March 6, 2020

Robert Bosch LLC
38000 Hills Tech Dr.
Farmington Hills, MI 48331
Telephone +1 734 979-4981
www.bosch.us

The Honorable James Owens
Acting Administrator
National Highway Traffic Safety Administration
U.S. Department of Transportation
1200 New Jersey Avenue, S.E.
Washington, DC 20590

Re: Request for Comments (RFC) for Advanced Driver Assistance Systems (ADAS) Draft Research Test Procedures
Docket No. NHTSA-2019-0102

Dear Acting Administrator Owens,

Robert Bosch LLC ("Bosch") appreciates the opportunity to provide its feedback to NHTSA concerning the advanced driver assistance systems (ADAS) draft research test procedures. Bosch thanks NHTSA for its efforts to seek industry perspective on the draft test procedures aimed to assess the operation, performance and potential limitations of ADAS technologies. Bosch strongly believes that ADAS technologies have the ability to improve vehicle safety and decrease fatalities, injuries and collisions on U.S. roadways.

Bosch also applauds NHTSA on its intent to publish a Federal Register notice in 2020 which will propose major upgrades to the U.S. New Car Assessment Program (NCAP). The U.S. NCAP is a critical tool for consumer education and awareness and an update is essential to ensure that consumers understand the role that crash avoidance technologies can play in preventing or mitigating crashes. Bosch believes that these ADAS draft research test procedures can serve as a basis to evaluate new technologies which could subsequently be incorporated into the U.S. NCAP.

Bosch's intent is to provide NHTSA with feedback on the ADAS draft test procedures, focusing on systems where we have specific expertise, as well as to identify areas of potential harmonization with related test procedures and/or industry standards.

BOSCH

Rear Automatic Braking

When evaluating the performance of a rear automatic braking system, Bosch recommends that NHTSA consider the scenario defined by Euro NCAP for 2020. More specifically, the car to pedestrian reverse adult stationary (CRPA-s) procedure which represents a collision in which a vehicle travels backwards towards an adult pedestrian standing still, striking at 25%, 50% or 75% of the vehicle’s width if no braking is applied. Bosch also recommends that NHTSA harmonize with this static Euro NCAP test procedure.

For example, if NHTSA were to incorporate rear automatic braking into a rating system, Bosch would recommend that NHTSA consider the average impact or mitigation speed of each repeated test trial performed. With respect to the environment of the test, Bosch also recommends that NHTSA harmonize with the types of ground markings defined in the Manual on Uniform Traffic Control Devices (MUTCD) to ensure repeatability and reproducibility of results (if line markings are utilized in the procedure). In addition, surrounding the speed of the SV, the Euro NCAP 2020 automatic emergency braking rear test procedure defines both an upper limit velocity of 8 kilometers per hour (kph) and as well as a lower limit at 4 kph.

Bosch further recommends that NHTSA restrict the rear automatic emergency braking procedure to an outdoor environment to better represent real world conditions and decrease potential test burdens on manufacturers. An indoor environment may create significant challenges for manufacturers who do not have access to such facilities. Furthermore, objects within an indoor testing environment may increase the likelihood of reflections and cause system inaccuracies or inconsistencies that are not representative of real-world functionality.

Bosch does not believe that it is necessary to mount lasers for path guidance and cameras to produce still photos in order to assess the performance of a rear automatic braking system as the inclusion of such requirements could impact the repeatability of results for all different types of vehicles. White remaining technology agnostic, Bosch would also request that NHTSA provide additional clarification surrounding the sensors and sensor location, for example, the range, resolution and accuracy specifications for related sensors. Finally, Bosch would recommend that NHTSA remove the weight requirement defined for vehicle preparation.

Bosch believes that NHTSA should also evaluate Rear Cross Traffic Alert (RCTA) for research purposes and consider it for inclusion in the U.S. NCAP proposal expected in 2020. RCTA systems can make reversing out of parking spaces easier by warning the driver of a vehicle or object approaching the path of motion, though it may not be visible from the driver's perspective. A 2018 study completed by the Insurance Institute for Highway Safety (IIHS)[1] assessed the performances of RCTA systems from two vehicle manufacturers. The IIHS found that the vehicles equipped with RCTA had a 22 percent lower backing crash involvement rate than vehicles without the system. Further, the study found that rates were 32 percent lower amongst vehicles with the system in scenarios where the vehicles were traveling in perpendicular directions. Similar to rear automatic braking systems, RCTA has the potential to increase safety by decreasing the number of back over crashes involving vulnerable road users (VRUs) and other vehicles.

