A TEST PROGRAMME FOR ACTIVE VEHICLE SAFETY – DETAILED DISCUSSION OF THE EVALUE TESTING PROTOCOLS FOR LONGITUDINAL AND STABILITY FUNCTIONALITY

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ABSTRACT

Active safety functions are massively implemented into new vehicle generations and offer a high potential in decreasing road accidents. While testing and rating of passive vehicle safety are based on established and accepted methods and programmes, no test programme is available for active vehicle safety today. Thus, it is difficult to assess the performance of those functions for industry, legislation and further stakeholders. In particular, the end customer cannot judge active safety of different vehicles based on easy-to-understand ratings as they are offered by different NCAP programmes for passive safety. In our opinion, this leads to a relatively low awareness of active safety functions and hinders a higher market penetration.

From January 2008 until December 2010, the European research project eVALUE has been working on objective testing and evaluation methods for active safety functions. According to investigated statistics and databases, critical and accident-prone driving situations have been identified that represent the majority of accidents, where active safety functions can come into effect. The methods are mainly based on physical testing of the full vehicle and do not take into account the influence of a single function, but rather the response of the vehicle as such. Intensive physical testing and application of the test protocols was performed in order to validate and improve the methods proposed by the consortium.

Another important topic concerns indicators, which show potential to assess the safety benefit by different active safety functions. Here, a major challenge was given by the lack of required input data, i.e. detailed accident statistics. A first set of indicators has been identified and proposed by the project consortium for further investigation.

The proposed new and highly needed test programme allows a first assessment of the overall safety performance potential of a vehicle with respect to active safety. However, the eVALUE consortium only defined the test methods while thresholds for specific indicator values and the derivation of final quantitative overall test results are not specified. This is left to the competence of every institution adopting the test methods and actually applying them in order to assess different vehicles. We believe that results gained from our programme will increase the public awareness for active safety functions and foster the development within the industry. However, the project partners also identified and expressed additional research need beyond the scope of the project, e.g. regarding accident statistics and driver behaviour models.

INTRODUCTION

Modern society strongly depends on mobility, and the need for transport of both people and goods is expected to grow in the future. Cleaner, safer and more efficient transport systems are needed. Mobility and especially road transport cause major societal problems: accidents, pollution and congestions. More than 34,000 lives were lost in 2009 due to road accidents in the European Union only [1], and the costs are estimated to be about 2 % of its GDP.

The development of road vehicles during the past decade has led to vehicles with improved passive safety. Systems of airbags, seat belts and protective structures have increased safety for the drivers, passengers and lately also pedestrians. Testing programmes for assessment of these passive safety measures have been established.

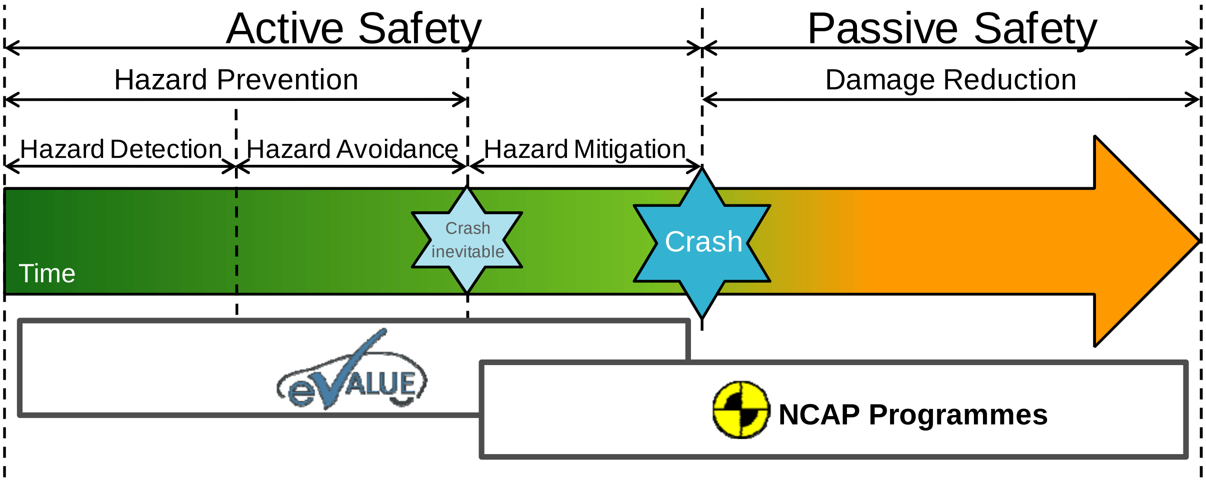

Figure 1. Timeline of Active and Passive Safety

Over the last years, active safety functions have been massively implemented into new vehicle generations, offering a high potential in decreasing road accidents. While testing and rating of the passive safety of vehicles are based on established and accepted methods and programmes, no such are available for active safety of cars or trucks today. Thus, it is difficult to assess the performance of such functions for industry, legislation and further stakeholders. In particular, the customer cannot compare the active safety provided by different vehicles based on easy-to-understand ratings as they are offered by different new car assessment programmes (NCAPs), see Figure 1.

