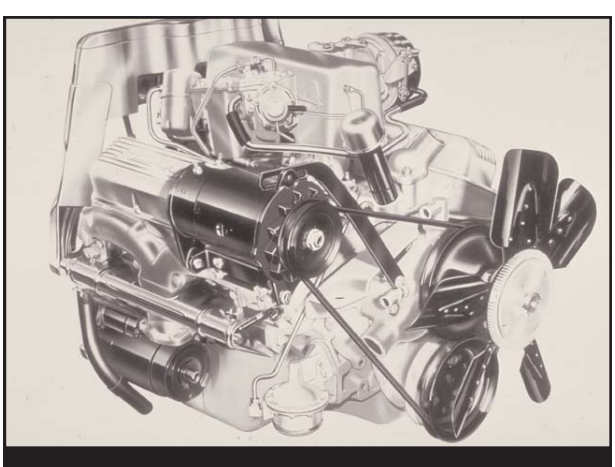
GM Powertrain's family of LS1-based engines is continuing the small-block V-8's decades-long record of success. This 21st century small-block V-8 has extended the performance envelope of two-valve pushrod engines.



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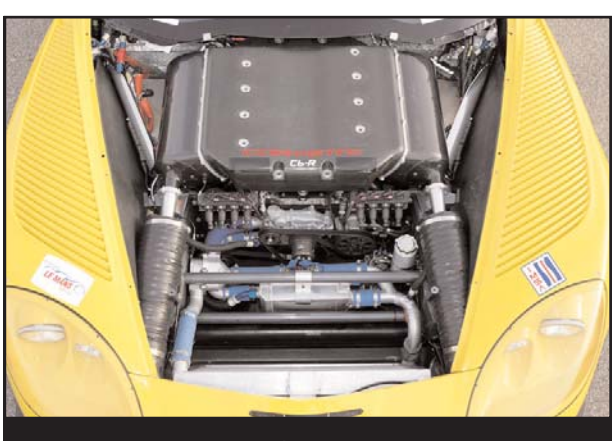
Ramjet mechanical fuel injection made it possible for Corvette's 283 ci small-block V-8 to produce one horsepower per cubic inch in 1957.

The ALMS rules mandate the use of air restrictors to equalize the performance potential of the wide variety of cars that compete in the series. The size of the restrictor is determined by the vehicle's weight, engine displacement, induction system (naturally aspirated or turbocharged) and other factors. The C6.R Corvette, for example, is required to breathe through two 31.8-mm restrictors. These orifices are about the size of a 50-cent coin.

Much like the carburetor restrictor plates used by NASCAR on superspeedways, the ALMS air restrictors limit airflow through the engine, thereby controlling the horsepower produced. Moreover, ALMS officials can change the size of the restrictor orifice to maintain a level playing field.



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The ALMS rules require two 31.8-mm restrictors to limit the flow of air to the Corvette C6.R engine. Each orifice is about the size of a 50-cent piece.

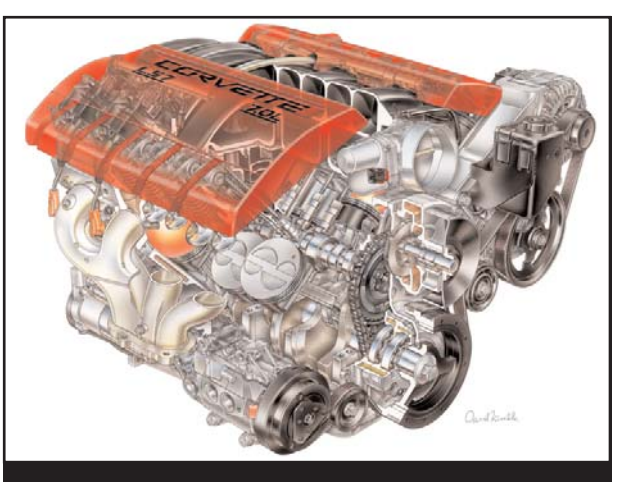
"The 7.0-liter engine combination allows us to run relatively low rpm to maximize fuel economy and reliability while producing extremely high torque numbers that make the cars very 'driver-friendly' on a road course," explained GM Racing engineer John Rice.

The key components of the LS7.R racing engine are a heavy-duty, siamesed-bore cylinder block and CNC-ported competition cylinder heads. These components have close ties to their production counterparts.

"We designed the competition engine using as much of the production designs and processes as possible," said GM Racing engine specialist Roger Allen.

LS7 technology transfer

Examples of the synergy between the Corvette Z06's production LS7 small-block V-8 and the LS7.R racing engine that powers the Corvette C6.R race cars abound. Both are powered by 7-liter engines with dry-sump lubrication systems, CNC-ported cylinder heads, titanium valves and connecting rods, forged steel crankshafts and plate-honed cylinder bores. While the components and specifications of the street and competition engines are tailored to their specific environments, the thought process behind them is identical.



