

# LMS testing systems help Volvo Truck to master exterior noise performance

Developing superior trucks that comply with ever-more demanding noise standards



Since ever-more demanding noise regulations are imposed on truck manufacturers, Volvo Truck leaves no stone unturned to minimize the exterior noise of the company's extensive truck range. At the NVH laboratories of Volvo Truck, engineers systematically measure, analyze and optimize exterior truck noise under different vehicle operating conditions using LMS NVH testing systems. During the development of new truck models, Volvo Truck NVH specialists focus on reducing the noise generated by the entire truck driveline, including engine, intake and exhaust, gearbox and transmission. The LMS systems support Volvo Truck in carefully analyzing and minimizing the contribution of driveline subsystems to the overall exterior noise. The end result are quieter trucks, with more efficient Diesel-powered drivelines, that comply with ever-stricter noise regulations.

### **Volvo Truck - the "Globetrotter" truck brand**

Volvo Trucks are sold and serviced in more than 130 countries in the world, and is the world's second largest manufacturer of heavy trucks. To further strengthen its position in a global market with growing road transportation demands, Volvo Truck concentrates on developing trucks that feature increased economic value and environmental care. High fuel efficiency and low noise emission are essential elements in this strategy.

As exterior noise regulations consequently become stricter, Volvo Truck focuses on mastering the key factors that contribute to the overall exterior noise of every single new truck model. For speeds up to 50 km/h, the exterior noise of a truck is predominantly generated by its driveline. Volvo Truck therefore carefully controls the overall

noise contribution of the driveline and pro-actively develops quieter driveline subassemblies. At higher speeds, the tires of the truck typically become the noisiest factor. This is why Volvo Truck also puts significant effort in reducing tire rolling noise by evaluating new tire types and profiles. Drilling down on driveline subsystem noise

As part of the strategy to minimize driveline noise, Volvo engineers perform a wide range of acoustic tests on individual driveline subsystems. Exhaust systems, which are significant pass-by noise contributors, are tested inside-out, also because exhaust noise regulations are strongly geography-dependent in terms of test conditions and tolerated noise levels. Also during the execution of engine development programs, Volvo engineers extensively test engine prototypes to evaluate their acoustic performance characteristics. In this regard, Volvo

Truck's 6-cylinder-in-line Diesel engines – ranging between 9 and 16 liter – are tested in a dedicated semi-anechoic engine test cell that is equipped with a dynamometer. This test facility allows engineers to precisely control the operation of the engine and measure the resulting acoustics. During such engine tests, the mechanical interaction between engine and gearbox is often also taken into account, by adding a gearbox assembly to the setup, connecting it to the engine and automatically controlling the gear shifting operation. A typical test consists of an engine/gearbox combination, which is operated through a complete runup and/or rundown cycle. For these tests, engineers use a 16-channel LMS test system to acquire and process microphone signals that are positioned in a hemisphere-shaped array around the test specimen. This setup enables Volvo Powertrain engineers to evaluate the acoustic pressure levels as well as the direction of the radiated noise.

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**Kaj Bodlund, Head of Volvo Truck's NVH laboratories**





## The LMS systems support Volvo Truck in carefully analyzing and minimizing the contribution of driveline subsystems to the overall exterior noise.

“We use the LMS test equipment to learn as much as possible about the structural and acoustic performance of engine and gearbox under realistic operational conditions,” Hans Kask, Gearbox Test Engineer at Volvo Powertrain in Gothenburg, Sweden, explained. “The versatile measurement capabilities of LMS systems offer us the flexibility to adapt the test strategy on the basis of initial test results, for example by performing a more detailed test or to quickly move on to another kind of test. Another advantage is the system’s high measurement robustness, which keeps day-to-day measurement inconsistency below 0.1 dB. In addition to acoustic tests, we also use LMS systems to measure Operational Deflection Shapes (ODS) of gearbox assemblies in order to obtain a sound grasp of the motion of parts and the interaction between parts.

Once we have acquired sufficient information and profound insight, we compare and evaluate results, and discuss these in light of related design, manufacturing and cost constraints. When defining effective design change packages, the discussions held with designers and test engineers are also taken into account, adding specific experience, feeling and judgment. Ultimately, the acoustic data we acquire in the laboratory serves to validate and update acoustic engine models that are created using LMS acoustic simulation software.”

### Confirmation of the full-truck exterior noise performance

Once a full-truck prototype becomes available for testing, the exterior noise performance of the truck is evaluated using a dedicated semi-anechoic test facility for pass-by noise testing. This indoor setup emulates an outdoor pass-by noise test by creating the effect of a truck driving past a microphone through multiplexing the signals of a number of fixed microphones. The acoustic test system of the facility consists of LMS SCADAS front-end hardware, to acquire the microphone signals, and LMS CADA-X software, to post-process and evaluate the measurements.

“Volvo Truck uses the LMS measurement setup in the truck noise chamber for over 12 years now, including several system upgrades along the way,” Kaj Bodlund, Head of Volvo Truck’s NVH laboratories in Gothenburg, stated. “The LMS data acquisition and processing solution offers us high test efficiency and enables us to make the most of the limited availability of truck prototypes. When setting up a new test, the interface of the LMS system allows operators to efficiently specify driveline details and measurement setup information, such as the layout specifications of the microphone array. After running a short fixed microphone calibration procedure, operators perform the measurements and evaluate a primary data check that takes into account maximum noise level

variations. Once the post-processed data become available, results and reports are shared among relevant parties, using Volvo Truck’s internal network. Pass-by noise result comparisons between trucks with varying driveline configurations are essential for us in defining design modifications and describing design guidelines for future developments. In general, the measurements we acquire in the laboratory are confirmed later on, during certification tests performed on Volvo Truck’s dedicated outdoor pass-by noise tracks in Borås, Sweden.”

### Responding to evolving testing challenges

At Volvo Truck, the use of LMS test solutions systematically provides the touch with reality that is needed to drive exterior noise engineering towards the requested targets. Throughout the entire detailed engineering process, LMS exterior noise measurements are leveraged to validate design prototypes and update virtual models. “The LMS testing systems enabled Volvo Truck to gradually increase the efficiency and accuracy of its NVH testing activities, in order to successfully deal with shorter development cycles and limited prototype availability,” Kaj Bodlund concluded. “In this scene of change, LMS test solutions deployed at Volvo Truck contributed significantly to the development of superior truck models that comply with ever-demanding exterior noise standards.” ■



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