The main focus of the European research project "Testing and Evaluation Methods for ICT-based Safety Systems (eVALUE)" was to define objective methods for the assessment of vehicle active safety. Since the start of the project, several other initiatives have identified this need for standardised testing and assessment methods. Although some of these projects are on-going, similar methods have been presented recently and a worldwide harmonisation process is required.

The eVALUE consortium consisted of eight partners from four European countries and was led by the Institut für Kraftfahrzeuge (ika) of RWTH Aachen University. Partners were Centro Ricerche FIAT (Italy) and Volvo Technology Corporation (Sweden), contributing as OEMs, SICK AG (Germany) as a sensor supplier, SP Technical Research Institute of Sweden and Statens Väg- och Transportforskningsinstitut (VTI) as research organisations from Sweden and Tecnalia Transport and IDIADA Automotive Technology from Spain as research and testing suppliers.

The test methods investigated and defined by the eVALUE project are compiled in protocols for both inspection of the subject vehicle as well as physical testing of it. They give a baseline for the assessment of the active safety performance of a vehicle. However, thresholds for specific values have not been specified by the consortium.

While some procedures are soon ready for implementation, some others require additional work that was out of scope for the project. These open research needs are summarised in the end.

OBJECTIVES

Performance test results presented to the public will help to understand the benefit of active safety functions. This has e.g. also been underlined by the European eSafetyForum working group on Research and Technological Development in their "Recommendations on Forthcoming Research and Development" [2].

By this means, also the research and development of new safety functions is encouraged. Accordingly, the long-term goal was and must be to agree on testing protocols that will be used by all involved stakeholders. This has already proven to be an effective way in terms of promoting passive safety [3].

However, the eVALUE project did not perform any activities which would have led to a direct standardisation of the methods developed. Furthermore, there were no pass or fail criteria defined for the different performance values. The clear focus was on objective and repeatable methods while rating remains to the potential users of these methods or methods based on the ones developed by the eVALUE project.

It must also be underlined that certain limitations apply to the scope of the project given by the limited time and resources that were available. Figure 2 highlights this scope in the context of safety performance analysis, which is based on real life accidents. The derivation of scenarios that represent dangerous traffic situations and the development of test methods based on those scenarios were part of the eVALUE project, while performance rating and subsequently an estimation of the safety impact could not be covered. This safety impact would in the end have an effect on the accidents, thus closing the circle.

METHODOLOGY

In 2007, the ASTE study [4] investigated the feasibility of performance testing for active safety functions. In addition, required methods and principles for verification and validation of those functions were investigated. Therefore, three different approaches were considered.

The system approach is based on the capabilities of specific systems and mapped to traffic scenarios. Performance of the different systems with similar functions is then assessed.

The scenario approach is directly based on traffic scenarios. The vehicle is tested as a black-box and its overall performance in those scenarios is determined.

As a third option, a document-based approach was discussed. This could complement physical testing and might be particularly valuable for e.g. basic HMI evaluation.

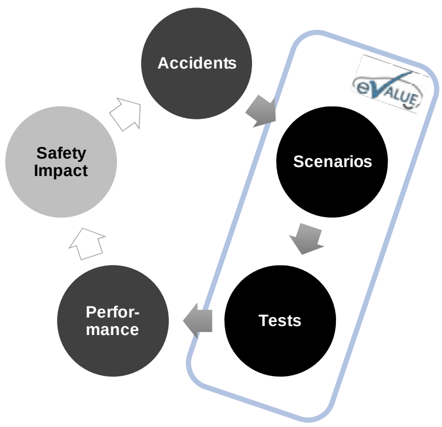

Figure 2. Safety Performance Analysis and eVALUE Project Scope

According to the conclusions of the study, vehicle active safety shall be tested following the scenario-based approach. The eVALUE project, a direct follow-up of this study, had most of the ASTE partners as members of its consortium.

Figure 3 gives an overview of the eVALUE approach for the development of the testing and evaluation methods. Based on accident statistics, relevant scenarios have been derived that represent the majority of accidents in which active safety functions could possibly mitigate the outcome.