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The production 7-liter LS7 engine that powers the 2006 Z06 Corvette produces 505 horsepower, the highest output of any GM small-block V-8.

GM Powertrain, using valuable data gleaned from the factory Corvette Racing program, developed the 505-horsepower LS7 with many competition-derived components and design features. It takes production small-block performance to an unprecedented level while demonstrating the continuing adaptability of the engine's compact, cam-in-block design. It is, quite simply, the largest, most powerful production small-block V-8 GM has ever produced.

"In many ways, the LS7 production engine is a racing engine in a street car," said Dave Muscaro, assistant chief engineer of small-block V-8 engines for passenger cars. "We've taken much of what we've learned over the years from the 7.0-liter Corvette Racing program and instilled it here. There really has been nothing else like it offered in a GM production vehicle."

Indeed, the LS7's engineers spent as much time at race tracks as they did at engine dynamometers. Everything from the cylinder heads to the unique dry-sump oiling system has a direct line back to the racing program. But while the LS7 has racing roots, it delivers its performance with uncompromising smoothness and tractability – qualities that make the Corvette Z06 a daily-driveable supercar.

The LS7's specifications are significant for a production engine:

- 505 horsepower @ 6300 rpm
- 470 lb.-ft. of torque @ 4800 rpm
- 7000-rpm redline
- Unique engine block with larger 104.8-mm (4.125-inch) bores and pressed-in cylinder liners
- Forged steel crankshaft with 101.6-mm (4-inch) stroke
- Titanium connecting rods
- Cast aluminum flat-top pistons
- Racing-derived CNC-ported aluminum cylinder heads with titanium intake valves and sodium-filled exhaust valves
- Dry-sump oiling system
- 11.0:1 compression ratio
- Camshaft with 15-mm (.591-inch) lift
- Hydroformed exhaust headers with unique "quad flow" collector flanges

"The racing experience enabled us to visualize how we could get more power out of the production engine," said Muscaro. "How much you get depends on where the bar is set, and racing helped us set realistic goals. A street engine has the constraints of emissions, noise and durability standards, but the race engine really challenged us to produce maximum power from a given package.

"When we started to look at upgrading the LS6, the first thing we did was sit down with the race group and talk about what they had done to build a 7-liter small-block," Muscaro explained. "What did they do to the block to make the cylinder bores bigger, what did they do to the heads to increase the airflow? That was the key to creating the LS7."

The LS7's racing roots are evident in the cylinder block and reciprocating assembly, where an all-new aluminum block casting accommodates large, 104.8-mm-diameter (4.125-inch) cylinder bores. Aluminum flat-top pistons produce an 11.0:1 compression ratio. Lightweight titanium connecting rods link the pistons to a precision-balanced forged steel crankshaft with a 101.6-mm (4-inch) stroke. The titanium rods weigh just 480 grams apiece – almost 30 percent less than comparable steel rods.

Both the production LS7 and the C6.R race engines use dry-sump oiling systems designed to keep the engines properly lubricated during high-speed cornering. In the production Corvette Z06, an 8-quart reservoir delivers oil to the engine oil pump under the demanding conditions of cornering loads in excess of 1 g. While common in racing cars, the Corvette Z06 is one of just a handful of production vehicles – and the only production Corvette – to incorporate such a high-performance oiling system.

The LS7's CNC-ported aluminum cylinder heads are yet another legacy of the Corvette racing program. To ensure optimum airflow, the LS7 has straight, tunnel-like intake runners. Large by production-vehicle standards, the ports are designed to maintain high airflow velocity, providing excellent torque at low rpm and exhilarating horsepower at high rpm.

The cylinder heads feature 70-cc combustion chambers that are fed by huge, 56-mm-diameter titanium intake valves. The lightweight titanium valves each weigh 21 grams less than the stainless steel valves used in the standard Corvette LS2 small-block V-8, despite the valve head having 22-percent more area. They are complemented by 41-mm sodium-filled exhaust valves (vs. 39.4-mm valves in the LS2). To accommodate the large valve face diameters, the heads' valve seats are siamesed. Drawing on the experience of Corvette Racing, the LS7's valve angles are 12 degrees – versus 15 degrees for the LS2 – to enhance airflow.

Both the street and competition engines have evenly spaced, symmetrical intake and exhaust ports. Complete CNC porting of the LS7 and C6.R cylinder head is performed on state-of-the-art, five-axis milling machines, which carve out the intake ports, exhaust ports and combustion chambers with mathematical precision. Airflow through the LS7's cylinder head ports was improved 43 percent on the intake side and 26 percent on the exhaust side over the LS2.

"The LS series of GM small-block V-8 engines is going to have a long-term impact on the performance industry," said KentDuchardt. "It was Zora Arkus-Duntov's vision that Corvette should lead the way with race-ready parts and designs. I think he would be proud of what the GM small-block V-8 has achieved."

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