Pedestrian Automatic Emergency Braking

Bosch recommends that NHTSA consider the 2020 Euro NCAP procedures to evaluate pedestrian automatic emergency braking (PAEB) systems. Similar to the PAEB draft test procedure developed by NHTSA, the Euro NCAP defines crossing scenarios, as well as longitudinal scenarios. The crossing scenarios include an adult walking from the driver side of the vehicle, an adult walking from the passenger side of the vehicle and a child running from between two parked cars on the passenger side of the vehicle. The longitudinal scenario includes an adult walking parallel away from the subject vehicle (SV) at 25 percent and 50 percent. Further, the Euro NCAP includes a low-light scenario for both the longitudinal scenario and a crossing scenario. One critical factor from Bosch's perspective is that each scenario utilizes an articulated target to better represent real world pedestrian movement.

With respect to the PAEB test scenario, Bosch requests that NHTSA define additional details about the vehicle's surroundings. Vehicle surroundings can include other vehicles, highway infrastructure, obstructions or other persons on the test track that are not explicitly used during the test scenario and which could influence the performance of the sensors. Bosch recommends that NHTSA align with Euro NCAP by defining a minimum distance of 6 meters on the driver side and 4 meters on the passenger side, as well as a longitudinal distance of 30 meters *(figure 1)* ahead of the SV when the test ends.

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[1] IIHS; Real-world effects of rear cross-traffic alert on police-reported backing crashes; February 2018

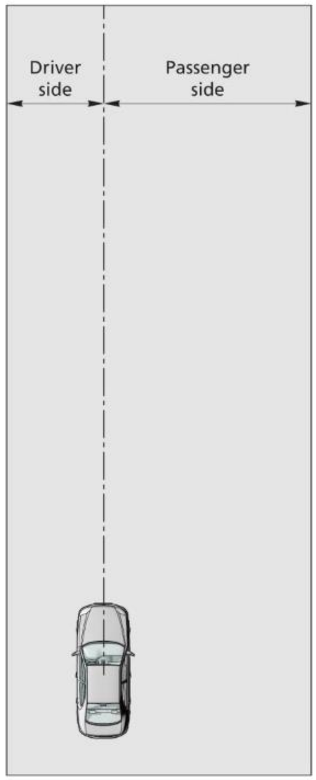

Figure 1: Vehicle surroundings

Bosch recommends that NHTSA harmonize the test course setup (9.2.5.1) with the Euro NCAP. More specifically, we recommend harmonizing the lane width tolerance values to +10 centimeters (cm) as opposed to +40 cm. Larger lane width tolerances may present greater risks for false-positives while testing, as well as increasing the risk of variance for the driving path of the SV and impact point calculation. Bosch respectfully requests that NHTSA provide details on the how the test is intended to be conducted and the initialization of the SV prior to each test trial. For example, it would be very helpful to have a detailed explanation as to how the SV should return to the starting position and whether there are required SV sequences, such as driving the SV in a circle to retain the system's GPS accuracy. Bosch recommends that NHTSA harmonize with Euro NCAP in this regard.

Concerning the crossing pedestrian scenarios (S1), more specifically S1f and S1g, Bosch believes that efforts to test false positives have limited benefits in light of the overall system testing effort. In the case of the S1f and S1g scenarios, the distance of the pedestrian is so close to the vehicle that it would be safer for the vehicle to stop due to the unpredictability of real world pedestrians.

Turning to the pedestrian standing along/against traffic scenarios, Bosch believes that the S4a and S4b procedures would produce the same results with respect to detection regardless of orientation (i.e. facing forward or facing away). To reduce the test burden on manufacturers, Bosch would propose that the NHTSA final result use either the S4a or S4b procedure as opposed to using both scenarios. Finally, Bosch recommends that the pedestrian test mannequin (PTM) acceleration distance and start distance for scenarios S1(a)-(b)-(c)-(d)-(f)-(g) be harmonized with Euro NCAP at 6 meters as opposed to 3.5 meters for the start distance and 1.5 meters as opposed to 0.5 meters for the acceleration distance.