A vehicle will be assessed by applying these novel methods and evaluating it in the identified accident-prone scenarios under controlled testing conditions. The scenarios shall be recognisable by the end customer as critical situations that can happen during normal driving. One example is approaching suddenly congesting traffic. The benefit of active safety functions like automatic braking will then become apparent.

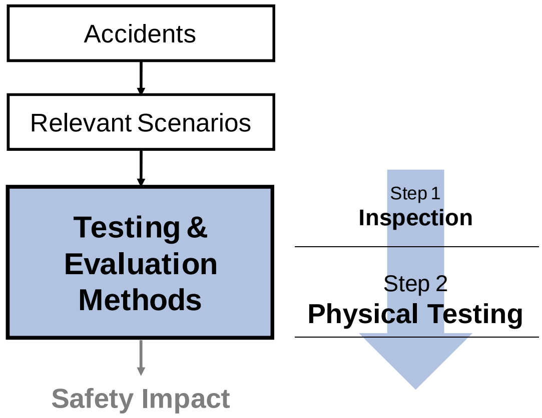

Figure 3. Scientific Approach for Active Safety Assessment Development

The technical development of the project was executed in a serial way. After the definition of the concept to be followed, the different testing strategies with respect to laboratory testing, physical testing and simulation as well as reviews by means of inspections were analysed. In the following step, the actual transition of the different test procedures into testing and inspection protocols was carried out. This was strongly linked to extensive physical testing. Since the application of the protocols led to valuable experiences this iterative approach of developing the testing protocols allowed a continuous improvement to their final form over the whole project period.

DEVELOPMENT

The derivation of relevant scenarios from accident statistics directly has already turned out to be a challenge. No reliable accident databases are available that are capable of delivering a comprehensive analysis of accident circumstances. While for instance some European projects such as TRACE [5] have been working on ideas for the harmonisation of accident statistics, waiting for them being available was not acceptable. Thus the eVALUE partners have defined relevant scenarios based on information that was available at the time being. This included standards for testing of certain systems, results from other projects and the expertise of the involved partners.

For the longitudinal direction, three different scenarios have been chosen. They represent a straight road, a curved road and a target, which is transversally moving in the way of the subject vehicle.

Regarding the straight road, the objective of the chosen scenario is to validate that the subject vehicle can detect and handle a target vehicle in the same lane, Figure 4. To handle the target vehicle means, that the subject vehicle warns or supports its driver and/or intervenes autonomously.

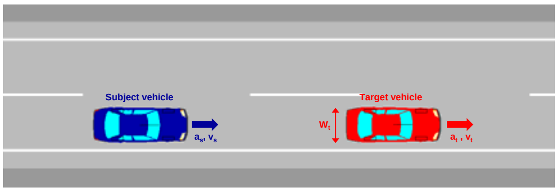

Figure 4. Rear End Collision on a Straight Road

The same objective applies for the second scenario, however for a curved road, Figure 5.

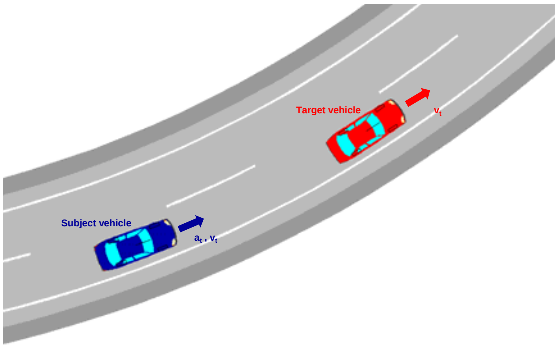

Figure 5. Rear End Collision on a Curved Road

The objective of the third scenario is to validate that the subject vehicle can detect and handle a target (e.g. other vehicle or pedestrian etc.) which moves lateral to the subject vehicle, Figure 6.

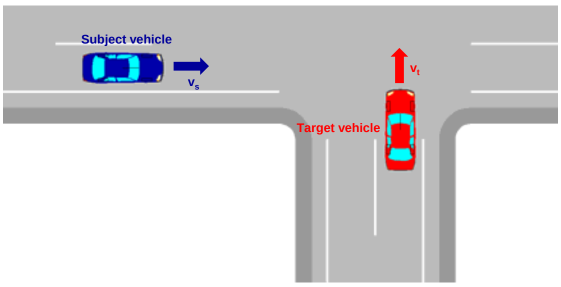

Figure 6. Transversally Moving Target

Regarding the assessment of yaw and stability assistance, four manoeuvres are already established in testing or as standards. One example is braking on µ-split, i.e. surfaces with different friction coefficients, Figure 7.

