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Next-Generation Northstar V8 to Benefit From New Manufacturing Equipment and Processes

WARREN, Mich. - In a major commitment to Northstar engine quality, General Motors has installed state-of-the-art equipment and adopted a new manufacturing strategy and innovative processes to produce next-generation Northstar V8 engines at its Livonia, Mich., plant.

Quality initiatives have already been put in place for 2003 front-wheel-drive (FWD) Northstar production and will further benefit rear-wheel-drive (RWD) versions of the Northstar going into production for Cadillac’s 2004 XLR and SRX.

"Our latest initiatives are not simply aimed at building a better engine or one of the best. We’re totally committed to providing Cadillac customers with the highest quality, most pleasing engine in the luxury segment," said Mike Arcamone, Livonia plant manager.

Highlights of GM’s quality drive at Livonia include brand new engine assembly and cylinder head sub-assembly lines, upgraded machining operations, major increases in error proofing using new state-of-the-art technology and significant refinements and upgrades in the state-of-art cold test equipment used for final inspection.

Early launch benefits FWD and RWD Models

As GM Powertrain’s first engine plant to adopt GM’s Global Manufacturing System (GMS), Livonia took a lead in using new processes and procedures. Traditionally, GM

Powertrain plants launch new products, like the 2004 RWD engine, and new assembly lines at the same time. Livonia’s early launch of its lines, ahead of 2004 RWD production, was a bold tactic, benefiting both FWD and RWD assemblies. Line operators played an unusually significant role in contributing to the timely, successful start-up.

"We spent a lot of time with people on both shifts and really drove home our ‘quality first’ agenda," said Robert Evangelista, Northstar launch manager. "We started and ended every day by calling all the employees together on the floor and talking about the challenges we were working on, what workstations we were concerned with, what issues and areas we wanted them to be sensitive to. Our goal was to create one big team with the same care and attention to detail that we put towards the new equipment."

Line operators reported every issue, however minute, affecting their job performance to Launch support people who logged them in books at each workstation, tracked and resolved them and gave the feedback to operators at the end of the day. Before long, the launch team had collected over 2700 issues, resolving 76 percent within one month.

"We really had 200 sets of eyes working for us," said Evangelista. "And by having the support people talk to operators every hour, every day, we were getting so much good information, we were catching everything. We had a blanket over the whole line. And our people responded so positively because they realized we were focused totally on them. It became the Cadillac team we needed."

With its speedy resolution of issues, the plant launched its lines in a record two months - less than half the time normally required to get new lines up and running at normal rate.

For 2003, the plant significantly improved internal, first-time quality (by 10 percentage points). Its direct run - the number of perfectly assembled engines coming off the end of the line - increased by 2 percentage points to 98.5 percent. And it has not had any assembly-related engine repair since launching 2003 production in June.

Prominently positioned by the new engine assembly line is a billboard-sized display. The display features four large group photos of the employees surrounding the first engine built. That engine was hand signed by every employee and currently is on display in the lobby. In the middle of the four photos is a large, hand-written note from Evangelista thanking the employees for their hard work. Inscribed above are the words that have become the motto for this enthused group of 200: "We don’t just build engines, we create the heart and soul of great automobiles!"

The advance start-up also will benefit the RWD engine quality, with pilot production scheduled to begin in late November.

"Normally at this phase of the program, you’re busy trying to install the assembly line and get it production-approved in time for the pilot engines," said Evangelista. "We’ve already got that behind us, so our product team has been able to totally focus on design and ensuring the quality of incoming supplier parts.

"It also gave us more experience working with prototype engines, more time to verify error proofing and more time for our people to grow through the learning curve. By the time we’re ready to begin building pilots, RWD engines will be nothing new to us."

State-of-the-Art Equipment and Machinery

FWD and RWD Northstar engines will be built alongside each other on the new assembly line. It uses a new two-loop system: "short blocks," consisting mainly of the cylinder block, crankshaft, pistons and oil pan, are assembled in the first loop; engine assemblies are completed in the second loop.

By allowing engines to be transported in a constant, fixed position on separate pallets, the two-loop system provides more precise location for installing components and improves efficiency.

An all-new, agile machining line also provides greater precision (measured in microns or millionths of an inch) and increased error proofing for RWD cylinder blocks. Agile machines also are being used to process the critical surface finish on cylinder head bores in the FWD block being machined on the original transfer line.

The new line uses highly flexible, computer numerical control (CNC) machines that allow multiple spindle heads to be used for creating different hole patterns. Their depth and profile can be simply and precisely programmed and re-programmed for optimum accuracy.

