GENERAL MOTORS LLC
Global Vehicle Safety

USG 4920
6 March 2020

Mr. James C. Owens
Acting Administrator
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE
Washington, D.C. 20590

Re: Advanced Driver Assistance Systems Draft Research Test Procedures, Request for Comments, NHTSA Docket 2019-0102, 84 Fed. Reg. 64405 (Nov. 21, 2019)

Dear Acting Administrator Owens:

General Motors LLC (GM) respectfully submits these comments in response to the Request for Comments (RFC) referenced above on the topic of draft research test procedures to assess the performance of the following types of Advanced Driver Assistance Systems (ADAS):

Active Park Assist	Heavy Duty Truck AEB	Pedestrian AEB
Blind Spot Detection	Intersection Safety Assist	Rear Automatic Braking
Blind Spot Intervention	Opposing Traffic Safety Assist	Traffic Jam Assist

GM supports NHTSA's efforts to develop standardized test procedures for evaluating these systems. Standardized procedures will allow consistent evaluation of ADAS systems and features, including across different manufacturers. It is also the first step in developing standardized criteria that might be applied to the New Car Assessment Program (NCAP) assessments for these systems.

GM has also participated in the preparation of the Alliance for Automotive Innovation's (the Alliance) response to NHTSA's proposal and supports that response in so far as it does not conflict with the comments in this response.

The enclosed Attachment contains GM's complete responses to each of the questions included in the RFC. In addition, we provide here some general comments to provide context for your review of those responses:

- The proposed procedures are generally appropriate for general research purposes. However, in some cases we have offered suggestions that may help clarify the procedures.

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- If these test procedures form the basis for future assessment as part of NCAP or as part of future NHTSA regulations, additional considerations may be necessary to ensure the procedures are clear and objective.

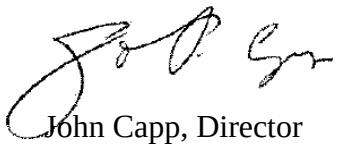
- Unlike most of the listed ADAS systems, Traffic Jam Assist and Active Park Assist are strictly customer convenience features to help in the driving task. As such they do not have a defined safety benefit, although they may have some secondary safety implications. As requested, GM has provided comments about these systems, but GM respectfully suggests that NHTSA reconsider including these systems in its safety evaluations.

- Other regional NCAPs world-wide have already developed test procedures to assess the efficacy of the identified ADAS systems. GM respectfully requests harmonizing, whenever possible, with these previously established test procedures being used worldwide. Harmonizing promotes global development to provide a consistent product world-wide.

- GM also respectfully requests that NHTSA adopt harmonized naming conventions whenever possible. Currently, the SAE and ISO are developing common names for various features and aspects associated with ADAS systems. GM recommends that these naming conventions also be adopted by NHTSA.

GM is willing to meet with NHTSA representatives to discuss any of the suggestions that GM has made, or if you would like to discuss any additional considerations. If you have any questions, or if there is anything else we can provide, please contact our Washington office, or me.

Sincerely,



John Capp, Director
Global Safety Strategy & Vehicle Programs

Attachment: Responses to Requests for Comments

cc: Docket No. NHTSA–2019–0102

ATTACHMENT:
GM Responses to Requests for Comments in Docket No. NHTSA–2019–0102

Active Park Assist questions and responses

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.

Yes, with one general suggestion to separate performance criteria between systems with vision (camera) input and those without. Unlike systems without vision input, systems with vision input can be evaluated against painted lines. This is in addition to other vehicles or other three-dimensional obstacles used to evaluate systems without vision input.

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?

GM identified the following as elements that may potentially confound the system operation and/or test results and offers the respective suggestions for addressing or mitigating them:

- Section 5.1: Pre-Test System Initialization –
    - Many systems require a minimum distance be driven to ensure automatic calibration has been completed. GM recommends the test procedures confirm the minimum calibration distance is met before initiating testing.
- Section 5.4.4: Automated Parking Completion –
    - Parallel or perpendicular
        - The test procedure suggests the system must notify the driver to turn off the vehicle and check surroundings before exiting. GM is unaware of any demonstrable need for this requirement. In addition, this warning does not impact the performance of Active Park Assist. We respectfully request additional research be conducted before inclusion in this test procedure.
    - Perpendicular parking only
        - The requirement that "at no point during the automated parking maneuver shall any part of the SV cross the inboard perpendicular edge of the desired SV parking space" may be too restrictive. The SV may cross the "inboard perpendicular edge" (back of parking space) if the SV is longer than the PVs. Some Automated Park Assist systems use only ultrasonic sensors which cannot perceive parking space markings but can detect space between objects. This allows the

system to park the vehicle in the available space without striking surrounding vehicles. However, it cannot guarantee that the subject vehicle will not cross the parking space markings.

