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Item 4 (b) of the provisional agenda
Awareness of the Proximity of Vulnerable Road Users:
UN Regulation No. 151 (Blind Spot Information Systems)

Proposal for Supplement 4 to the original version of UN Regulation No. 151 (Blind Spot Information Systems)

Submitted by the expert from the Informal Working Group on Awareness of Vulnerable Road Users Proximity *

The text was reproduced below was prepared by the experts from the VRU-Proxi Informal Working Group (VRU-Proxi) to propose a supplement to the UN Regulation on uniform provisions concerning the approval of motor vehicles with regard to the Blind Spot Information Systems (BSIS). It is based on informal documents GRSG-122-18 and GRSG-122-26 distributed at the 122nd session of the Working party on General Safety Provisions (GRSG). The modifications to the existing text of the draft 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 2022 as outlined in proposed programme budget for 2022 (A/76/6 (part V sect. 20) para 20.76), 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

Contents of the UN Regulation,

Insert new Annex 4, to read:

"Contents

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Insert new paragraph 2.19., to read:

"**2.19.** **"*TTC*" means the time to collision, calculated between the bicycle reference point and the (theoretical) collision point. In context of this regulation the equation can be calculated as $TTC = x_{bicycle}/v_{bicycle}$.**"

Paragraph 5.1., amend to read:

"5.1. Any vehicle fitted with a BSIS complying with the definition of paragraph 2.3. above shall meet the requirements contained in paragraphs 5.2. to 5.7. of this UN Regulation.

When the vehicle is equipped with a means to automatically deactivate the BSIS function in situations such as, having street cleaning equipment or snowplows attached, emptying waste containers, or having doors opening to the outside of a bus, the following conditions shall apply as appropriate:

The vehicle manufacturer shall provide a list of situations and corresponding criteria where the BSIS function is automatically deactivated to the technical service at the time of type approval and it shall be annexed to the test report.

The BSIS function shall be automatically reactivated as soon as the conditions that led to the automatic deactivation are not present anymore.

A constant optical warning signal shall inform the driver that the BSIS function has been deactivated. The yellow failure warning signal specified in paragraph 5.6. below may be used for this purpose."

Paragraph 5.3.1.4., amend to read:

"5.3.1.4. The BSIS shall give an information signal at last point of information, for a bicycle moving with a speed between 5 km/h and 20 km/h, at a lateral separation between bicycle and vehicle of between 0.9 and 4.25 metres, which could result in a collision between bicycle and vehicle with an impact position 0 to 6 m with respect to the vehicle front right corner, if typical steering motion would be applied by the vehicle driver.

The information signal shall not be visible before the first point of information. It shall be given between the first point of information and the last point of information.

It shall also give an information signal for a bicycle moving with a speed between 5 km/h and 20 km/h, at a lateral separation of between 0.25 m up to 0.9 m and longitudinally located between -0,6 and +0,6 m in reference to the centre of the most forward front wheel while driving straight.

However, the information signal is not required when the relative longitudinal distance between bicycle and front right corner of the vehicle is more than 30 m to the rear or 7 m to the front. **Furthermore, the information signal is not required if the TTC is higher than [9] s."**

Insert a new paragraph 6.3.4., to read:

"**6.3.4. Pre-Test Conditioning**

If requested by the vehicle manufacturer, the subject vehicle may be driven a maximum of 100 km on a mixture of urban and rural roads with other traffic and roadside furniture to initialise the sensor system."

Paragraph 6.5.7., amend to read:

"6.5.7. **Verification of Blind Spot Information signal**

Verification of the Blind Spot Information signal can be made by following two methods, at the manufacturer's choosing:

(a) Verify if the Blind Spot Information signal has been activated before the vehicle crosses line C in Figure 1 of Appendix 1 to this Regulation, and if the Blind Spot Information signal has not been activated before the vehicle crosses line D in Figure 1.

(b) **The activation of the blind spot information signal may be checked using the test procedure as specified in Annex 4 to this UN Regulation.**"

Paragraph 6.5.10., amend to read:

"6.5.10. The test is passed when the Blind Spot Information signal has been activated in all test cases as shown in Table 1 of Appendix 1 to this Regulation before the vehicle has crossed line C (see paragraph 6.5.7. above) **or the activation of the blind spot information signal has been verified using the test procedure as specified in Annex 4**, and the Blind Spot Information signal has not been activated in any test run when the vehicle passes the traffic sign (see paragraph 6.5.8. above).

