ZF Response to RFC – NHTSA ADAS Test Procedures

ZF is pleased to offer its perspective on NHTSA's draft test procedures for ADAS technology. We hope that these procedures will expedite the deployment of meaningful safety enhancements on U.S. roads. For each question posed in the RFC, ZF has itemized its responses to indicate which specific draft procedures its comments address.

As a general note, for many ADAS technologies, test procedures have already been developed and implemented – particularly in the EU, where working groups have been formed and collaborative work has been done to develop ADAS test procedures. Examples include Intersection 2020 and EVADE 2022. Unless there is a deficiency identified with existing test procedures, or the circumstances on American roads demand a unique test methodology, it is suggested that general alignment with developed test procedures would reduce manufacturer burdens and expedite testing and deployment of safety-advancing technologies.

A list of NHTSA's questions and ZF's complete responses can be found below.

1. Can the test procedures be expected to assess adequately for the purposes of research, within practical limitations, the performance of the underlying ADAS technologies? If not, please provide specific reasons why, and suggestions for how they may be improved.

Opposing Traffic Safety Assist:

For scenario 4, because many drivers do not use turn signals consistently when changing lanes, ZF recommends that the test also be conducted without turn signal activation to evaluate if the system performs any differently.

Pedestrian Automatic Emergency Braking:

The proposed non-articulated mannequins to be used (4ActivePS static pedestrian) could yield less reliable test results than more advanced versions. ADAS sensors are designed for detection and avoidance of collisions with humans, so it is important to emulate lifelike testing scenarios to the greatest degree possible. It is therefore recommended that NHTSA utilize state-of-the-art mannequins with articulated and moving legs to provide more representative targets and improve the accuracy of sensor detection and performance of test procedures.

2. Do any of the draft research test procedures contain elements that may potentially confound the system operation and/or test results (e.g., regarding test conduct)? If so, please indicate what those elements are and how they might be addressed and/or mitigated?

Intersection Safety Assist:

Scenario S1-B and S2-B include recommended speed combinations that are most realistic for collision mitigation – otherwise, there is a very high false activation rate risk, in which the system would act to avoid a collision even when no collision would have occurred. Scenarios S2-A and S3 include turning speeds that require unrealistic lateral accelerations.

For Scenario S1-B and S2-B, a reduction in speed would help mitigate ZF's design concerns. For Scenarios S2-A and S3, we recommend that the paths be clothoid rather than constant radius to better reflect real-world road design.

Pedestrian Automatic Emergency Braking:

For the S1f test scenario, clarification is needed regarding when and how the pedestrian target would stop moving so that the sensors have time to calculate the change in trajectory. We recommend that the test scenario include information regarding mannequin deceleration profile including timing, distances and speed.

In addition, the test procedure for S1f states "PTM will contact front of the SV at 50 percent of the SV width, but the PTM forward motion is stopped at -25 percent of the SV width". ADAS sensors work on both current and predicted positions of the target at impact. Given the starting distance of 3.5 meters, and the requirement that the target would've contacted at 50 percent had it not stopped, the target would most likely always be predicted to be in the path with standard tuning parameters, and a braking command would most likely be issued. This is not confounding the system – it is designed to work that way – but the result of the test would most likely not achieve the desired test result. A true negative test could instead be designed in which the target stops at -25 percent of the SV width with the predicted position of the target outside of the activation zone by the time the host enters the TTC threshold. Designing the test this way would help avoid stoppage of vehicles while ensuring that the subject vehicles recognize the mannequin and operate as intended.

There are also questions raised by the proposed test procedures: For example, if the SV initially decelerates but does not stop and crosses the line, is that a pass or fail for test procedures S1f and S1g? For the S1g test, a 125 percent overlap implies that the car will pass (at most) 0.45m behind mannequin at up to 40kph. What level of vehicle deceleration would be considered a fail?

3. Are the draft research test procedures clearly written, understandable, and executable? If not, please provide specific areas for which clarification is necessary, and suggestions for how they may be improved.

Intersection Safety Assist:

For crash-imminent and near-miss scenarios, evaluation criteria could also incorporate consideration of a forward collision warning alert. This would indicate that the onboard sensor set is capable of detecting the collision scenario and alerting the driver, even if the vehicle does not actively respond.

In certain scenarios, a warning may be preferred to an automated response, such as where a driver can make a slight steering adjustment to avoid collision without the vehicle decelerating quickly, avoiding risks to the vehicle and other traffic that would come from a sudden and unexpected stop.