- The perpendicular depth reference for some APA systems, especially those utilizing ultrasonic sensors, is the front edges of the adjacent PVs. A suggested modification to the performance criteria would be to measure final parking position relative to adjacent PVs' front edge, or front or rear edge.

- Section 5.5.1.1(b) Front Encroaching Pedestrian Test (parallel)–
  - The point of contact between SV and pedestrian will be dependent upon where the SV begins the maneuver (meaning how far past the spot SV stops, pedestrian starts moving 1 second after the SV). Controlling the distance driven past the spot (define a start position and tolerance for stage 2) will keep the pedestrian to SV point of contact consistent. Some APA systems rely on front and rear facia-mounted sensors and therefore have limited ability to sense to the side of the vehicle. If the pedestrian approaches the side of the vehicle, ultrasonic-based APA systems will have difficulty detecting the pedestrian. However, if the pedestrian is behind the vehicle during this test, detection is more probable.
- Section 5.6 - System Override Assessment
  - The current test procedure may be too specific (and therefore restrictive) in its assessment of manual overrides. During the research phase we would request less prescriptiveness in describing override features. Otherwise, valid and potentially superior override features may be excluded. Some other valid override inputs include, but are not limited to:
    - Steering input from driver
    - Pressing the APA button
    - Driver's door open and seat belt off
    - Driver inactivity for 30s or 60s (e.g., ignoring a request to shift, or holding the vehicle stationary by the brake pedal)
    - (only if equipped with automated shifting) Any input to shifter
  - The test procedure could also allow some other driver inputs without causing a manual override, like the following:
    - Throttle pedal – (without automated acceleration) will allow slight propulsion torque increases to climb a grade, limited to slow parking speeds; (with automated acceleration) will ignore the throttle pedal.

        - Brake pedal – operator can press to stop the vehicle and pause the maneuver. An inactivity timeout begins to accrue time once the vehicle is stationary. At 30s or 60s the maneuver is aborted.

- In addition to the preceding, whenever using a pedestrian mannequin wind speed should not be above 10 MPH. Otherwise, the mannequin may not be stable and remain upright. GM recommends adding a notice in the test procedure that testing with this mannequin should only occur when wind speeds are below 10 mph.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- In the test procedure, the measurement tools and metrics are not defined. GM respectfully recommend NHTSA define the tools that will be used and the metrics to which the system will be evaluated.
- The override values set for SW torque, accel pedal, brake pedal and timeout are OEM specific. The research procedure should be worded to understand what the OEMs have chosen for these, instead of specifying required values, unless NHTSA has driver response research to show these required values.

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.

Large performance variation can occur between test runs if the vehicle speeds is not closely controlled during the search phase of the test procedure. Therefore, GM respectfully suggest a tolerance of +/- 2 mph be specified during the search phase of Section 5.4.1.

The pedestrian dummy movement equipment may not be able to perform the movement as specified without the dummy falling over due to the high jerk rate. GM suggests using movement specs from Pedestrian AEB or Euro NCAP VRU.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

GM suggests that UN ECE R79 Annex 6 may provide additional areas for testing or insight into slight differences in APA system design with this test procedure. The procedure is similar. We defer to NHTSA, based on their research needs, to determine if the test methods inUN ECE R79 Annex 6 provide additional guidance.

Blind Spot Detection Confirmation Test

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.

GM believes the proposed procedure can be used to evaluate, for the purpose of research, the performance of Blind Spot Detection. GM has offered some suggestions below to help clarify.

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?

No confounding elements were identified at this time.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- In the RFC document under "Supplementary Information", NHTSA states, in part, "This RFC includes test procedures that have been developed for research purposes only. Additionally, NHTSA notes within the same section that "While the procedures include draft evaluation criteria, there are no pass/fail assessments provided because they have been assembled for research purposes only." However, the "Evaluation Criteria" section of this test procedure appears to be