…"

Insert a new Annex 4, to read:

"Annex 4

Alternative Blind Spot Information Dynamic Test

0. Test concept and requirements for use (not legally binding)

This alternative test procedure can be used to verify the conformity of the blind spot information system to paragraph 5.3.1.4. with regard to the activation timing as specified in paragraph 6.5.7. and 6.5.10., provided that the tests are performed with equipment that allows to control the position of both the vehicle under test and the bicycle dummy with an absolute accuracy of ± 0.5 m at all times. This equipment consists of a means to influence the vehicle movement, such as a driving robot system or a driving system that utilizes access to the vehicle's actuators, a robot-controlled platform for the bicycle dummy, and position measurement systems using a fusion of differential global navigation satellite systems and an inertial measurement unit. Note that the other requirements of paragraph 5.3.1.4., especially false positives and first point of information (FPI), still need to be checked with the test procedure as specified in paragraph 6.5 and its subparagraphs.

1. Test procedure

1.1. Verify that the vehicle and the test track are in the condition as required per section 6 and its subparagraphs.

1.2. Equip the vehicle with the following equipment:

1.2.1. A position measurement system, able to measure the vehicle position with an accuracy of [5] cm, such as a differential global navigation satellite system (GNSS) and inertial measurement unit fusion system, sampling at no less than 100 Hz.

1.2.2. A driving system that is able to modulate the direction, deceleration and acceleration of the vehicle under test in order to follow recorded trajectories with an accuracy of [50] cm when comparing recorded and replayed trajectory over time.

If the driving system does not allow a sufficient manual control, it may be absent during the recording of the trajectory as defined in paragraph 1.3 below.

1.2.3. A system to detect the information and warning signals after their activation with a time delay of not more than [25] ms.

1.3 Drive manually and record vehicle position over time for all relevant envelopes described in Appendix 1 for the vehicle under test. Modulate the speed as necessary during the turn while staying in the performance requirements as specified in section 5.3.1. (e.g. up to 30 km/h vehicle speed). The initial speed as specified in Appendix 1 should be maintained until passing a line corresponding to x=-30 in the coordinate system as specified in Appendix 1.

The vehicle shall be driven in such a way that the vehicle front is inside the dedicated points given for the respective envelopes in Appendix 1 at all times. This shall be verified with the measured data.

A marking of the positions using markers is permitted but not necessary.

If deemed justified by the technical service, any other trajectories that would be driven with the given vehicle to negotiate 90° turns may be tested as well.

1.4 Drive the tests according to the table in appendix 1, using the driving system and the trajectories as recorded while performing paragraph 1.4 of this annex, ensuring the bicycle dummy robot is synchronized to impact the vehicle under test at the respective impact position (the front right corner (-0, +0.5 m) or a position 6 m (+0, -0.5 m) behind the front right corner of the vehicle) and is travelling on the respective y coordinate.

It may be necessary and shall be allowed to synchronize the dummy robot against a replay of the vehicle under test (VUT) trajectories (with full driving system control over speed and steering) rather than against the originally recorded trajectory while driving manually.

The dummy speed shall be at the respective speed with a tolerance of +- 2 km/h at all times. The dummy robot starting position should be X=-65m. The acceleration of the dummy shall be such that the dummy shall have reached the speed for the actual test case, as shown in Table 1 in Appendix 1 to this Annex, after a distance of not more than 5.66 m and after the acceleration the dummy shall move within the specified tolerance of +- 2 km/h. The vehicle shall start to move sufficiently before dummy start to allow this dummy starting position.

If the correct collision position for each VUT trajectory has been verified with a test run without a dummy on the carrier platform and repeatability of the test setup has been verified as well, the test may be aborted after detection of the information signal.

1.5. Calculate the stopping distance with respect to passing the bicycle trajectory for each individual trajectory and each available sampling point, taking into account a possible vehicle deceleration of 5 m/s² and a reaction time of 1.4 seconds.

The calculation may be performed in the following manner:

Calculate the required braking distance d_{brake} for each data point on the trajectory, using the following equation:

$$d_{brake,total}(t) = \frac{v(t)^2}{2 \cdot \frac{5m}{s^2}} + 1.4s \cdot v(t) \quad ,$$

using the momentaneous vehicle speed $v(t)$ in m/s.

The distance of the VUT front right corner on its path to the bicycle line of movement shall be $d_{Bicycletrajecrory}(t)$.

