High-Revving Ford 5.0-liter V8 Delivers Power, Speed, Flexibility Befitting the Boss Name

- 2012 Ford Mustang Boss 302 engine delivers 444 horsepower and 380 lb.-ft. of torque without the aid of forced induction
- Purpose-built Boss engine is based on production 2011 Mustang GT 5.0-liter DOHC V8, heavily modified with unique, Boss-specific parts to withstand all-day thrashing
- Revised intake, CNC-machined heads, lightened valvetrain and strengthened reciprocating assembly result in a race-proven engine meeting production durability standards

The all-new 5.0-liter dual-overhead camshaft (DOHC) V8 in the 2011 Mustang GT already is the most powerful naturally aspirated production V8 Ford has ever produced. To make it worthy of the Boss name, Ford engineers tweaked more than a few bits of the engine.

They re-engineered an entire dynamometer cell to handle the engine's 7,500 rpm redline; put the first engines into Boss 302R race cars and sent them straight onto the track; and they designed a torture test equivalent to running the Daytona 250 race flat-out more than 175 times – in a row.

Only when the 444-horsepower V8 passed these tests, ensuring maximum power output without sacrificing durability, reliability and driveability, was it worthy of being called a Boss.

Bulletproof and blower-free

Planning began with a small group of engineers within the 5.0-liter V8 team. Starting with open minds and enlisting the help of two members of the original 1969 Boss 302 design team, the group began working its way toward the ultimate evolution of the new 5.0-liter: 444 horsepower and 380 lb.-ft. of torque, along with a broad, flat output curve all the way through its 7,500 rpm redline.

The Mustang team knew a supercharger would be the simplest way to extract significant power improvements from the new 5.0-liter V8, but they elected not to pursue forced induction for the 2012 Boss to stay true to the original Boss 302 engine.

"The core group of engineers on the Boss 302 engine understands and respects the heritage of the name and the history behind the original engine," explains Mike Harrison, Ford V8 engine program manager. "The first Boss 302 was a specially built, free-breathing, high-revving small V8 that gave it certain desirable characteristics on a race course – and we capture that essence in the new engine."

The team also realized the additional hardware meant more weight, the bane of any racing program and the opposite of what the Boss design team was attempting to achieve. Instead, the same technology that has made the new Mustang GT engine such a formidable force was applied to the Boss 302.

"In keeping with the spirit of the original, the new Boss 302 engine achieves its maximum power output at speeds at or above 7,500 rpm," says Harrison. "Unlike the original engine, however, low-speed torque and driveability are uncompromised thanks to twin independent variable camshaft timing (Ti-VCT) technology and computer-aided engineering design tools."

Harrison and his team began exploring Boss 302 concepts starting with the engine's ability to breathe – essential to the production of horsepower. Because credible track performance requires high power production between 5,000 rpm and 7,000 rpm, the team needed a new approach to intake manifold design.

Borrowing from the Ford Daytona Prototype engines, the resulting short-runners-in-the-box design virtually eliminates lag when the throttle is snapped open while producing peak power output at high rpm.

"The effect of the new intake design is dramatic," says Harrison. "When I took the prototype car to

Mustang Chief Engineer David Pericak, he took a short drive, tossed me the keys and said 'Book it…it's in the program.' He knew what we were on to, and that's really the point where the Boss 302 was born."

To take advantage of the racing intake manifold, cylinder head airflow was fully optimized by CNC porting the entire intake and exhaust port and combustion chamber. The painstaking machining process takes 2.5 hours per head to complete.

To accompany the higher peak-power engine speed, the team had to engineer a lightweight, high-speed valvetrain and bulletproof reciprocating assembly that would not only hold together for 150,000-plus miles but also produce power at peak rpm.

"What most people don't realize is that engine stresses increase exponentially as engine speeds rise," explains Harrison. "So moving up from GT's 7,000 rpm redline required significant re-engineering of many different parts. Sacrificing reliability and usability over the GT engine was never an option."

Some of the Boss-specific parts contributing to the Boss 302 V8's output and durability include:

- Revised composite intake system with shorter runners, inspired by Daytona Prototype racing engines, for high-rpm breathing
- Forged aluminum pistons and upgraded sinter-forged connecting rods for improved strength, needed for the higher combustion pressures and engine speeds
- New high-strength aluminum-alloy cylinder heads with fully CNC-machined ports and chambers for exceptional high-rpm airflow without sacrificing low-speed torque
- Lightened valvetrain components to provide excellent dynamic performance up to speeds well above the engine redline
- Sodium-filled exhaust valves for improved heat dissipation
- Race-specification crankshaft main and rod bearings for higher load capability and improved high-speed durability
- 5W50 full-synthetic oil with engine oil cooler for improved oil pressure and longer-lasting lubrication during extreme racing conditions
- Revised oil pan baffling for improved oil control under racing conditions and during cornering loads greater than 1.0 g

Close connection with race teams

Contrary to normal engine development protocol, the first batch of durability test engines weren't installed in an engine dyno. Instead, thanks to a request from Ford Racing, they went straight to the track.

"Ford Racing had challenged the Boss engine team to give them the first available Boss 302 engines," explains Harrison. "They came to us in August 2009 and told us they needed engines as soon as possible to build a limited number of Ford Racing Boss 302R cars for the January (2010) Daytona race. They got the engines 12 weeks later and the team got five Boss 302R cars prepped for the January race. This gave us a fantastic opportunity to be able to get full-on race experience with the engine so early in the program."

Using race telemetry, the Boss team gathered on-track data to help optimize engine calibrations, oil pan designs and cooling. In order to engage in virtual racing whenever they needed, the team used the telemetry data to re-create a hot lap at Daytona on the dyno back in Dearborn, allowing further fine-tuning.

"Working with Ford Racing has been invaluable," said Harrison. "They were a wealth of information for setting up torque and power curves for road racing and for identifying areas of concern during track runs that we wouldn't have considered if we were just building a hot street engine. Every Boss 302 owner will benefit from their contributions to the program."

Production engine durability testing

Despite its racing heritage – and the rigors of track-day testing – the Boss 302 V8 is still a production Ford engine, built alongside the 5.0-liter GT engine at Essex Engine Plant in Ontario, Canada. That means it has to meet or exceed all the standard durability testing every Ford engine is required to complete.

The high-winding engine presented a challenge: The engine had no trouble staying together at its redline, but the Ford durability dynamometers weren't designed to operate at the speeds the Boss engine was capable of.

"Ford had no engine test cells built to run at that kind of sustained speed," said Harrison. "Ford Racing had one, but it wasn't instrumented to do production durability testing. So we had to re-engineer the dyno cell with new balancers and jackshafts so the dyno wouldn't fly apart running at redline hour after hour."

Once an adequate test stand was configured, the Boss engine was run at its full rated output for tens of millions of cycles, eventually outperforming its specifications at every stage of testing. Engineers calculated that the test regimen was equivalent to running the Daytona 250 race flat-out more than 175 times – in a row.

Team members also devised an additional durability test specific to the Boss 302 engine – one that reflects the unique demands of Boss drivers. The engine was subjected to a regimen simulating 1,500 quarter-mile races typical of events at drag strips across the country.

"Even though the production Boss engine is designed to be very close to a full race engine, it had to achieve the same vehicle durability signoff any other production engine requires," says Harrison. "Then it went on to get the track durability test signoff too. It's really an engineering accomplishment that a Boss owner can thrash his car on the track and still expect the same outstanding reliability that the owner of a regular Mustang GT will enjoy."

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