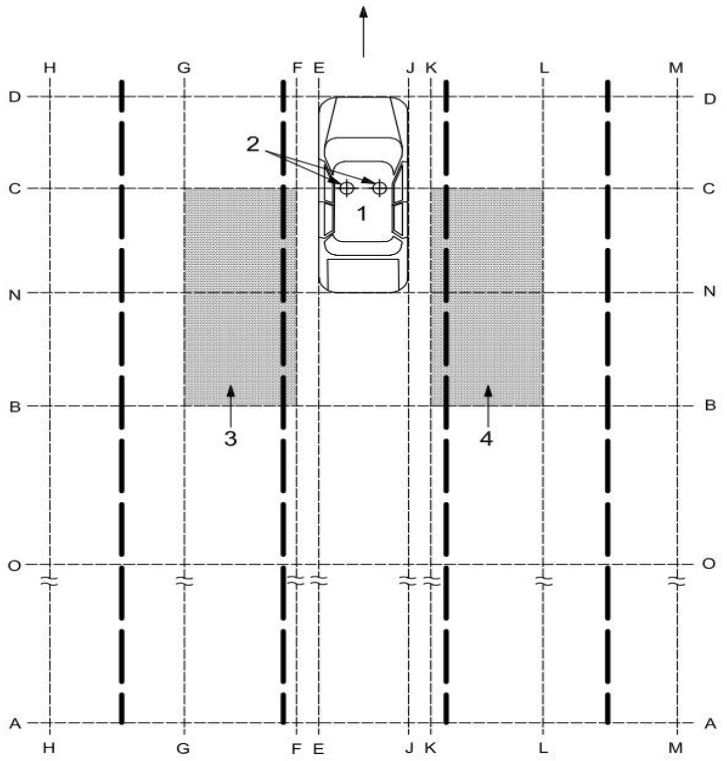
written as a performance requirement and not merely and assessment criteria for research. (may be needed for general comments in cover letter)

- Similar test protocols following the Euro NCAP model use a Lane Width is 3.5-3.7m. Section 4.3 of this protocol specifies a lane width of 3.7-4.3m. GM recommends harmonizing the lane width specification to better accommodate the global implementation of these features.
- Section 4.4.1 of this procedure specifies an ambient temperature of 45° F – 104° F. However, ambient temperature has little impact on performance of this feature since performance is not based on a dynamic change in the vehicle path. GM suggests that this parameter could be relaxed and allow testing in a wider range of conditions.
- If this test procedure is extended to regulatory and/or NCAP assessments in the future, adjustments are recommended to the Instrumentation Dynamic Initialization instructions described in Section 5.1.1. This procedure does not reflect the initialization procedures applicable to all GPS-based instrumentation options that may be used for this testing including the latest releases for OxTS RT equipment commonly used throughout the industry. GM recommends simplifying this section to instruct testers to follow the equipment manufacturer initialization guidelines.
- In Section 5.3.1, "Straight Line Converge & Diverge Test", the text refers to a lane change with lateral velocity of 3 ft/s. Figure 2, however, includes a value range of 0.8 – 4.9 ft/s that is not described in the text. This value range either needs to be explained or corrected to align with the lane change parameters described in the text.
- Section 5.3.2, "Straight Line Pass-by Test", states the SV & POV are to remain 1.5m apart throughout duration of test. Yet, Table 3 includes two tolerances: 1.5±0.5m & 1.5±0.3m. GM respectfully request this tolerance be clarified.

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.

GM offers the following suggestions for improvements to the definitions of the test zone combinations for this test procedure:

- GM recommends following ISO Standard 17387-2008 for defining the blind zone for Section 3.2. For example, Line B from ISO 17387-2008 should be used instead of the line C definition shown in this procedure. This would reduce confusion since other NCAPS globally reference & use the ISO definition.



- Using defined values for line C may improve clarity and reduce the likelihood of errors. Line B in ISO 17387-2008 is 3m, for example. The included formula for longitudinal distance (BC) works out to TTCs of 2.5, 3.0 and 3.5 at the various relative speeds (10, 15, 20 m/s). The formula may be shown as reference to indicate how the specific TTC's were developed but GM recommends utilizing defined values for the test specifications.
- GM recommends eliminating the high relative test velocities (45/60 and 45/65 mph) due to the difficulty in maintaining the prescribed validity criteria. Factoring in distance to get to these speeds and hold them for the needed time, a straightway of longer than 2km would be needed. Consider reducing the SV test speed to 35 mph and opening the validity criteria to get more valid tests with human drivers.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

6. Are there additional ADAS technologies NHTSA should be evaluating for research

purposes? If so, please indicate what they are.

GM does not have any recommendations at this time.

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.

GM recommends following ISO17387 definitions for lines and pictograms. This document references ISO17387 but does not follow the ISO definitions. GM also recommends following ISO naming conventions, as these are now used by China, Korea, Latin and ASEAN NCAPs.

The title of this draft test procedure is "Blind Spot Detection Confirmation Test", yet the procedures apply to a zone extending well behind the actual vehicle blind zone. Other test protocol names tend to be more generic yet inclusive of blind spot detection such as Euro NCAP's Lane Support System protocol. GM recommends updating the procedure name to better reflect the feature set under evaluation as well as improve feature naming consistency.