The position of the last point of information then is given by the first time where the following condition applies:

$|d_{Bicycletrajecrory}(t)$. - $d_{brake,total}(t)| < [0.35]$ m

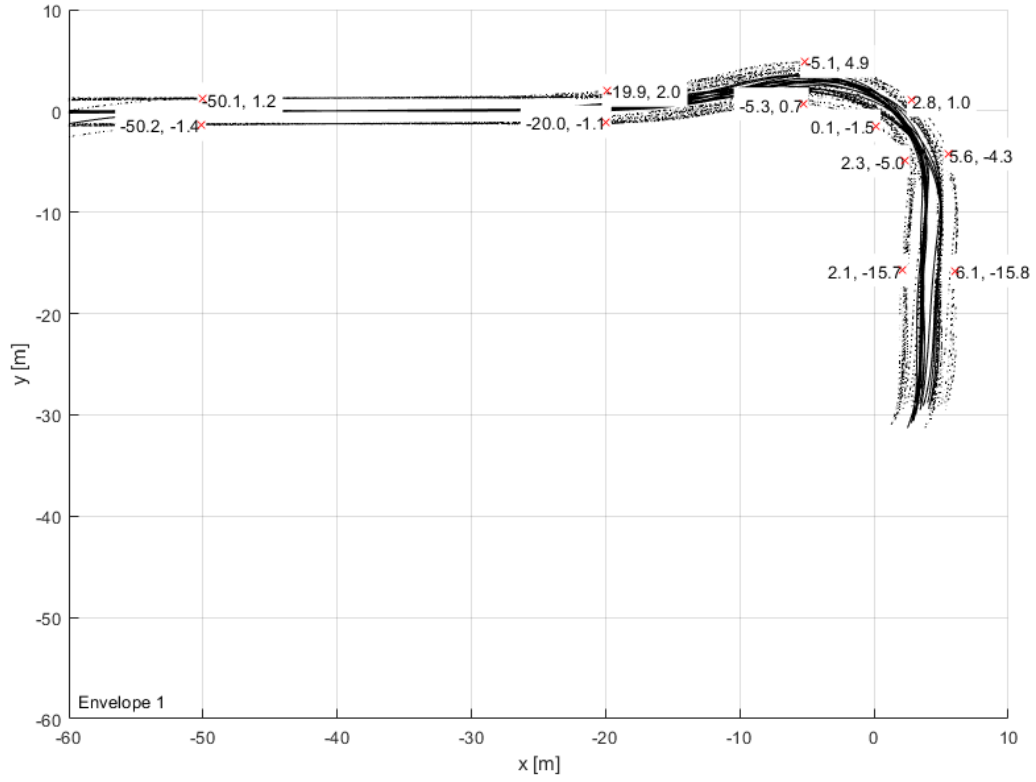
1.6 The test procedure is considered to be passed, and consequently the vehicle is deemed to have fulfilled paragraphs 6.5.6., 6.5.7. and 6.5.10., if the information signal is given at a distance (on the path coordinate of the individual trajectories) greater than the stopping distance (on the path coordinate of the individual trajectories) as calculated in paragraph 1.5. above for all required test runs conducted according to paragraph 1.4. above.

1.7 All measurement data (in the form of plots) and all calculations done in paragraph 1.5. shall be included in a test report with regard to this annex. The test report shall be annexed to the certificate.

