EVERSAFE

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Content

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• Volvo Car Corporation (VCC)

• Royal Institute of Technology (KTH)

• Technische Universität Chemnitz (TUC)

• Fraunhofer-Gesellschaft (FhG)

• Bundesanstalt für Straßenwesen (BASt)

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The Eversafe Project

The Eversafe project (Everyday Safety for Electric Vehicles) focuses on the determination of safety requirements for 2nd generation electrically propelled vehicles. Eversafe is part of the European Union Seventh Frame-work Programme, within the ERA-Net Transport Electromobility+ call.

Background and Goals

The successful integration of electrically driven vehicles into Europe's future transport system will depend on clear and transparent functional and safety requirements for the vehicles and their subsystems. These requirements play an important role in the transport system in several ways:

• The costumer needs to be confident with the safety of the vehicle.

• The road owner must know that vehicles conform to the infrastructure requirements.

• The automotive industry must have design standards to guarantee performance and reliability.

The objective of the project is to provide safety requirements for electrically propelled vehicles, thus answering the current need for standardization within this area.

Under the scope of the Eversafe project, safety issues are categorized in two groups:

• Active Safety: Under this topic vehicle stability will be addressed under fault conditions which would not arise in a conventional vehicle, i.e. failures in wheel hub motors, faulty regenerative braking systems.

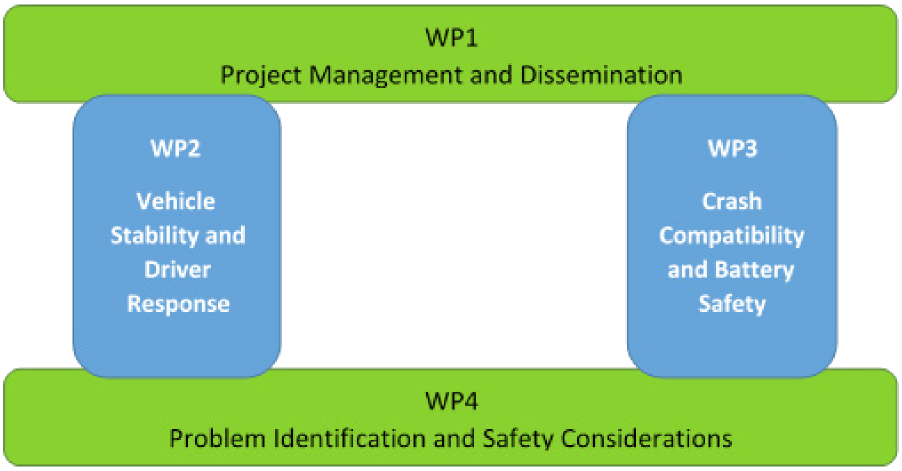
• Passive Safety: Within this area, the project will focus on issues within the fields of crash compatibility (conventional fleet with EV fleet) and Energy Storage Systems (ESS) behaviour under and after crash loading. There will also be an effort to develop concepts for safety regulations for the handling and testing of electric vehicles.

To complement the safety analysis, there will also be a user evaluation of safety related aspects, given the importance of user acceptance in market penetration. The goal of this exercise is to identify both perceived and real safety issues that need to be addressed to facilitate customer acceptance.

Work Plan

The work planned under Eversafe is divided among four work packages. The figure illustrates the work flow.

The project has two main technical work packages that are visualized as vertical pillars. These focus on active and passive safety issues for electric vehicles. Project management and exploitation of technical results are established in the horizontal actions that then result in focused research outputs into guidelines and standards.



WP1 – Project Management

WP1 manages the project, including technical and financial coordination as well as dissemination activities. The focus of the management activities will be to facilitate data sharing between the partners and effective decision making in the project. Only essential management routines and modest dissemination efforts are anticipated reflecting the size and scope of the project.

WP2 – Vehicle Stability and Driver Response

This work package aims to deliver requirements for vehicle stability under fault conditions. Relevant fault conditions will be based on work done within WP4 (problem identification and assessment). WP2 begins with a detailed problem identification/definition phase where fault conditions, unique to electric vehicles, will be identified. Based on the attained results, an experimental setup is then designed where the faults which most affect vehicle stability are tested. Finally, the designed experimental setup is used to define experiments in a driving simulator and a test track. These aim at investigating the consequences of different faults on the driving task.