Blind Spot Intervention System Confirmation Test

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.

GM believes the proposed procedure can be used to evaluate, for the purpose of research, the performance of Blind Spot Intervention. GM has offered some suggestions below to help clarify.

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?

No confounding elements were identified at this time.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- In the RFC document under "Supplementary Information", NHTSA states, in part, "This RFC includes test procedures that have been developed for research purposes only. Additionally, NHTSA notes within the same section that "While the procedures include draft evaluation criteria, there are no pass/fail assessments provided because they have been assembled for research purposes only." However, the "Evaluation Criteria" section of this test procedure appears to be written as a performance requirement and not merely and assessment criteria for research.
- Similar test protocols following the Euro NCAP model use a Lane Width is 3.5-3.7m. Section 4.3 of this protocol specifies a lane width of 3.7-4.3m. GM recommends harmonizing the lane width specification to better accommodate the global implementation of these features.
- Section 4.4.1 of this procedure specifies an ambient temperature of 45° F – 104° F. However, ambient temperature has little impact on performance of this feature since performance is not based on a dynamic change in the vehicle path. GM suggests that this parameter could be relaxed and allow testing in a wider range of conditions.
- If this test procedure is extended to regulatory and/or NCAP assessments in the future, adjustments are recommended to the Instrumentation Dynamic Initialization instructions described in Section 5.1.1. This procedure does not reflect the initialization procedures applicable to all GPS-based instrumentation options that may be used for this testing including the latest releases for OxTS RT equipment commonly used throughout the industry. GM recommends simplifying this section to instruct testers to follow the equipment manufacturer initialization guidelines.
- Section 5.3.2, "Straight Line Pass-by Test", states the SV & POV are to remain 1.5m apart throughout duration of test. Yet, Table 3 includes two tolerances: 1.5±0.5m & 1.5±0.3m. GM respectfully request this tolerance be clarified.

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.

The Global Vehicle Target (GVT) is run from batteries that are drained quickly at high speeds. GM's experience with ADAS testing is that operation of the GVT has issues at 45 mph with wind flutter and path control. GM recommends reducing the test speed to 35 mph.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

The title of this draft test procedure is Blind Spot Intervention System Confirmation, yet the procedures apply to a zone extending well behind the actual vehicle blind zone. Other test protocol names tend to be more generic yet inclusive of blind spot detection such as Euro NCAP's Lane Support System protocol. GM recommends updating the test procedure name to better reflect the feature set under evaluation as well as improve feature naming consistency.

GM recommends following ISO17387 definitions for lines and pictograms. This document references ISO17387 but does not follow the ISO definitions. GM also recommends following ISO naming conventions, as these are now used by China, Korea, Latin and ASEAN NCAPs.

Test Track Procedures for Heavy-Vehicle Forward Collision Warning and Automatic Emergency Braking Systems

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.

One major challenge in developing an AEB test procedure for heavy/commercial trucks is the wide range of vehicle sizes and GVW ratings included within that rather broad category. Heavy Duty pickup trucks (2500 & 3500) with hydraulic brake systems, for example are more likely to have AEB systems that perform closer to full-size SUV's or LD pickups with perhaps somewhat slower response times and speed reductions. At the other extreme, tractor/trailers with airbrake systems would likely perform significantly differently. GM recommends monitoring the research test results of various types of HD trucks to determine whether this procedure is applicable to the full range of described truck types or if the HD pickup segment might better be assessed using a test procedure closer to the existing NHTSA NCAP Collision Imminent Braking (CIB) and Dynamic

Brake Support (DBS) test CIB/DBS procedures but with performance criteria adjusted to compensate for the segment weight differences.

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?

GM identified the following as elements that may potentially confound the system operation and/or test results offers, and offers the respective suggestions for addressing or mitigating them:

- Section 1.3 requires that brake burnishing be conducted with the test vehicle ballasted to GVWR. Requirements for the remaining test procedures do not appear to specify a specific test weight or ballast condition. GM requests clarification of the ballast conditions to be used for these test types. GM recommends test conditions like those used for NHTSA's Collision Imminent Braking test procedures for LD vehicles. If different requirements are applied to HD vehicles, the research should identify the effects on velocity reductions for the selected loading conditions.
- Some of the weather and other test conditions, like wind, lateral offset, etc. are different than the CIB NCAP test. NHTSA should clarify and explain the selection of these different test parameters.
- With respect to Section 1.5, GM does not recommend the installation of brake pressure sensors for AEB testing. Installing brake pressure sensors can potentially introduce air into the hydraulic brake lines which can adversely affect braking performance. Brake pressure also does not provide the most relevant information related to AEB performance. Achieved deceleration levels, duration of deceleration and relative speed reductions provide much more meaningful functional performance metrics. Brake pressure measurements alone also do not provide sufficient data related to system activation timing without also knowing the timing of brake commands from the sensing systems and response times from the brake control module.
- This test procedure does not contain information on allowed lane markings. NCAP CIB allows up to two markings. This can cause variation in the performance of the detection system. GM recommends including the same lane marking specifications included in NHTSA's CIB NCAP procedure.
- To prevent variation, Section 1.4 should recommend example test targets appropriate for this research. Such as EVT, GVT, SSV, other.
- For the Dynamic Brake Support – Lead Vehicle Decelerating test condition, based on the specified TTC (0.675s), it is likely that the regular CIB braking will have already occurred prior to onset of the robot braking in the subject vehicle. Brake application should occur prior to 1 second TTC to avoid CIB activation. Conversely, for the DBS LVD test @ 23m, the brake application in this test

procedure occurs at 2.41s. GM recommends a TTC of less than 2 seconds to avoid potential nuisance activations. As noted in Question #1, these are examples of test method differences that may need to be identified/adjusted for different weight ranges of HD vehicles.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- The brake characterization requirements for Dynamic Brake Support tests specify a vehicle travel speed of 55 km/h to achieve 3.5 – 4.5s of braking. This may be sufficient for tractor/trailers but may not be sufficient for HD pickups. Depending on the results of NHTSA's initial research tests on HD pickups, NHTSA may need to consider DBS brake characterization tests that more closely align with NHTSA's NCAP DBS tests for light-duty vehicles.
- The DBS section of this test procedure also specifies brake robot control settings to achieve -2.75 m/sec^2 of deceleration from brake pedal input. The NHTSA CIB DBS procedure for LD vehicles, however, specifies -3 m/sec^2 and Euro NCAP calls out settings to achieve -4 m/sec^2. Customer data, however, suggests that lower brake input requirements to initiate DBS can increase customer dissatisfaction as a result of unnecessary/nuisance activations of DBS. GM recommends implementing DBS brake input parameters that are no lower than their DBS NCAP criteria for LD vehicles.
- For DBS tests the accelerator pedal should be released prior to brake pedal application.
- The End of Test criterion for Lead Vehicle Decelerating scenarios is different from the CIB/DBS NCAP criterion. GM recommends using a common end-of-test criteria. The current passenger vehicle test does not require SV to come to a stop but looks at "1 second after minimum longitudinal SV-to-POV range occurs."
- GM recommends eliminating the steel trench plate test from the HD vehicle AEB assessments. This scenario is not a meaningful test for assessing potential false activations especially for HD vehicle applications. First, the steel trench plate test only applies to RADAR sensing systems and does not assess potential performance issues with other common sensing systems such as camera systems. Secondly, the steel trench plate becomes more of a test performance issue for RADAR modules that are mounted low in-vehicle. HD vehicle applications tend to have much higher ride heights than LD vehicles and are therefore much less likely to mount RADAR modules close to the road surface.
- This test procedure does not specify which test target will be used to represent the Principal Other Vehicle. Significant differences in AEB performance may be

noted based on the target selected, dependent on the level of effort made to correlate the target to actual vehicles. Considering the range of potential test weights included in this procedure and the likelihood of impact to the test target, GM recommends using the Global Vehicle Target adopted by Euro NCAP.

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.

GM identified the following potential issues related to test speed combinations in this procedure:

- Especially for HD pickup truck applications, GM recommends implementing test speed combinations that are consistent with NHTSA's CIB and DBS protocols for light duty vehicles. The research test reports NHTSA referenced in this test procedure appear to apply to Class 8 Tractor/Trailers and motorcoaches with no data indicating the applicability of that data to HD pickup trucks. Additionally, NHTSA's CIB and DBS NCAP protocols apply to vehicles up to 10,000 lbs. GVWR and HD pickup trucks tend to weigh within a few thousand pounds of that limit. Therefore, performance for that class of vehicles, as noted in question #1, is more likely to align with the test methods defined in the light duty protocols, adjusted for the stopping distance and brake response time from their higher mass.
- During the Lead Vehicle Decelerating test with 80 m headway, given the specified test speed, initial range of 80m and deceleration level of 0.31g, this test would likely result in the Principal Other Vehicle coming to a complete stop in about 40m. This would then be similar to a Lead Vehicle Stopped test except that the POV was seen moving in this scenario before coming to a stop rather than "Never Before Seen Moving" in an LVS test. This may tend to be redundant to the LVS scenario. This test also does not align with any other AEB test criteria. Therefore, GM recommends eliminating this test.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

NHTSA referenced EC Reg 6612009, but not ECE UN-R131. UN-R131 is the European heavy vehicle AEB standard most comparable to this standard. The test speeds and velocity reductions are different in ECE UN-R131 to what NHTSA is proposing.

