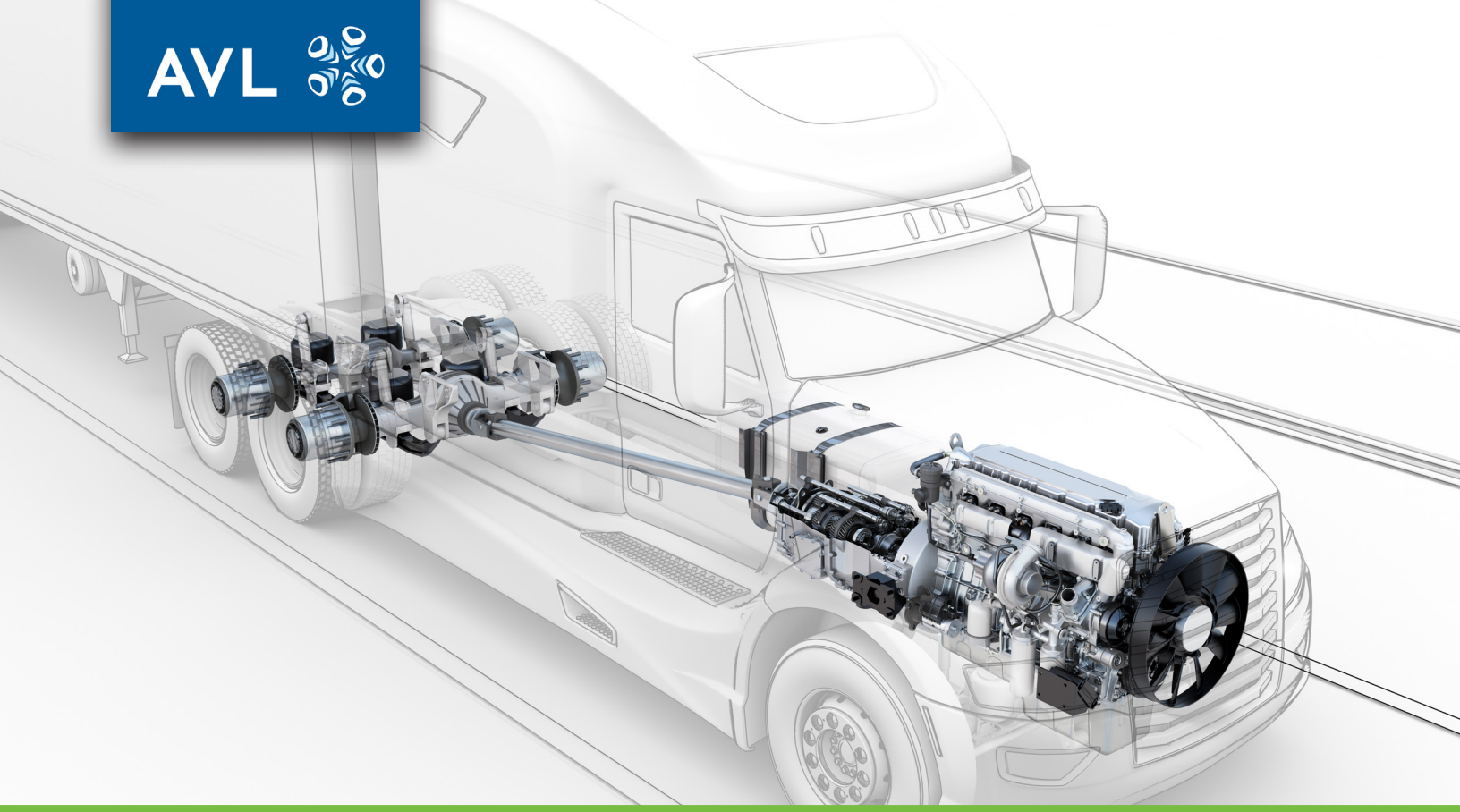

# *IMPROVING ENGINEERING EFFICIENCY WITH AVL'S LOAD MATRIX*

## Cummins partners with AVL to optimize durability testing costs


### SUMMARY

Cummins set a goal to reduce the cost of its engine validation testing and improve engineering effectiveness. Decreasing spending while maintaining high standards is no small feat, but Cummins and AVL did just that.