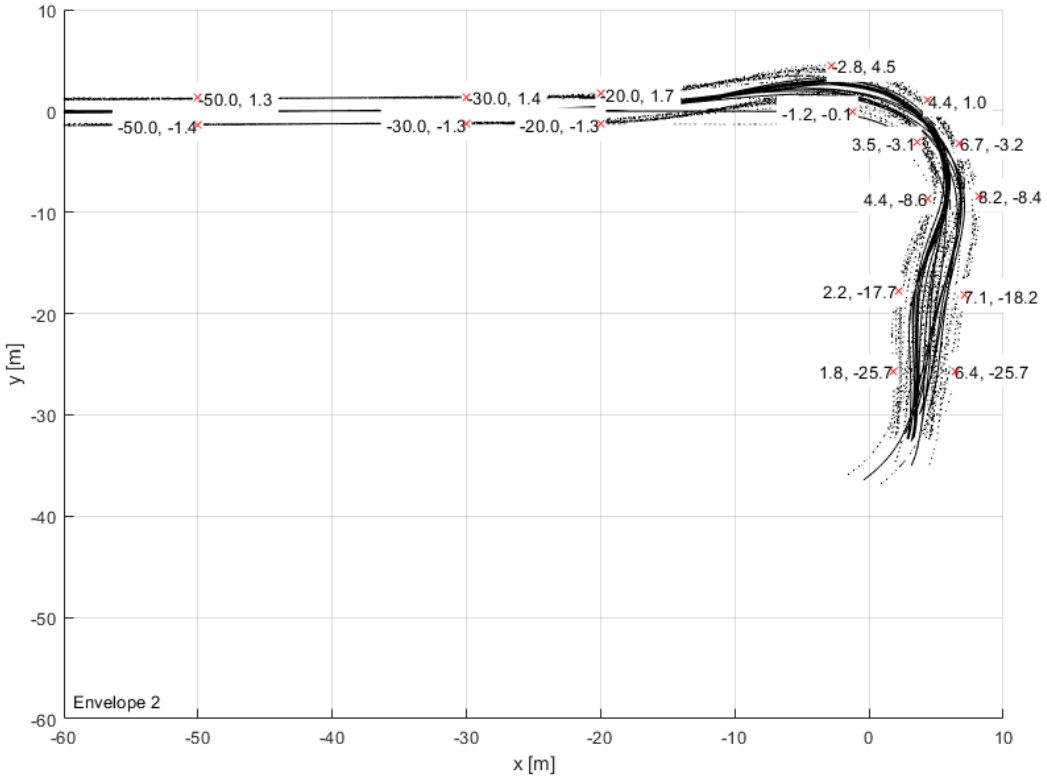
Appendix

Envelopes and their dedicated points

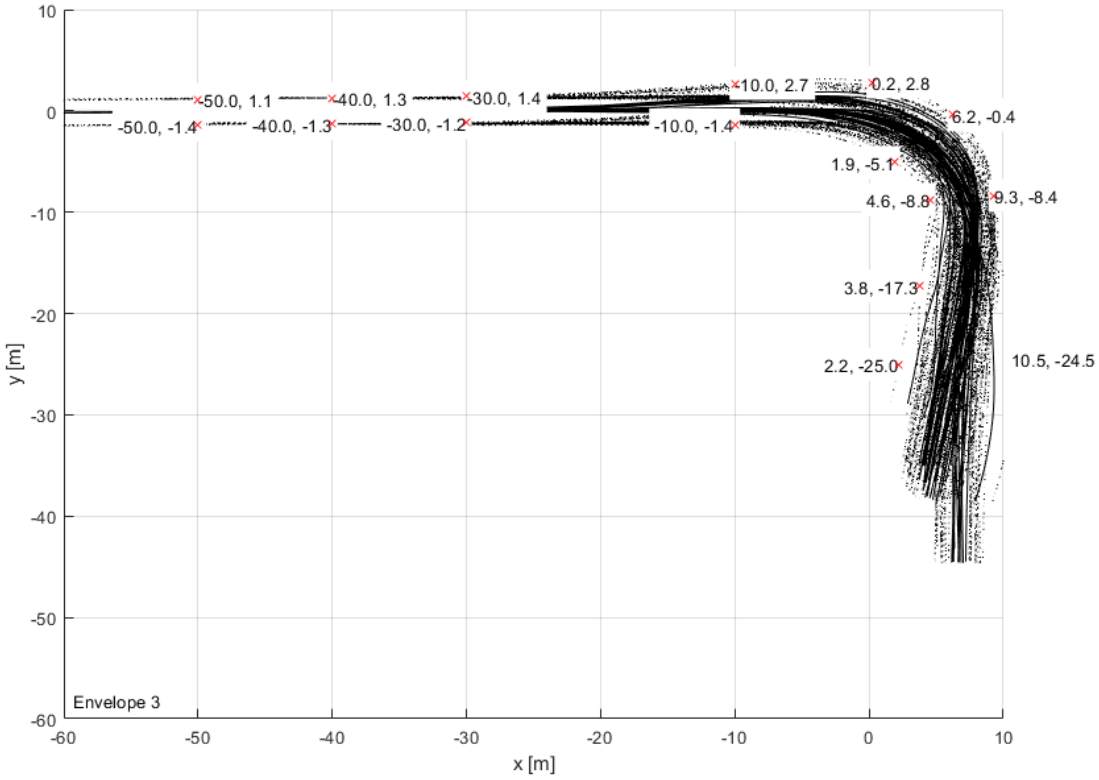
Envelope 1:



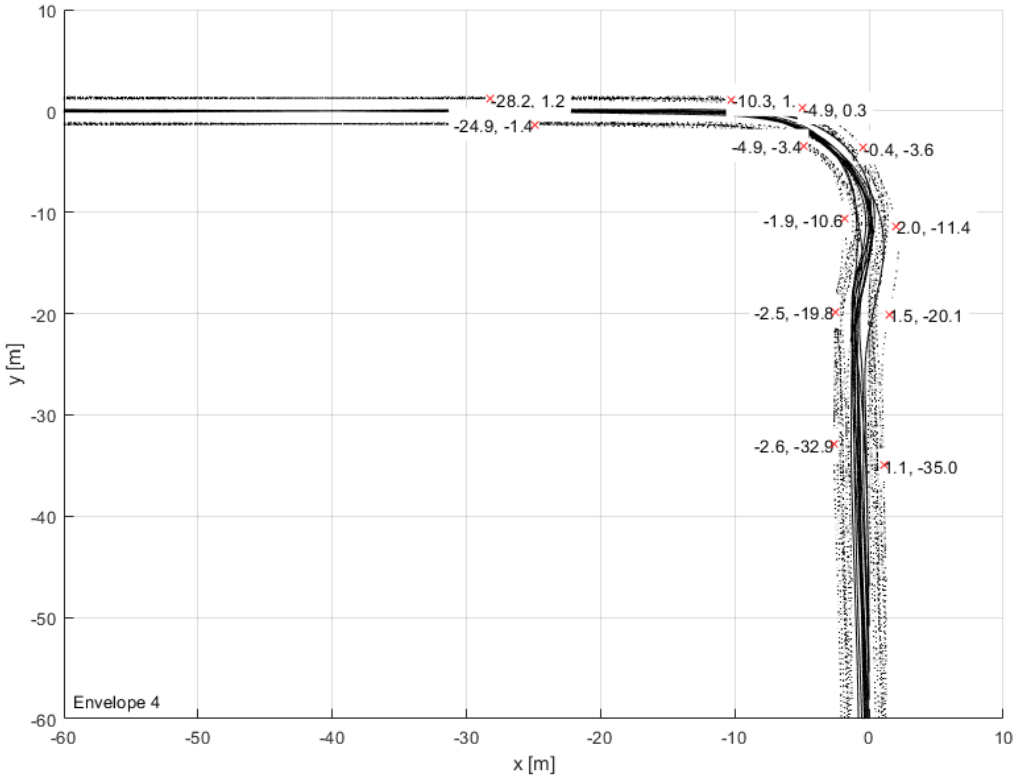
Envelope 2 (not considering the outlier test run):



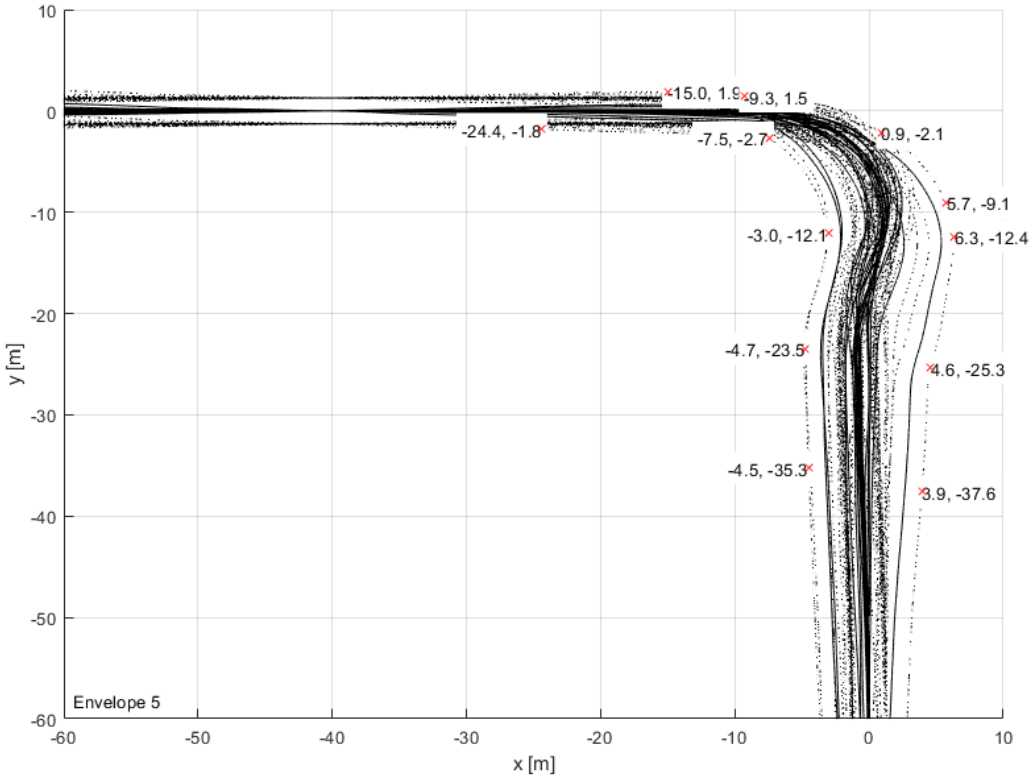
Envelope 3:



Envelope 4:



Envelope 5:



Scenarios (other parameters possible as long as those are within the limits as defined in the core text)

	Envelope	Lateral bicycle coordinate with respect to dummy center, in the coordinate systems as shown above (tolerance: ± 0.1 m)	Bicycle speed (tolerance: ± 2 km/h)	Initial vehicle speed (tolerance: ± 2 km/h)	Impact position with tolerance (for two points each)
Single trucks, single tractors	**1,3**	**-2.9 m, -5.7 m**	**10 km/h, 20 km/h**	**10 km/h, 20 km/h**	**0m (-0 m, +0.5 m), 6m (-0.5 m, +0 m)**
Trucks equipped to tow trailers	**1, 2, 3**	**-2.9 m, -5.7 m**	**10 km/h, 20 km/h**	**10 km/h, 20 km/h**	**0m (-0 m, +0.5 m), 6m (-0.5 m, +0 m)**
Tractors (equipped to tow semitrailers)	**1, 3**	**-2.9 m, -5.7 m**	**10 km/h, 20 km/h**	**10 km/h, 20 km/h**	**0m (-0 m, +0.5 m), 6m (-0.5 m, +0 m)**
M_3 of Class I	**4, 5**	**-2.9 m, -5.7 m**	**10 km/h, 20 km/h**	**10 km/h, 20 km/h**	**0m (-0 m, +0.5 m), 6m (-0.5 m, +0 m)**
All other M_3	**5**	**-2.9 m, -5.7 m**	**10 km/h, 20 km/h**	**10 km/h, 20 km/h**	**0m (-0 m, +0.5 m), 6m (-0.5 m, +0 m)**

Place the relevant speed signs in relation to the vehicle longitudinally within the first 10 m of the trajectory, and with a distance of up to 2 m laterally to the foreseen vehicle path, but not in the vehicle path.

II. Justification

1. There are some vehicle configurations for which BSIS may not work correctly (e.g.: because of the vehicle body, the vehicle use). As we do not want to exempt these vehicles as in some UN Regulations (e.g.: UN Regulations Nos. 58, 73, 151, 159). The above proposal aims at allowing these vehicles to not fulfil the requirements of the BSIS as long as they are not ready to drive off or during operation of incompatible auxiliary equipment if it is agreed by the Type Approval Authority.

2. There are some combinations of vehicle and bicycle speeds for which the formulas in the UN Regulation lead to unintentionally high TTCs. Therefore, we propose to limit the TTC to a value slightly larger than the highest value calculated based on the last point of information (LPI) conditions in Table 1 of Appendix 1.

3. The blind spot information system must detect bicycles up to 30 m. For such long distances a good alignment of the system is needed to evaluate the information signal conditions properly. We propose to allow a pre-test condition of the vehicle on public roads as it is allowed in other UN Regulations (e.g.: UN Regulation No. 159).

4. The alternative test procedure allows to give the information signal later than specified in the original version of the UN Regulation, yet still early enough for the driver to come to a comfortable stop after noticing the information signal. There is more flexibility to the system design, with which comes more responsibility for the manufacturer.

5. The alternative testing annex also paves the way for introducing automated braking functions, since testing those requires test procedures with actual collisions between vehicle and dummy. Therefore, it makes UN Regulation No. 151 future-proof.

6. See presentation GRSG-122-20.