Intersection Safety Assist System Confirmation Test

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.

Overall, this test procedure is expected to adequately assess the subject features for the purposes of research. GM has offered some recommendations for potential improvements below. These include some ongoing research through a collaborative project with IDIADA that has developed similar test procedures but with some different conclusions and approaches, as detailed in response to Question 7.

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?

No confounding elements were identified at this time.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- In the RFC document under "Supplementary Information", NHTSA states, in part, "This RFC includes test procedures that have been developed for research purposes only. Additionally, NHTSA notes within the same section that "While the procedures include draft evaluation criteria, there are no pass/fail assessments provided because they have been assembled for research purposes only." However, the "Evaluation Criteria" section of this test procedure appears to be written as a performance requirement and not merely an assessment criteria for research.
- The acronym ISA has been used by Euro NCAP and other NCAPs globally to refer to Intelligent Speed Assist / Intelligent Speed Adaptation. GM recommends renaming this test procedure to better align with harmonized naming conventions.

SAE has been working with industry and automotive publications to identify more consistent feature names.

- The intersection defined in Section 4.3.1 is somewhat different than that already defined by Euro NCAP. The differences do not appear to affect performance of this feature. GM recommends harmonizing these types of specifications to better accommodate global product development.
- In several places, vehicle acceleration references are given in "Gs" and in others are in "m/s^2". We suggest acceleration references be m/s^2.
- In Section 4.5.1, Table 1, requiring 1mm accuracy is unrealistic for the measuring the GPS antenna locations and front/rear bumpers. GM suggests using the 10cm accuracy that is standard for RT measurements for locating the primary GPS antenna and IMU relative to vehicle, and the 5mm accuracy for primary to secondary GPS antenna.
- In Section 4.5.1.8, NHTSA should not restrict manufacturers to implementing Forward Collision Warning (FCW) as the designated alert strategy for intersection applications. Manufacturers may choose to implement warning strategies that more intuitively convey the direction of the threat to further enhance safety benefits and should be provided the flexibility to do so.
- Section 5.1.2 contains significant details on how to initialize differential GPS. However, not all systems utilize this specific initialization procedure. GM recommends simplifying this section to refer instead to test equipment manufacturers' initialization instructions.
- In Section 5.3.7, ISA Scenario 2, POV Left Turn Across SV Path – this test scenario is opposite the functionality of Euro NCAP in which the SV turns across the path of the POV. The NHTSA proposal may be difficult to sense with existing technology, whereas the Euro NCAP approach should provide the same or better functionality. The speed variations associated with these tests, as defined, would be difficult to execute consistently unless the SV is also driven by a robot and significant pre-work is conducted to determine staging locations.
- Test scenarios S1-B and S1-C seem difficult to execute. Significant variability could be introduced with accelerating targets or hosts and should be simplified in the test matrix. It is also not clear if the accelerating vehicle is expected to start at the stop bar. If so, it's not likely that the speed will reach 25mph at the time of impact so the speed reference of 0->25 mph should be clarified.
- In Section 5.3.12, many conventional cruise control systems cannot be engaged below 25 mph, so utilizing cruise control consistently across all test vehicles may not work for the 15 mph test conditions.
- It is very likely that full robotic equipment is needed in the SV to match the choreography and validity criteria. Manual driving by a human does not seem likely to meet the strict criteria. This is not mentioned. It is also likely robots will be too jerky to get the speed matching correct in the required timeframes at these low speeds.

- The ABD and other robot driving systems provide path programming and control that makes a lot of the math and path specification in this procedure unnecessary. GM recommends ensuring that these specifications do not preclude use of robotic test equipment.

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.

GM identified the following potential issues related to test speed combinations in this procedure:

- Feature performance should not be different if the SV or POV maintained 15 mph throughout the test scenario instead of the slowing from 25 to 15. This presents unnecessary complexity and variation into the robot programming as well as to vehicle response.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

IDIADA is managing a collaborative project, named "EVADE 2022", developing similar test procedures covering "Straight Crossing Path" and "Opposite Direction" scenarios for Euro NCAP for 2022 implementation. A similar project, named "INTERSECTION 2020", developed "Left Turn Across Path" scenarios for implementation in Euro NCAP 2020 protocols. The 2020 project also included detailed driver performance studies to determine more realistic paths that drivers take as they navigate different intersection types and at different speeds. Contact Guillermo Mur @ IDIADA for more information. (Guillermo.Mur@idiada.com)

Opposing Traffic Safety Assist System Confirmation Test

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.