Bosch strongly recommends that NHTSA utilize an articulated pedestrian target, as defined in ISO/PRF 19206-2[2], for the pedestrian automatic emergency braking (PAEB) test procedure as opposed to a static pedestrian target. In 2015, Bosch conducted a study to observe the radial velocities using a radar when a SV approaches a crossing pedestrian. It was found that the Doppler spread of an articulated target is more representative of a real pedestrian than a static target *(figure 2)*.

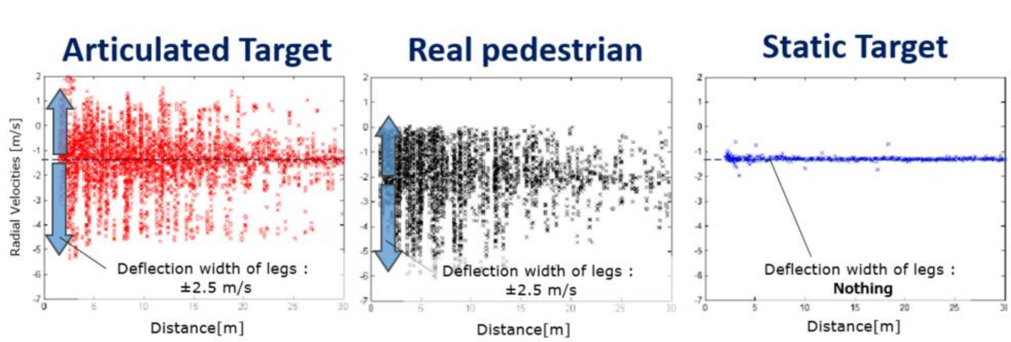

Figure 2: Radar measurements of radial velocities on different targets

For reference, the speed of the articulated target, static target and the real pedestrian was 5 kph. Based on the results, Bosch believes that high performance testing with a static target would not represent the behavior characteristics of a real pedestrian; therefore, the use of an articulated pedestrian target over a static pedestrian target would more accurately represent system robustness and effectiveness. In order to determine the impact speed on a pedestrian target by the SV, Euro NCAP uses a virtual box *(figure 3)* as opposed to “no contact” criteria thereby ensuring the repeatability of tests in case of varying arm or leg positions of the target. This type of

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[2] ISO/PRF 19206-2: Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 2: Requirements for pedestrian targets

assessment supports the increased robustness of a PAEB system. Bosch would urge NHTSA to harmonize with Euro NCAP with respect to the use of an articulated target for the procedure, as well as the use of a virtual box to determine the impact speed.

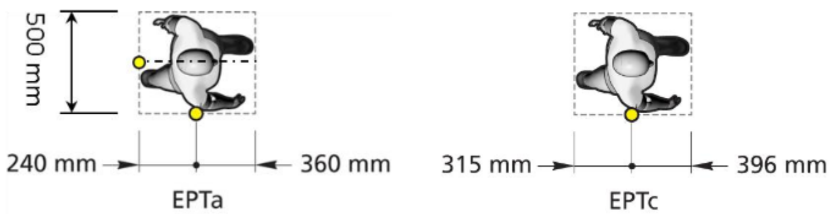

Figure 3-4: Virtual box dimensions around EPTa and EPTc

Figure 3: Virtual box defined in Euro NCAP

Bosch also believes that the research that NHTSA developed to determine the appropriate number of trials, for this and other technologies, should be shared with the industry. The number of trials should result in valid assessments that would be necessary to evaluate the robustness and effectiveness of the related system.

Bosch encourages NHTSA to include cyclist automatic emergency braking in its research efforts, as well as to consider the technology for inclusion in the U.S. NCAP proposal expected in 2020.

Blind Spot Detection

Bosch urges NHTSA to consider the existing industry standard ISO 17387:2008[3] and harmonize with related performance evaluations. ISO 17387 standardizes the performance requirements and test procedures for lane change decision aid systems (LCDAS). Aligning with the industry standard would decrease the testing burden for manufacturers while allowing for an appropriate mechanism to assess system robustness. The industry standard has been active in supporting blind spot detection (BSD) systems since 2008.

