Crash safety of new engine technologies

Project within Vehicle and Traffic Safety

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Content

FFI in short

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

For more information: www.vinnova.se/ffi

1. Executive summary

The purpose with this project was to develop relevant verification methods for crash safety of heavy commercial vehicles with new engine technologies. Focus was on electrical hybrids, but safety aspects of gas technologies as dimethylether (DME), Compressed Natural Gas (CNG) and Liquidised Natural Gas (LNG) were also considered.

The project has performed the following deliveries:

- A series of test methods and performance criteria of relevance for electric hybrid and gas propelled heavy commercial vehicles have been developed.
- A large number of crash simulations have been performed on electric hybrid concepts (truck and bus) and on DME and LNG truck concepts. The results showed high probability to fulfill the performance criteria developed.
- Three different physical crash tests (side collision, rollover and frontal crash) have been performed on Volvo FE hybrid truck, all with fulfilled performance criteria.
- The project results will be used as a base for internal development and evaluation of crash safety of future heavy commercial vehicles with alternative drivelines.

2. Background

Hybridization of vehicles is a relative young technique. With this follows a need of new types of criteria and load cases of relevance for the crash safety of these vehicles. Based on state-of-the-art accidental data, Volvo has therefore identified a number of accident scenarios of relevance for alternative drivelines.

3. Objective

The purpose with this project was to further develop these accidents scenarios into relevant verification methods for crash safety of heavy commercial vehicles with new engine technologies. The verification methods were both physical and numerical, and on component, system and/or full scale levels. Focus was on electrical hybrids, but safety aspects of gas technologies as dimethylether (DME), Compressed Natural Gas (CNG) and Liquidised Natural Gas (LNG) were also considered.

4. Project realization

The following project activities have been performed:

- Definition of load cases and test methods of relevance for alternative drivelines
- Definition of performance criteria for electric hybrid and gas propelled vehicles
- Crash simulations on electric hybrid and gas propelled vehicle concepts
- Three physical crash tests on Volvo FE electric hybrid truck;
    - Collision of moving deformable barrier (MDB) into the side of the hybrid assembly on a complete truck
    - Rollover of complete truck with hybrid assembly contacting ground
    - Frontal collision system test of hybrid assembly

5. Results and deliverables

- Based on statistics from severe to fatal accidents involving trucks, it was concluded that truck frontal collision, truck side collision, and rollover together potentially cover more than 80% of all relevant severe to fatal accident types.
- Truck frontal collision is performed by a trailer back barrier test, which covers approximately 70% (all injury levels) of all Volvo investigated accidents of this type. Truck side collision is performed by a FMVSS214 moving deformable barrier into side of a stand still truck, with an equivalent kinetic energy level to the APTA Bus Procurement Guideline for car vs. bus side impact test. Truck rollover is performed by a closing curve test, which corresponds well to the common 90 degree rollover scenario occurring when taking a curve at too high speed.
- If needed, complementary pendulum tests (proving to be relevant for severe rollover accident cases with respect to cab deformation), and/or various component tests (bonfire, short circuit) may be performed to cover load cases not included in the frontal collision, side collision or rollover tests.
- The suggested Volvo internal post-crash performance criteria for all load cases were based on available legislation/amendments for legislation on passenger cars, adjusted to conditions of relevance for heavy vehicles.
- Both the simulations and the physical tests show that the hybrid system passes the suggested performance criteria for all relevant load cases; frontal collision, side collision and rollover. The simulations performed on the DME and LNG systems show high probability that these systems will pass the suggested performance criteria for the relevant load cases, when tested.

5.1 Delivery to FFI-goals

The work has contributed to the development of knowledge and strategic tools that are needed to ensure that Swedish manufactured heavy commercial vehicles maintain the position as leading in safety, which is as important contribution to the goal to contribute to a *continued competitive Swedish vehicle industry*.
Furthermore, the project has contributed to the Vehicle and Traffic Safety program goals by definition and validation of *evaluation methods for passive safety*.
The results are relevant for industrial applications within heavy commercial vehicle transports.

6. Dissemination and publications

6.1 Knowledge and results dissemination

The results have been presented internally and externally at e.g. FFI seminars. The results will also be used internally as a base for the development and evaluation of future heavy commercial vehicles with alternative driveline technologies.

7. Conclusions and future research

The work has strengthened Volvos strategic work on a high safety standard, independent on driveline technique.

8. Participating parties and contact person

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