Cylinder head machining is performed on a highly modified and updated transfer line that formerly produced only FWD cylinder heads. The FWD cylinder head has enough features in common with that of the RWD that both can take advantage of some of the same equipment. The transfer line portion performs common machining operations, such as valvetrain operations, deck face, intake manifold flange and exhaust manifold flange milling. Where specific workstations or the equipment were required for the two engines, CNC equipment has been installed to create agile stations.

FWD and RWD cylinder heads are sub-assembled on an all-new line. The line accommodates different cylinder head geometry and allows a more extensive array of technologically advanced error proofing techniques. The new sub-assembly line also incorporates a high level of workstation modularity to easily permit potential future changes to cylinder head assembly with a minimum of investment.

Enhanced error proofing

Significantly more error proofing, employing additional levels of detection and the latest detection equipment, are used throughout the assembly, sub-assembly, machining and all manufacturing operations to ensure the highest quality level of installation and proper functioning of parts.

As part of an upgraded parts identification system, cylinder blocks and heads are coded with ID numbers, readable by both automated equipment and operators, who check the matching numbers at various junctures. Engines have their own unique ID number and, as they head down the line, also are probed at various junctures to verify that the right engine is being assembled using the right parts. Material is directed to the line from different lanes. Operators are assisted in selecting the right parts by bins that illuminate, when parts are selected.

Overall, the new assembly line uses 300 percent more error proofing. All items are checked with at least two levels of error proofing. Many have three levels of error proofing, and critical ones are checked at four different junctures. Crankshaft bearings, for example, are:

1. First loaded onto a fixture that checks to make sure they're the right set of bearings for that particular model of engine and automatically loaded into the engine
2. Tested in an automatic "torque-to-turn" test that spins the crankshaft, checking for proper tightness and cleanliness, and blows air through oil passages to check backpressure
3. Subjected to another torque-to-turn test after the cylinder heads and timing chain are installed
4. Checked for vibration with an accelerometer as part of a final cold test of the engine.

More sophisticated laser detection equipment is now used in place of sonic checking devices on the assembly and subassembly lines. Laser switches are used to check basic installation and also the orientation or positioning of critical components, like cylinder head keys, roller finger followers (RFF) and piston rings during their assembly.

The error proofing equipment itself was also validated with an unparalleled degree of testing prior to building salable engines. The first layers of error proofing were checked 10 times; the second layers, seven times; and the third layers, five times. Each is considered equally important; successively less testing was employed at each layer because of the increasing difficulty of tricking the test equipment to get to next layer.

The launch team also took the extreme measure of proving out manual backup workstations. The assembly line has 53 people-operated workstations and 40 automated stations. In the very rare event that an automated station, like that used for loading crankshafts, goes down, it has a manual backup station. With a close inspection of the results, operators tested these back-up stations by installing components for 50 engines at each of them.

Overall, up to seven layers of error proofing were employed during the launch phase of the new assembly and subassembly lines

Enhanced Cold Test Capabilities

Cold testing provides a final check of the engine after it has been fully assembled. It provides as close to a complete running, functional test of the engine as is possible, without putting fuel in it. The engine is put on a test stand and hooked up with an engine controller, just like that used in the vehicle. The different wave forms it generates, like those created by exhaust and oil pressure, vacuum and acceleration, are scrutinized to verify proper installation and functioning of different components.

The new 2003 cold test procedure monitors many more features, accelerates the engine more quickly and takes it to twice former RPM test levels (highway cruising speed), providing greater severity in testing and more sensitive detection of any anomalies. Cold test enhancements include:

- Oil temperature compensation -- the cold test now monitors oil temperature and compensates for changes in viscosity.
- Supercharging during exhaust testing -- this provides improved detection capability for roller finger followers (RFF) and cylinder head defects.
- Added accelerometers on the cylinder heads and a microphone - this enhances detection of valvetrain noise, such as noisy RFFs and sticky valves, and improves noise, vibration and harshness detection.
- Additional accelerometers on the cylinder heads -- these allow more sensitive testing for any defects in cylinder machining.

- Higher 2000-RPM capability (twice that of before) -- this provides increased detection capability for select components, such as the connecting rod bearing. If the bearings aren't properly installed, the engine will fail all vibration tests.
- A continuous running vibration test -- this new feature allows detection of intermittent noise occurring outside of normal vibration testing.

GM Powertrain is a global producer of engines, transmissions, castings and components for GM vehicles and other automotive, marine, and industrial OEMs. Headquartered in Pontiac, Mich., GM Powertrain has operating and coordinating responsibility for GM's powertrain manufacturing plants and engineering centers in North America, South America, Europe, and the Asia-Pacific region.

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