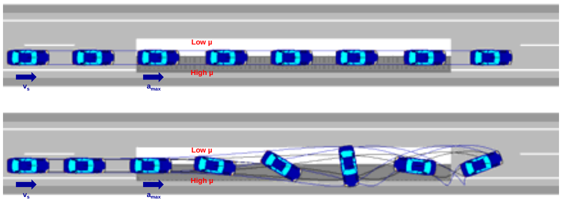

Figure 7. Emergency Breaking on µ-Split

The capability of the vehicle to avoid loss of control in a sudden obstacle avoidance manoeuvre is chosen as the second scenario, Figure 8.

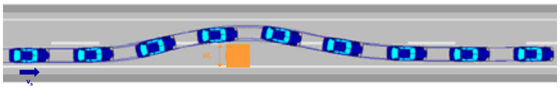

Figure 8. Obstacle Avoidance

Finally, critical situations linked to curved roads are represented by the third scenario, Figure 9.

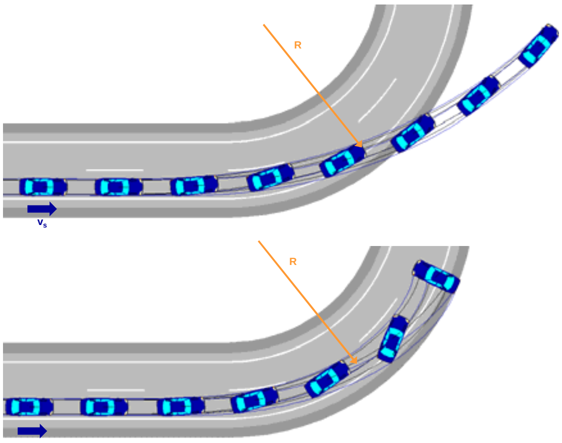

Figure 9. Highway Exit

All scenarios do not only consider passenger cars but generally also apply for trucks and busses. However, special requirements by commercial vehicles concerning active safety test methods have not been analysed due to time constraints.

Assistance and safety functions in the lateral direction of travel have also been analysed by the project. The development showed that these functions, as their implementation has started only recently, require significant additional efforts in order to develop comprehensive testing and evaluation methods. They are thus not in the focus of this paper. However, critical scenarios have also been identified and shall be mentioned.

The first scenario is meant to validate the subject vehicle capability to avoid involuntary (left/right) lane departure driving on a straight road, Figure 10.

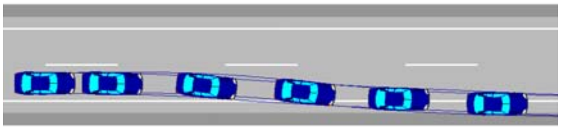

Figure 10. Lane Departure on a Straight Road

Comparable to the first, the second scenario regards a lane (or road) departure while the subject vehicle is driving in a curve. Again, the capability to avoid the involuntary lane or road departure is the objective here, Figure 11. A similar scenraio is given in case of a lane departure on a straight road just before a curve, but may require a different set of testing parameters.

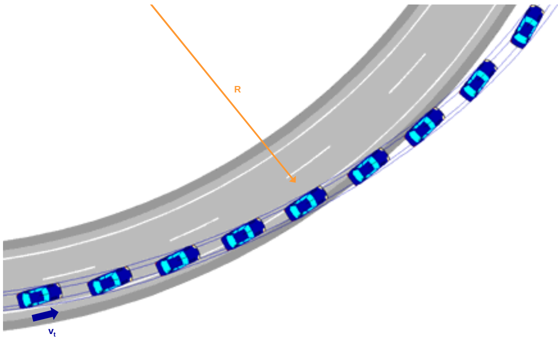

Figure 11. Lane Departure in a Curve

While the first two scenarios do not consider interaction with a second (called target) vehicle, the third scenario does so. It addresses lane change collisions which are well-known in multi-lane traffic both at low and high speeds, Figure 12.

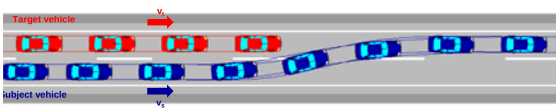

Figure 12. Lane Change Collision Avoidance

Based on the described scenarios, the eVALUE test programme consists of inspection and physical testing protocols. In the following, a brief overview is given. A complete description can be found in the publicly available "Final Testing Protocols" [6]. Figure 13 describes the proposed performance testing process in general.

Inspection Protocols

By inspection of the subject vehicle, important aspects such as the functionality of the different safety functions on board including any limitations as described in the documentation, the HMI used for warning and information of the driver, environmental conditions applying for the test. It further includes efforts made by the manufacturer in terms of functional safety are investigated and documented.

The inspection protocols define a systematic and comprehensive analysis. The objective is to identify and determine the capability of the vehicle. Most parts of the inspection are done studying the documentation and interviewing the manufacturer, but other parts of the work might be done investigating the vehicle.