With respect to the BSD procedure, Bosch requests that NHTSA provide a more explicit definition of the lateral distance between the SV and principal other vehicle (POV), as well as the lateral distances of the starting and ending position of the POV in both the Straight Lane Converge and Diverge test (5.3.1) and the Straight Lane Pass-by test (5.3.2). Concerning the Straight Lane Pass-

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[3] ISO 17387; 2008; Intelligent lane change decision aid systems, performance requirements and test procedures

by test (5.3.2), Bosch recommends that NHTSA allow a BSD alert to be triggered when the POV is detected. It is likely that certain types of technology used for a BSD system would trigger an alert prior to when the defined starting longitudinal distance is reached. This is aligned with ISO 17387:2008 and would enable greater flexibility in technical solutions.

In order to promote consistency with ISO 17384:2008, Bosch recommends that the BSD alert be deactivated earlier than defined in the Straight Lane Pass-by test procedure (5.3.2). Specifically, Bosch believes that the BSD alert should be allowed to deactivate once the front most part of the POV passes the b-pillar of the SV, as opposed to the rear bumper passing the rearview mirror. Once the front most part of the POV passes the b-pillar of the SV, the vehicle would also be in the driver's line of sight.

Looking at the diverge lane changes defined in 5.3.1.4, Bosch would note that (for certain technologies) the BSD alert may remain active if the lateral distance between the SV and POV is greater than 3 meters but less than or equal to 6 meters. As a result, Bosch recommends that the lateral distance be extended from 5 meters to 6 meters. Likewise, the blind spot detection alert shall not be active once the lateral distance between the SV and POV is greater than 6 meters. This would also bring the BSD draft test procedure in alignment with ISO 17384:2008.

Finally, as defined in ISO 17384:2008, Bosch recommends that the BSD termination headway for the POV nominally occur at 0 seconds as opposed to 1 second. Once the rear most part of the POV passes the front most part of the SV, Bosch believes that a delayed alert is unnecessary since the POV would again be in the line of sight of the driver.

Bosch requests additional specificity from NHTSA regarding the use of the Global Vehicle Target (GVT) when converging and diverging. Bosch believes that manufacturers of blind spot detection systems should have the ability to use real vehicles as the POV (with steering and pedal robots) as opposed to only using the GVT.

Traffic Jam Assist

With respect to the traffic jam assist (TJA) test procedure, Bosch requests that NHTSA provide more details on the lead vehicle decelerates, accelerates, then decelerates (LVDAD) procedure and the suddenly revealed stopped vehicle (SRSV) procedure. More specifically, Bosch requests that NHTSA provide the timing and braking magnitude values for POV braking in a similar manner to the values provided in the lead vehicle lane change with braking (LVLCB) procedure. When considering the braking magnitude defined in the test overview (5.3.5.2), Bosch would recommend that NHTSA consider deceleration boundaries that are defined in industry standards for automatic cruise control. ISO 20035:2019[4] defines a maximum average deceleration rate of 0.35g when the vehicle is traveling above 20 meters per second (m/s) and 0.5g when the vehicle is traveling below 5 m/s.

NHTSA should also consider the fact that the ability to test the TJA system with the SV driver's hands off the SV steering wheel may be dependent on the level of automation of the system. Unlike a level 3 system, a level 2 TJA system is defined as a "hands-on" system and may have system requirements that would force the driver to apply torque to the steering wheel within a fixed duration of time. This could make it challenging to test the lateral performance of the system because the SV driver would have to apply torque to the steering wheel to prevent the system from disabling. Further, if the SV driver is permitted to touch the steering wheel, it is important that the lateral performance of the TJA system still be able to be tested without SV driver influence.

NHTSA references the Soft Car 360 micro being used as the POV in the supplemental Traffic Jam Assist Test Development Considerations[5]; however Bosch would urge NHTSA to utilize the Soft Car 360 hatchback variant. The hatchback variant has characteristics that better represent a real vehicle and it has been standardized to test many different functions and/or systems addressing challenging scenarios in NCAPs around the world.