Opposing Traffic Safety Assist:

As with Intersection Safety Assist, for positive and false positive tests, evaluation criteria could include whether a forward collision warning alert was given to the driver to warn of the approaching vehicle. This would indicate that the onboard sensor set is capable of detecting the collision scenario, even if the vehicle does not actively respond.

Again, in specific scenarios, this may be considered the safest response. An example of this is an opposing traffic scenario on a rural road. To avoid a collision, a minor steering maneuver back into the lane – prompted by a forward collision warning – may be sufficient to avoid the oncoming vehicle. The automated alternative, a severe braking event from 55mph to 0mph, could pose greater risk of collisions with other vehicles.

Pedestrian Automatic Emergency Braking:

In the cases of test S1f and S1g, it is important to define how the mannequin is positioned at -25 percent and 125 percent overlap. Specifically, should these locations refer to the center of the mannequin or the leading extreme edge (S1f) or trailing extreme edge (S1g)?

For example, if the mannequin is 0.6m wide as presented to the vehicle from leading hand/ foot to trailing hand/foot, if the mannequin centerline is set at -25 percent of vehicle width (0.45m for a 1.8m wide vehicle) the leading hand / foot would protrude into the vehicle lane by 5cm when the mannequin stops in test S1f and be only 15cm from the vehicle itself. Therefore, either the mannequin leading/ trailing edge should be defined accordingly as the -25 percent and 125 percent positions or an additional lateral offset should be calculated to accommodate the mannequin width.

The true negative test procedures (S1f, S1g) should allow for the triggering of forward collision warning as an alert for partial points, and for very close negatives it is recommended that partial deceleration (perhaps 50 percent) be allowed without triggering a test failure. As stated previously, this could be the preferable response in certain scenarios.

Heavy Vehicles Forward Collision Warning and Automatic Emergency Braking:

It would help to clarify the use of the words “stopped” and “stationary.” A stopped vehicle is typically something that the ADAS sensor has seen moving before, while a stationary vehicle is something that the ADAS sensor has never seen moving before. There is some inconsistency in the use of these terms in the test procedures outlined, and it would be helpful to keep the terms consistent with the generally used definitions of these words.

4. Are the ranges of test speeds, speed combinations, and/or speed increments specified within each draft research test procedure reasonable? If not, please provide any data or evidence to support any claim of unreasonableness from a research perspective.

Rear Automatic Braking:

For the rear automatic braking tests, presumably, real-world conditions would include the vehicle operating from a cold start at low temperatures, triggering a faster idle – and therefore, faster reversing speed – especially at ambient temperatures close to the 32°F minimum permitted. However, these circumstances are difficult if not impossible to replicate on repeated tests, when the engine would be warmed up and operate at a lower-speed idle. The concern is that the most practical testing scenario might not emulate the real-world operational scenario. It is therefore recommended that maximum engine idle speed be defined and controlled for purposes of repeatability. This could be facilitated by adding a requirement that the vehicle be driven or idled until the engine coolant has reached nominal operating temperatures (e.g. thermostat has opened) before beginning tests.

It is also noted that the permitted ambient temperature range is not consistent across the test protocols, with several tests requiring a range of 45-104°F, while rear automatic braking requires a range of 32-100°F. The reason for this differentiation is not clear, and it is recommended that these testing temperatures be harmonized.

5. To reduce test burden for the assessment of some technologies for research purposes, the number of repeated trials per test condition is proposed to be less than or equal to seven based on our experience from past test procedure design work. Is this adequate, or should another number of repeated trials be performed for all technology/condition combinations to support an assessment of whether differences in the test results, for a given condition, are statistically significant?

ZF does not have any feedback on this question at this time.

6. Are there additional ADAS technologies NHTSA should be evaluating for research purposes? If so, please indicate what they are.

Heavy Vehicles Forward Collision Warning and Automatic Emergency Braking:

It is recommended that test procedures also be developed to assess the effectiveness of lane keeping and lane centering technologies.

7. Are there existing, alternative test procedures for the ADAS technologies identified in this notice that NHTSA should consider? If so, please identify them and provide any comparisons/contrasts that might be useful to the agency.

Heavy Vehicles Forward Collision Warning and Automatic Emergency Braking:

SAE J3029 includes similar test procedures, with some additional tests for failure detection and deactivation indication. This would serve as a good reference point for development of NHTSA test procedures.