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World Forum for Harmonization of Vehicle Regulations**Working Party on Automated/Autonomous and Connected Vehicles****Nineteenth session**

Geneva, 25 June 2024

Item 7 of the provisional agenda

Advanced Emergency Braking System**Proposal for a supplement to 01 series of amendments to
UN Regulation No. 152 (Advanced Emergency Braking
System for M₁ and N₁ vehicles)****Submitted by the expert from France***

The text reproduced below was prepared by the expert from France, with the aim to introduce provisions for using virtual testing as an alternative to physical tests in UN Regulation No. 152. It is based on informal document GRVA-18-24. The modifications to the existing text of the Regulation are marked in bold for new or strikethrough for deleted characters.

* In accordance with the programme of work of the Inland Transport Committee for 2024 as outlined in proposed programme budget for 2024 (A/78/6 (Sect. 20), table 20.5), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Add a new paragraph 2.18., amend to read:

“2.18. “Virtual testing” is the process of testing a system using one or more simulation models.”

Add a new paragraph 6.7., amend to read:

“6.7. Virtual testing of dynamic tests

6.7.1. Virtual testing may be used by request of the vehicle manufacturer as an alternative for the tests described in paragraphs 6.4. to 6.6. The provided virtual testing shall be verified and validated according to and are used in accordance with Annex 4.

6.7.2. Virtual testing may be used in the evaluation of the warning and activation tests in accordance with paragraph 1.8. of Schedule 3 and Schedule 8 of Revision 3 of the 1958 Agreement.

[6.7.3. In addition to the simulation results, simulated test runs [shall / may] be conducted as physical tests as well on the request of the type approval authority and technical service.]

6.7.4. In case of virtual testing is chosen by the manufacturer, a separated report including at least the additional data information specified in annex 4 paragraph 1.5. shall be annexed to the test report.”

Add a new Annex 4, to read:

“Annex 4

Virtual testing of dynamic tests

0. Introduction (for information only)

This annex describes the method that can be used to consider virtual testing as an alternative to physical testing, based on the manufacturer request.

This method is mainly based on 2 separate pillars:

- (a) Pillar 1: the validation of the virtual testing method by comparison with physical results and,
- (b) Pillar 2: the virtual testing results for approval process.

1. Validation of the virtual testing method (pillar 1)

1.1. General specifications

1.1.1. The manufacturer shall provide documentation to prove the credibility of the virtual testing results.

1.1.2. The vehicle manufacturer shall define the validity domain on which the virtual testing will be applicable. This annex only applies within this validity domain.

1.1.3. Credibility of the virtual toolchain that is used for the virtual testing shall be demonstrated by the vehicle manufacturer to the Type Approval Authority and Technical Service.

For this, the following five criteria shall be considered:

- (a) **Capability** – what virtual toolchain can do, and what are the associated risks;
- (b) **Accuracy** – how well virtual toolchain does reproduce the target data;
- (c) **Correctness** – how sound & robust is the used data and the algorithm in the tools;
- (d) **Fit for Purpose** – how suitable is the virtual toolchain for the assessment (e.g. vehicle dynamic model, sensor model, system control model, environment model, scenario model, targets model, ...) within its validity domain.
- (e) **Usability** – What training and experience is needed and what is the quality of the process that manage its use.

1.2. Physical validation tests

1.2.1. At the request of the technical service, in addition to the documentation provided by the vehicle manufacturer, physical tests shall be performed or witnessed to confirm the accuracy between the physical and the simulation results.

1.2.1.1. The number of physical tests to be tested shall be defined in agreement between the manufacturer and the technical service in order to sufficiently cover the validity domain specified by the vehicle manufacturer.

1.2.2. The number of tests performed shall ensure a statistical comparison between physical and simulation results.

1.3. Simulation model

1.3.1. The simulations (including development of the model) shall be run under the responsibility of the vehicle manufacturer. It shall reflect the architecture of the vehicle, system and components to be tested in relation to the requirements of the current regulation on the specified validity domain.

1.3.2. The models that are developed and tested shall be capable of accurately representing the relevant aspects of the physical AEBS that is being modelled. The models are used in tools and the tools are incorporated into toolchains which emulate the overall physical behaviour of AEBS with the appropriate quality within the declared domain of validity.

1.4. Simulation model validation process

1.4.1. The simulation model shall be validated in comparison with the physical validation tests performed under paragraph 1.2. and comparability of the test results shall be proven.

1.4.2. The validation strategy shall be based on scientific methods, defined by the car manufacturer and agreed with the type approval authority and technical service.

1.4.3. For the validation, key performance indicators shall be assessed such as time to collision, remaining distance or impact speed.

1.5. Additional data and information

For this application, the following information shall be supplied to the approval authority and technical service in addition to the data, and drawings listed in paragraph 3.2. of this Regulation.

1.5.1. A description of the applied simulation ~~and calculation~~ method which has been used such as identification of the model, the analysis software, its producer, its commercial name, the version and contact details of the developer.

1.5.2. A description of the input parameters.

- 1.5.3. A description of the validity domain taking into account AEBS performance influencing factors.
- 1.5.4. All parts of the simulation toolchain such as interlinked simulation modules and tools shall be described by the manufacturer.
- 1.5.5. The methodology used to generate physical validation data, such as data recording equipment, data processing, calculation of scalar values shall be documented in the simulation report.
- 1.5.6. A description of the data management archiving system shall be provided by the manufacturer.
- 1.5.7. A description of the versions control and the review processes in case of modification within the simulation toolchain shall be provided by the manufacturer.
- 2. Virtual testing results for approval process (pillar 2)
 - 2.1. Compliance of the Advanced Emergency Braking System with the performance requirements as defined in paragraphs 5.2.1 to 5.2.3. of this Regulation may be demonstrated by the vehicle manufacturer to the Type Approval Authority or Technical Service by making use of virtual testing of the dynamic maneuvers of the paragraph(s) 6.5. to 6.7. of this Regulation.
 - 2.2. All simulation results provided by the manufacturer in applying for an approval in accordance with paragraph 4. of this regulation shall refer to the method evaluated and validated according to paragraph 1. of this annex.
 - 2.3. Additional data and information

For this application, the following information shall be supplied to the technical service in addition to the data, and drawings listed in paragraph 3.2. of this Regulation.

 - 2.3.1. A description of the applied simulation method which has been used such as identification of model, the analysis software, its producer, its commercial name, the version and contact details of the developer.
 - 2.3.2. A description of the input parameters.
 - 2.3.3. A reference to the validated simulation method used in application of paragraph 1 of the current annex.
 - 2.3.4. All parts of the simulation toolchain such as interlinked simulation modules and tools shall be described by the manufacturer.”

II. Justification

1. This proposal aims to allow the approval applicant to use a virtual testing methodology as an alternative to physical tests. This requires a preliminary assessment of the methodology to be used, as already defined at European Union level in the Whole Vehicle Type Approval (WVTA) regulation, in other regulations and as considered by the Informal Working Group on Validation Method for Automated Driving (VMAD) and its Subgroup 2.
2. This proposal defines a practical approach to anchor the main safety relevant principles while letting the flexibility to the applicant in selecting the virtual tools to be used.
3. An example of the application is presented in informal document GRVA-15-20.

Note by the secretariat: this amendment proposal, if adopted as supplement to the 02 series of amendments, would require adjustments in the paragraph numbering (6.11.), as para. 6.7. already exist in the 02 series of amendments, reading:

“6.7. Warning and Activation Test with a Bicycle Target”