Physical Testing Protocols

The core of performance testing is the physical testing of the subject vehicle. The purpose of this type of test is to assess the overall performance of the vehicle rather than testing one particular safety function under different scenarios, i.e. specific real driving situations, which are relevant regarding the functionality of the considered safety systems.

In order to do so, a differentiation between longitudinal, lateral and stability-related functionality was followed. This differentiation reflects the different levels of driver support as well as it supports the development within different expert groups. It is imaginable that a similar differentiation can be made in a later implemented test programme since it seems understandable for the customer. This, however, depends on the organisation to implement the procedures.

Each physical testing protocol contains all relevant information which is necessary to perform the related tests. This includes the general scope, references and definitions, test conditions regarding track, weather and visibility, data collection and measurement, and configuration of the vehicle under test. It is followed by the principles of the specific test, the objectives, requirements on the target and driver used, and finally the test procedure and data processing.

Safety Indicators

Adequate safety performance indicators are essential to characterise the behaviour of the tested vehicle according to the concept adopted in eVALUE. The number of selected indicators of safety performance should be limited in order to reduce the complexity of the assessment.

A safety performance indicator shall reflect a real impact on road safety and should not be confused with test conditions or measured values. Test conditions are prerequisites for the test procedure e.g. the speed of the target vehicle. Measured values are

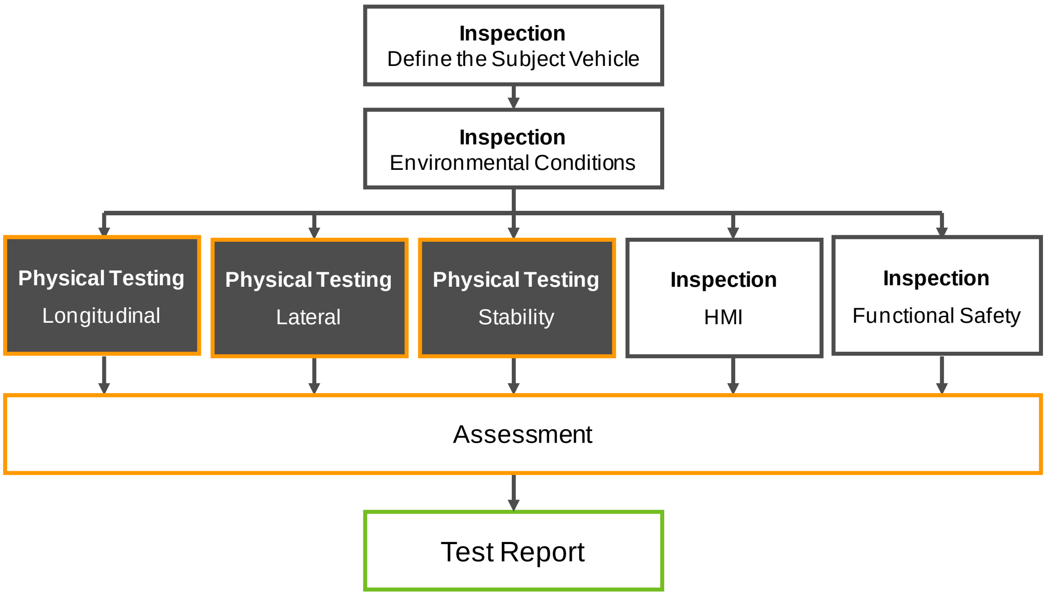

Figure 13. The eVALUE performance testing process

logged during the test e.g. the global position of the subject vehicle. The concept is to select the most important safety performance indicators where a real impact on road safety can be expected.

An assessment of the most representative safety performance indicators was made to quantify the overall safety performance of the vehicles. They have been chosen to a) characterize the safety performance associated to the sequence of events that take place in the current test, b) provide information about the tested vehicle to the developer and c) quantify the test results for comparison with a threshold value. In this regard, also the issue of open or closed loop testing is important, i.e. taking driver reactions into account or not when evaluating the performance of the vehicle. To be as realistic as possible, it is desirable to perform close loop tests. However, the lack of comprehensive driver behaviour models prevents this in many cases.

Based on some investigations, the eVALUE partners propose to use the following safety performance indicators for the longitudinal-related active safety performance:

- Collision speed
- Time-to-collision (TTC) at warning

For the stability-related performance, the following indicators are proposed:

- Mean longitudinal deceleration
- Equivalent deceleration
- Equivalent deceleration on different tracks
- Use of adherence
- Stability
- Yaw rate ratio
- Lateral displacement
- Driver intention following
- First steering wheel torque peak
- Wheel lift
- Relative radius
- Slip angle

These indicators and the formulas for their calculation are described in detail in the report “Final Testing Protocols” [6]. They must also be subject to further investigation and harmonisation between different initiatives.