Intersection Safety Assist

In order to evaluate intersection safety assist systems, Bosch recommends that NHTSA harmonize with the EVADE 2022 proposal. Although the EVADE 2022 proposal is not yet published, nearly 20 partners across the industry are working to develop test procedures for intersection safety assist (ISA) systems. These procedures includes straight cross path (SCP) scenarios and left turn across path lateral direction (LTAP/LD) scenarios. The recommendations and testing proposals developed within the EVADE 2022 working group will likely support the development of other similar regional NCAP procedures (e.g., the Euro

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[4] ISO 20035, 2019, Intelligent transport systems — Cooperative adaptive cruise control systems (CACC) — Performance requirements and test procedures

[5] Traffic Jam Assist Test Development Considerations; DOT HS 812 757; July 2019

NCAP 2022 automatic emergency braking junction assist procedure). With respect to evaluating the effectiveness of an ISA system, Bosch believes that the rating criteria should incorporate full object avoidance, as well as an acceptable level of SV crash mitigation in the form of speed reduction.

With respect to the execution of the “near-miss” scenario defined in the ISA scenario 1 (5.3.5.1), Bosch believes that the distance for “near-miss” of two meters behind a perpendicular plane could result in false positive activations. Bosch would recommend that NHTSA expand this distance to a value greater than 2 meters but less than 4 meters.

Relative to the ISA scenarios S1-a (5.3.5.1) and the longitudinal distance to stop bar (4.3.6), Bosch recommends that the acceleration rate of the SV vehicle be increased to 2.5 meters per second squared (m/s^2) from 1.25 meters per second squared (m/s^2) at 25 miles per hour (mph). Roughly 58 meters is needed to accelerate the SV at 1.25 m/s^2 to 25 mph as well as another 33 meters to hold the vehicle speed constant for 3 seconds. Due to space limitations, this could be difficult to execute on some test tracks. Increasing the SV acceleration rate to 2.5 m/s^2 would reduce the required SV acceleration distance from 58 meters to 25 meters. Therefore, the SV longitudinal distance to stop bar could be reduced from 91 meters to 58 meters.

Bosch notes that it can be challenging to perform a constant radius maneuver, as defined in the S2 and S3 test scenarios. In alignment to related Euro NCAP procedures, Bosch recommends that the path maneuver be performed as a clothoid *(figure 3)* as opposed to a constant radius to support test repeatability. A clothoid path is more representative of real world conditions, particularly in the case of a human driver performing a left turn at an intersection.

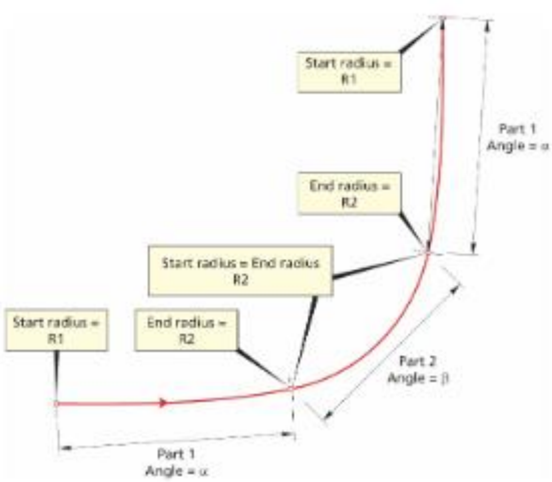

Figure 3: Example clothoid path from Euro NCAP

Finally, Bosch suggests that NHTSA define the free space or surroundings around the SV and POV on the test track to prevent abnormal sensor measurements. For example, in similar scenarios, the Euro NCAP states that no other vehicles, highway furniture, obstructions, other objects or persons can exist within lateral distances of 3 meters on either side of the path, as well as a longitudinal distance of 30m ahead of the SV when the test ends.

Blind Spot Intervention

Bosch urges NHTSA to harmonize with the industry standard ISO 19638:2018[6]. This would minimize the testing burden on manufacturers, while supporting the development of robust blind spot intervention systems.