WP3 - Crash Compatibility and Battery Safety

WP3's objectives are to investigate how electric vehicles (EV) will blend into the existing vehicle fleet with respect to crash compatibility. Automotive energy storage systems (ESS) and their protective structures will be analyzed under crash loads both in experiments and simulation. Compatibility criteria will be addressed and recommendations given for new safety standards concerning EVs and ESSs. Furthermore, guidelines will be developed for the safe handling of ESSs for post-crash scenarios. WP3 concludes with full scale testing of a vehicle applying the knowledge gained in the project.

WP4 – Problem Identification and Safety Considerations

The objective of WP4 is to provide the technical WPs with a setting of the problem formulation regarding standards and user expectations and scenario. The project's general technical output and recommendations for requirements will be compiled as a last task in this WP.

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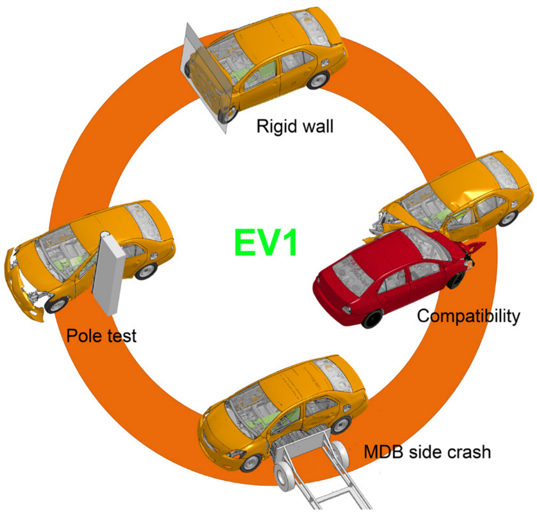
The Project so far

User Expectations

Of crucial importance for market penetration of electric vehicles (EV) is the acceptance among potential customers. Uncertainty concerning several aspects (e.g. safety of batteries in crash situations, risk of electric shock) can lead to negative safety evaluations and might affect the attitudes and purchase intentions of potential EV buyers. Bearing this in mind, methods were developed to assess safety concerns among potential customers. Of special interest are consumer concerns and expectations relating to safety in EVs.
To address these concerns two focus group sessions were conducted at Chemnitz University of Technology (Department of Psychology). Inexperienced and experienced electric vehicle drivers were invited to discuss critical safety concerns regarding the utilization of electric vehicles. In total, 25 safety concerns distributed over 4 distinct categories were identified from the sessions: 13 while driving, 4 while charging, 5 in case of accident and 3 due to vehicle aging. Safety-critical aspects vary both in terms of type of interaction and human involvement. A taxonomy of concerns related with electric vehicle was elaborated to classify and explain potential reservations among drivers.



Passive Safety Studies and Battery Safety

Safety considerations for vehicles with traction batteries were studied. The layout of vehicle components is sensitive to the mechanical loading expected in collisions. A review of the distribution of crash types involving high acceleration or high deformations were studied to establish relevant loading cases. Specific queries of databases to identify traction battery incidents were also conducted.
The main impacts identified for further study were side impacts. An FE model of an electric vehicle and critical sub components are under development.
The load cases identified from real world collisions will be used in simulations to establish critical conditions for the energy storage system (ESS) which are not fully addressed in current regulations and standards. Information from the simulation activities will serve as a basis for experimental tests. The electro-chemical behavior of ESSs is already under investigation and these results will be used to improve post-crash handling of traction batteries.

Fault Assessment

A fault in the powertrain of a vehicle can influence its dynamic stability during normal driving conditions, thus compromising safety for occupants and surrounding traffic. Vehicles with electrical powertrains can be affected by different types of problems from those which can be identified in vehicles in the current road fleet. This further motivates the need to investigate which issues might arise specifically in an electric vehicle (EV) and what their consequences might be. With this in mind, different types of faults in the electric power train of second generation EV were collected and simulated in a full vehicle simulation study.
The analysis of the results show that the faults have different effects on vehicle stability and can be grouped in fault classes. Three typical faults in an electric power train were selected, i.e. an inverter shut-down, a short circuit in the electric machine and a failure in the regenerative braking system. These were taken for further analysis with real drivers at a test track experiment and in a driving simulator study.