RESULTS

In the following, the protocols for physical testing of longitudinal and stability-related functions are presented in detail.

Longitudinal Physical Testing Protocols

As described above, the physical testing protocols for the longitudinal direction are based on the identified critical driving scenarios. The first tests described aim to represent a scenario where a vehicle is approaching another vehicle which is moving slower in the same direction, decelerating, or being stationary on a straight or curved road.

The test is based on the observation of the subject vehicle behaviour when executing the manoeuvres specified in the respective test. The open loop tests are focusing on the vehicle's technical performance.

The objective of the open loop test is to evaluate the technical performance of the vehicle, without considering natural response and feedback from an arbitrary driver. A professional driver or a driving robot is used for triggering an action from the vehicle. There are three open loop tests depending on the type of action from the professional driver or driving robot (no action, mild brake after warning, and strong brake after warning). The outcome of the tests will depend on the level of assistance from the subject vehicle (warning, support, and/or intervention).

To facilitate a possible collision, the target vehicle is simulated by a vehicle dummy similar to ordinary vehicles with regard to physical dimensions and detection characteristics. For each of the three tests there are a number of test cases. The test cases represent different combinations of subject vehicle speed as well as target vehicle speed and deceleration. Additionally, the test cases consider: straight road, left curve, or right curve.

The following measurements need to be recorded while testing:

- Local time reference
- Local position of both vehicles
- Speed of both vehicles
- Longitudinal deceleration of both vehicles
- Longitudinal distance between both vehicles
- Lateral distance between vehicles
- Warning instant
- Collision instant (if there is any)
- Brake pedal actuation force

After the pre-stabilisation period, t_1, the initial speeds (and clearance) has been established by the use of professional drivers in the subject and target vehicles. Depending on the test case, the target vehicle may initiate a robot-controlled braking at t_2.

Subsequently, typical driver action is simulated by doing nothing (passive driver) when the warning is issued or by a robot-controlled braking after a typical reaction time has elapsed. The tests progress until a collision occurs or when the speed of the subject vehicle is equal or lower than that of the target vehicle, i.e. no collision.

For each of the three tests (no, mild or strong braking), a number of test cases have been specified, characterised by different speed combinations of the subject and target vehicle, initial clearance between them, different target vehicle decelerations as well as the road's topology (straight or curved). Full details can be obtained directly from the protocols, which are publicly available.

The test procedure for the transversally moving target scenario is similar, also open loop. The moving target can in this case be a passenger vehicle, a motorcycle or a pedestrian. Again, three different levels of reaction are utilised: no, mild or strong braking by the driver or driving robot. The initial conditions are described by Figure 14.

The different test cases are related to different initial speeds of the subject and target vehicle as well as different subject and target vehicle distances.

For the longitudinal-related performance of the vehicle, the indicators collision speed and time-to-collision (TTC) at warning are proposed to be utilised. Their derivation based on the results of the described tests is described in the protocols [6].

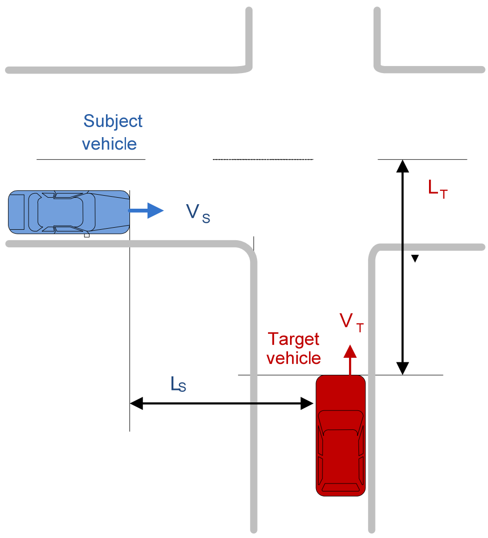

Figure 14. Initial Conditions for Transversally Moving Target Test (Vehicle Target)

Since dedicated initiatives are focussing on the development of testing protocols for this domain, development beyond the eVALUE proposals is already underway, and even harmonisation processes between the initiatives are under first discussions.

Stability-related Physical Testing Protocols

In the stability-related testing protocols, open and closed loop manoeuvres are proposed. This is due to the fact that it either seems reasonable to integrate a driver reaction or that the test procedure itself requires a steering input. The protocols for the stability domain refer to the same references, definitions etc. as the longitudinal protocols.

The first protocol based on the µ-split scenario describes the test procedure for testing the safety performance of the subject vehicle during a braking manoeuvre on dissimilar surfaces so that the left wheels of the vehicle are exposed to a significantly different coefficient of friction (µ) than the right wheels.