Active Parking Assist

Concerning the evaluation of active parking assist (APA) systems, Bosch recommends that NHTSA align with the industry standard ISO 20900:2019[7] when applicable. ISO 20900:2019 defines performance requirements and test procedures for partially automated parking systems.

For this test procedure, Bosch recommends that NHTSA define the size of the parking spots relative to the size of the vehicle being tested. Having parking spots proportional to the size of the vehicle as opposed to fixed sizing would align with ISO 20900:2019. For parallel parking, ISO 20900:2019 defines for (1) a vehicle length (VL) less than 4 meters, the parking spot dimensions would be equal to VL plus 1 meter. Likewise, for (2) VL in between 4 and 6 meters, the parking spot dimensions would be the VL times 1.25 meters. Lastly, for (3) VL greater than 6 meters, the parking spot dimension would be VL plus 1.5 meters. For perpendicular or cross parking, the standard space width is defined as (4) the width of the ego vehicle including the side mirror plus 1.2 meters.

> ***Parallel parking***
> ***(1)*** *For VL < 4 meters: VL + 1 meter*
> ***(2)*** *For 4 meters < VL < 6 meters: VL x 1.25 meters*
> ***(3)*** *For VL > 6 meters: VL + 1.5 meters*

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[6] ISO 19638; 2018; Intelligent transport systems — Road boundary departure prevention systems (RBDPS) — Performance requirements and test procedures

[7] ISO 20900;019; Intelligent transport systems — Partially automated parking systems (PAPS) — Performance requirements and test procedures

Perpendicular or cross parking
***(4)** Width of standard space: width of ego vehicle + 1.2 meters*

Bosch would highlight that, in general, perpendicular parking is more time consuming than parallel parking due to the greater number of maneuvers required. If NHTSA incorporates a time limit to complete the parking maneuver as opposed to assessing only on the completion of the parking maneuver and/or final positon of the PV, Bosch would request that NHTSA set a greater time limit for perpendicular parking (higher than 45 seconds).

Bosch urges NHTSA to specify the use of curbs during the test procedure (4.3). Bosch believes that the inboard perpendicular and longitudinal edge of the parking space should be limited with the use of curbs, as defined in ISO 20900:2019. The use of curbs supports technology neutrality of the test procedure, whereas the sole use of pavement markings favors camera-based systems. Bosch also recommends that NHTSA utilize safety contours around the adjacent vehicles (e.g., PV2, PV3). Specifically, it should be clear that the SV shall not contact the adjacent vehicles or cross into the safety contours defined. This would enable the SV to maneuver outside of the perpendicular lines during the parallel scenario and outside of the parallel lines during the perpendicular scenario, setting criteria that is more representative of real world behavior while ensuring safe performance of the system.

In addition, Bosch requests that the relative position of the SV to the pedestrian target be defined. More specifically, the position and speed of the SV and pedestrian target once the SV begins to move backwards. This level of detail would support the reproducibility and repeatability of the tests. Looking at the obstruction vehicle detection performance (5.5.2.2), Bosch does not believe that the parking maneuver necessarily needs to be terminated. For example, when an obstacle is detected, the automated parking system can either terminate the parking maneuver if the obstacle does not move within a timed duration (i.e., 60 seconds) or wait until the obstacle moves without a timed duration but allow for the driver to take over at any time to terminate the maneuver. In summary, the automated parking system can be configured to better represent real world situations.

Conclusion

Bosch commends NHTSA for its continued efforts to evaluate ADAS and welcomes the release of the draft test procedures. Bosch also appreciates NHTSA's willingness to engage with the industry and garner feedback that will help increase understanding around system operations, performance and potential limitations.

Bosch respectfully requests that NHTSA further consider convening a workshop with interested parties at VRTC to run through and review the text procedures. In the past, these types of opportunities have been extremely helpful and insightful.

Bosch is grateful for NHTSA's consideration of our input and welcomes future opportunities to further discuss the ADAS draft test procedures. If you have any questions, please do not hesitate to contact Ana Meuwissen at (202) 815-7645 or at Ana.Meuwissen@us.bosch.com.

Yours sincerely,

D. Scott Winchip
Regional President North America
Chassis Systems Control
Robert Bosch LLC

Ana M. Meuwissen
Director, Federal Government Affairs
Robert Bosch LLC