As part of a joint demonstration, the companies applied AVL's Load Matrix methodology to develop a test suite for a new heavy-duty Cummins engine. The results were better than expected - the approach achieved both an increase in failure mode coverage and a decrease in total dynamometer (dyno) hours.


| QUICK FACTS | |
|---|---|
| Customer / Country: | Cummins, Inc.<br>USA |
| Challenge: | • Find a solution to reduce durability testing cost while maintaining coverage of important failure modes |
| Solution: | • Application of AVL's load matrix, a physics-based methodology<br>• Correlated for multiple component failure modes, customer usage, and testing approaches via physics-based damage models |

"The physics-based Load Matrix approach enables us to make smart choices while remaining connected to our deep testing experience and development history. The damage factor modeling complements, rather than competes with, our existing testing approaches. One really needs test standards, test results and damage factors calculations to effectively validate a new product and place the results in context. AVL helped us find ways of combining all three factors to obtain a better outcome for our business and our customers."

Tom McKinley, Global System Integration and Validation Director
Cummins

## LOAD MATRIX ELEMENTS

| MODULE 1 | MODULE 2 | MODULE 3 | MODULE 4 |
|---|---|---|---|
|  |  |  |  |
| SYSTEM ANALYSIS | APPLICATION & TARGETS | TEST SUITE & DAMAGE CALCULATIONS | EVALUATION & OPTIMIZATION |
| Builds a structured system representation and prioritizes the components to be analyzed by failure mode. | Constructs customer references based on the field duty cycles with respect to the intended durability targets. | Defines the durability test suite and connects the results of system analysis, application, and targets with durability test cycles via specific damage factor models. | Uses damage calculation results to highlight validation gaps and over-coverage, enabling optimization of the dyno test suite coverage within available resources. |

## EFFICIENT & EFFECTIVE DURABILITY TESTING

Before this project, Cummins tested its engines with traditional methods. The challenges of today's increasingly complex systems and shortened development cycles drove Cummins to consider new approaches. Because of a relationship spanning decades, Cummins agreed to run a case study with the methodology in hopes of improving development efficiency and reducing cost.

AVL's Load Matrix, a systematic methodology, was the right fit for improving the heavy-duty engine test suite at Cummins. The Load Matrix uses physics-based damage models to correlate dyno test approaches to field usage in quantifiable terms, which allows for more effective and efficient durability testing. This cuts down the amount of testing engineers must conduct - and helps improve the quality of the final product.

AVL's multidisciplinary team of engineers worked closely with Cummins during a series of workshops to apply the Load Matrix process and better understand what a well-designed durability test suite means to Cummins. AVL first identified the specific test cycles in Cummins' portfolio that would best cover targeted failure modes, and then improved those test cycles and conditions to make them even more effective.

From the results of the damage calculation, the Cummins-AVL team decided which changes were necessary on the test suite to achieve the requirements, while still balancing timing and cost.

Through this joint case study, AVL highlighted validation priorities and gaps, which allowed the Cummins team to clearly communicate risks and opportunities to management. In this case, the Load Matrix combined proven methodology and systematics with customized solutions for Cummins' heavy-duty engine, but the methodology can be applied to any development process in a customer's portfolio.

## RESULTS

The Load Matrix methodology increased failure mode coverage by nearly a factor of two and reduced Cummins' dyno test hours by 20 percent. This case study left Cummins with confidence in its product validation, and the efficiency gains allow the company to release more products, faster. AVL and Cummins prove that effectiveness often leads to efficiency.

### READ MORE ABOUT THE LOAD MATRIX

A technical paper titled "Durability Test Suite Optimization Based on Physics of Failure," co-authored by Cummins and AVL, is available for purchase from SAE.

FOR FURTHER INFORMATION, PLEASE CONTACT:

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