The open loop test is to evaluate the technical performance of the vehicle while either a professional driver or a driving robot is used to trigger an actuation from the vehicle. The closed loop test is to evaluate the overall performance of the vehicle when considering natural response and feedback from the driver. A driver is used to trigger an actuation from the vehicle.

In the open loop test, the braking manoeuvre consists of braking from a speed of 50 km/h to 0 with the steering wheel kept at 0° during the manoeuvre. In the closed loop test, the braking manoeuvre consists of braking from a speed of 100 km/h to 0 with the driver acting on the steering wheel to try to make the vehicle run in a straight line.

The following measurements need to be recorded while testing:

- Distance
- Speed
- Position
- Longitudinal acceleration
- Lateral acceleration
- Steering wheel angle
- Yaw rate
- Brake force trigger
- Brake friction material temperature

For the open loop test, three test cases are proposed, which are differentiated by initial speeds (50 or 100 km/h) and friction (high, low or split with the first two required in order to determine braking distances on non-split surfaces). For the closed loop test, a constant initial speed of 100 km/h is proposed.

Out of the measurements, it is proposed to generate the following three safety performance indicators for the open loop test:

- Mean longitudinal deceleration
- Equivalent deceleration
- Equivalent deceleration on different tracks

For the closed loop, it is proposed to generate as indicators:

- Use of adherence
- Stability

The required formulas are defined in the protocol document [6].

Representing the obstacle avoidance scenario, the corresponding testing protocol requires extra safety performance indicators to be evaluated during the well-established sine-with-dwell manoeuvre. However, the manoeuvre itself is performed exactly as described in the ECE R13-H regulation or in the NHTSA FMVSS126 conformation test. Besides the measures specified in the ECE R13-H regulation, the steering wheel torque shall be recorded.

Again, this is an open loop test, and a steering robot is used to trigger an actuation from the vehicle.

Out of the measurements, it is proposed to determine the following safety performance criteria:

- Yaw rate ratio
- Lateral displacement
- Driver intention following
- First steering wheel torque peak
- Wheel lift

Yaw rate ratio and lateral displacement are measurement according to ECE R13-H regulation, while steering wheel torque is measured to describe the effort of the driver to perform the manoeuvre. Driver intention following means how closely the vehicle responds (in terms of yaw motion) to driver's intention (commanded by the steering wheel). Wheel lift is used to describe roll-over stability with the tip-up criteria directly carried over from NHTSA fishhook test.

The third protocol describes the test procedure for testing the safety performance of the subject vehicle e.g. when exiting a highway at too high speed. The vehicle has to follow a closing radius trajectory, Figure 15. It is defined as an open loop test utilizing however a steering robot to follow the trajectory with high accuracy.

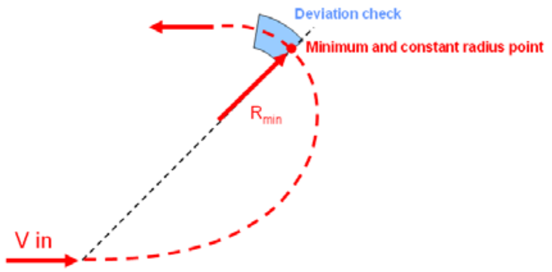

Figure 15. Highway Exit Trajectory

For these tests, the following measurements are recorded:

- Distance
- Speed
- Position
- Lateral acceleration
- Steering wheel angle
- Steering wheel torque
- Yaw rate
- Centre of gravity sideslip angle

At first, the Slowly Increasing Steer (SIS) manoeuvre is used to characterize the lateral dynamics of the subject vehicle. The manoeuvre is used to provide the data necessary for determining the steering wheel angle (δ0.3g) capable of producing a lateral acceleration of 0.3 g. This steering wheel angle is then used to determine the magnitude of steering required during the manoeuvre. A speed of 80 km/h and a ramp steer of 13.5 °/s are used, Figure 16.

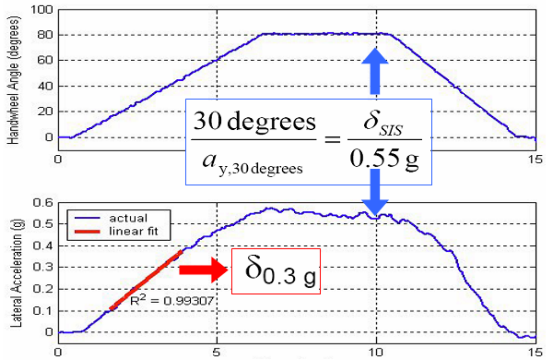

Figure 16. Vehicle Steer Characterisation

This is followed by a curve manoeuvre, which is performed without throttle (coasting) using a steering rate of 0.3 g/s and a steering angle of 0 to 6.5 • (δ0.3g).

Afterwards, successive runs are performed at increasing vehicle speed and steering wheel rate. The speed is increased in 5 km/h steps from 80 km/h until a final speed of 110 km/h. Each test case should be performed once. In the end, another curve manoeuvre is performed without throttle (coasting). The steering rate is increased proportionally to the vehicle speed increase (compared to initial run) again using a steering angle of 0 to 6.5 • (δ0.3g).

These tests aim at determining the safety performance indicators relative radius, slip and wheel lift for the subject vehicle. The relative radius (R_{rel}) is the difference between the trajectory radius in the test run (R_i) and the trajectory radius in the initial test run (R_1): $R_{rel} = R_i – R_1$.

In all cases, measurement of radius is made at the end of the steering wheel ramp. The slip angle at the centre of gravity of the vehicle is used as an oversteer indicator. The wheel lift is used to assess roll stability.

The maturity of the stability-related protocols is regarded as rather high, which is underlined by the fact that very similar protocols are under discussion for implementation e.g. within the Euro NCAP organisation.

DISCUSSION

Preliminary and final results of the technical development have been discussed with interested and renowned experts from inside and outside of the consortium at several occasions. This was in line with the very open approach the project partners have decided to follow right from the beginning of the project in order to allow an unhindered exchange with organisations and experts not directly involved in the project.

Assessment of active safety in the longitudinal direction is currently within the scope of several projects and initiatives. The corresponding protocols developed by the eVALUE partners are rather mature, but cannot go in as much detail as dedicated projects can. Reviewing experts however acknowledged the pioneering work that was done by eVALUE and was taken over in the meantime by consortia such as ASSESS [7] and vFSS, which are also striving for a worldwide harmonisation.

The protocols for evaluation and assessment of lateral safety are probably the least mature and major efforts need to be invested in the future to enhance them.

Weaknesses and Open Issues

The eVALUE project followed the objective to develop testing and evaluation methods for active safety functions. However, during the early phase of the project, this objective was shifted towards testing methods that take the full vehicle rather than a specific function or system into account. Being one of the first projects active in this regard and with this intention, experiences were made that disclosed issues of high relevance for the development of vehicle active safety assessment methods but could not be covered by the project. The partners then decided to follow a straight forward approach based on data which was available at the time. However, good science requires pointing out those open issues, allowing them to be addressed at a later stage by different initiatives and, thus, allowing the improvement of the presented results.

In accordance with the above given weaknesses, future research is needed in order to finalise the testing protocols and allow an application for real assessment purposes. This includes a fully comprehensive accident database that is freely available for both the development of new and enhanced safety functions on the road towards the vision of halving the number of road fatalities until 2020 [8] as well as for the derivation of the most relevant traffic scenarios with respect to active safety functions and the impact they have on real life safety on our roads.

Furthermore, standardised driver reactions need to be investigated and later-on implemented into driving robots. This would then allow taking the driver reaction into account and thus fully assess the safety performance of a vehicle. An investigation of statistical effects on performance results and, related to this, an open discussion within the research community whether only one trial per test can be acceptable need to take place as well. This would re-quire a large number of tests at different locations as a test programme cannot only be performed at the same location (cf. the different certified test laboratories for passive safety testing) and under the exact same conditions (e.g. weather due to the required space and testing outdoors).

These research topics are of common interest for all involved stakeholders and can thus be addressed in joint consortia in order to avoid duplication of work and waste of resources.

CONCLUSIONS

For the performance assessment of automotive active safety functions, still no generally accepted standards are available today. Manufacturers of systems, components or vehicles all developed and use their own testing procedures in order to provide both development goals and means to evaluate the system performance.

Due to this situation of inhomogeneous testing practice throughout the industry, test results acquired in different manufacturer-specific tests cannot be compared by customers and authorities. Furthermore, manufacturers still have no means to assess their systems in a generally accepted way.

The eVALUE project now offers testing protocols for vehicle active safety that can found the basis for either implementation or more detailed specification, depending on the level of definition. The scenario-based approach taking the full vehicle rather than a specific system into account is today generally supported. While the methods for stability-related testing are regarded as mature, testing of longitudinal and lateral safety function requires more research.

This is also necessary in order to reach accepted methods and protocols among all stakeholders fostering the perception and understanding of the active safety performance of a specific vehicle.

Communication with and amongst stakeholders that might be involved in a later standardisation process has been established and will remain in the future, e.g. in the future workshops to be organised by the support action ActiveTest [9].

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NOTE

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