Overall, this test procedure is expected to adequately assess the subject features for the purposes of research. However, GM has offered some recommendations for potential improvements below. These include some ongoing research through a collaborative project with IDIADA that has developed similar test procedures but with some different conclusions and approaches, as detailed in response to Question 7.

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?

GM identified the following as elements that may potentially confound the system operation and/or test results offers, and offers the respective suggestions for addressing or mitigating them:

- Section 5.3.4 indicates that Lane Keep Assist is to be disabled for this testing. It is likely that any OTSA feature would be combined with LKA functionality to perform these functions. So, it is likely that disabling LKA would also disable OTSA. It is highly likely that a customer would keep both LKA and OTSA enabled, so this test is not representative of the standard operation of the vehicle. If LKA is capable of keeping the vehicle from inadvertently crossing into oncoming traffic and provide this same benefit as OTSA, then the system should not be penalized for this performance.
- In Section 5.3.6.5, Criteria 2, if OTSA and LKA systems are operating properly, the vehicle will maintain its place in the center of the current lane of travel, therefore this would be beyond the 1ft (0.3m) from the inboard edge of the lane line. A better requirement would be >= 0.3m to the inboard edge of the lane marker on the right side of the SV.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- In the RFC document under "Supplementary Information", NHTSA states, in part, "This RFC includes test procedures that have been developed for research purposes only. Additionally, NHTSA notes within the same section that "While the procedures include draft evaluation criteria, there are no pass/fail assessments

provided because they have been assembled for research purposes only." However, the "Evaluation Criteria" section of this test procedure appears to be written as a performance requirement and not merely assessment criteria for research.

- GM recommends replacing the term "Lane Centering Control" with "Lane Keeping Assistance" to better align with harmonized naming conventions. SAE has been working with industry and automotive publications to identify more consistent feature names. Sections 5.3.3 and 5.3.4 include a discussion of LKA and LCC. Current consumer-group input is that customers don't know the difference and they only see the need for one term (LKA). LKA may also do lane centering within the same feature.
- Section 2.0 requires clarification defining the initialization of a lane change when in Level 2-3 especially when the note forbids manual intervention. The procedure also does not explain how a lane change will be initiated for a Level 2 system that does not provide lane change on demand.
- Section 4.5.1 includes a definition of requirements for the rear of the surrogate vehicle but does not include requirements for oncoming test scenarios. Target requirements for the oncoming direction need to be added.
- Section 5.1.1 contains significant details on how to initialize differential GPS. However, not all systems utilize this specific initialization procedure. GM recommends simplifying this section to refer instead to test equipment manufacturers' initialization instructions.
- Section 5.3.6 specifies a limit within 1.5 feet from any part of the POV. This distance may be excessive in some crowded situations or urban driving where this might be violated.

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.

GM identified the following issues related to test speed combinations in this procedure:

- The 25-mph use case does not appear to align with reasonable feature performance expectations. This condition represents subdivision or city-street driving speeds, where there may not be lane markings and risk of driver inattention is low. GM is not aware of the crash statistics that support this speed. We respectfully request NHTSA provide the supporting data. The 45/45 use case seems to be the most relevant, however this speed is difficult for the ABD GVT to achieve and the GVT would deplete its batteries quickly.
- The GVT is run from batteries that are drained quickly at high speeds. GM's experience with ADAS testing is that operation of the GVT has issues at 45 mph with wind flutter and path control. GM recommends reducing the test speed to 35 mph.

- GM is unaware of the data source that supports the lane change velocity. Is it representative of a typical % driver of lane change velocities for a given condition? GM respectfully request NHTSA identify the basis for the lane change velocity.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

IDIADA is managing a collaborative project, named "EVADE 2022", developing similar test procedures covering "Straight Crossing Path" and "Opposite Direction" scenarios for Euro NCAP for 2022 implementation. A similar project, named "INTERSECTION 2020", developed "Left Turn Across Path" scenarios for implementation in Euro NCAP 2020 protocols. The 2020 project also included detailed driver performance studies to determine more realistic paths that drivers take as they navigate different intersection types and at different speeds. Contact Guillermo Mur @ IDIADA for more information. (Guillermo.Mur@idiada.com)

Pedestrian Automatic Emergency Brake System Confirmation Test

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.

Overall, this test procedure is expected to adequately assess the subject features for the purposes of research. However, GM has offered some suggestions for potential improvements below.

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?

Wind of 15 mph is usually enough to make the dummies unstable using the movement system. This is consistent with other NCAPs, but typically less than 10 mph of cross wind is needed to successfully perform testing.

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.

GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- As indicated in the cover letter, GM suggests harmonizing feature names and acronyms used throughout the document as much as possible with other naming conventions. SAE has been working with industry and automotive publications to identify more consistent feature names. Other regional NCAPs globally have also adopted common terms such as Vulnerable Road User, references for adult and child mannequins, and "nearside / far side" to describe pedestrian approach direction as opposed to NHTSA's "Nearside / Offside". Additional new terms add confusion across different test procedures for the same feature.
- GM supports the inclusion of the S1f and S1g test but recommends adjusting the lateral position to -50% and 150%. The current values of -25% and 125% leave the pedestrian within inches (~3 in.) from the edge of the wheel and could cause activations of AEB that the driver would still find beneficial.
- Additional clarification is needed for the procedure defining vehicle width to be clear that it does or does not include the mirrors. 4. Page 9 (5.2.1 Test Vehicle Measurements and Preparation) D. states that 'the left- and right-side outermost edges of the SV's body not including the outside rearview mirrors' whereas Page 5 Vehicle Width states only 'the left and right-side outermost edges of the SV's body'.
- This test procedure does not define the test track as a minimum of 0.9 surface coefficient as NHTSA's other ADAS test procedures include.
- On Page 18 (9.1.5 SV Approach to a Crossing Pedestrian (S1)) C. the acceleration distance of 0.5 and 1 meter is too short and can cause the pedestrian dummy to fall down during ramp up. Similar test procedures use peak acceleration levels of 0.3g for 5 kph and 0.395g for 8 kph. GM recommends doubling the acceleration ramp length to avoid this issue.
- Section 5.3.6 specifies a limit within 1.5 feet from any part of the POV. This seems excessive in some crowded situations or urban driving where this might be violated.

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.

GM identified the following issues related to test speed combinations in this procedure:

- GM supports the use of the "static" dummies instead of articulating. These are easier to setup and test. GM also supports the standing pedestrian test cases (S4a/b) which represents real world scenarios not currently included in other NCAPs.
- In the RFC document under "Supplementary Information", NHTSA states, in part, "This RFC includes test procedures that have been developed for research purposes only. Additionally, NHTSA notes within the same section that "While the procedures include draft evaluation criteria, there are no pass/fail assessments provided because they have been assembled for research purposes only." However, the "Evaluation Criteria" section of this test procedure appears to be written as a performance requirement and not merely an assessment criterion for research. As such, GM will hold comments on this section until any comment periods related to potential future regulatory or NCAP activities.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

All of the other major NCAPs are now performing these tests and have complete test protocols to reference, including Euro, China and Korea. Unless there are unique crash statistics for the US that are significantly different, GM recommends harmonizing with those protocols as much as possible to support global product development.

Rear Automated Braking Feature Confirmation Test

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.

GM believes that the test procedure is a reasonable starting point to develop a test for evaluating rear automatic braking; however, we offer the following comments for NHTSA's consideration:

- Rear Automatic Braking systems are based on various sensing systems: camera, radar or ultra-sonics. To appropriately evaluate a system, the target should be chosen based on the sensing system. The currently defined pedestrian targets work well for camera; and can work for radar if articulating legs are also included.

  Ultra-sonic based systems do not reliably detect pedestrians. If the goal of the testing is to evaluate the system's ability to respond to non-pedestrian objects, then other targets, for example the ISO pole (25mm diameter metal rod, 1m tall inserted into a 75mm diameter PVC pipe) and ¼ car target, work well with ultra-sonic systems.

- The test facility should specify surface friction of the test pad. For forward automatic braking, this is usually 0.9g. GM proposes to apply the same to rear braking. Typically, the surface friction of an indoor garage floor is less than 0.9g and may not be representative of a driveway or roadway.

- Because vehicle widths vary, it may be desirable to specify the object be located between the center of the vehicle and its outer edge.

- Drivers may be dissatisfied if the vehicle brakes too soon and there is a large gap between the object and the vehicle. Consequently, it may be desirable to measure stopping distance.

- GM respectfully requests removing Section 4, which references specific vehicles and associated performance results.

- Some of the evaluation criteria could be clarified. For example, does NHTSA intend to only use stopping distance to the object or also base its assessment on the provided alerts?

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?

Future rear pedestrian braking systems may be camera based. Therefore, it may be necessary to consider the inclination of the sun. NHTSA may consider including a requirement to not to test directly into the sun at less than 15 degrees sun angle, the same as for forward automatic braking.

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.

GM believes the procedure is clearly written. We have one suggestion that we believe could improve the procedure. We suggest including a minimum activation speed prior to commencing testing.

GM systems activate only once a minimum speed is reached. We believe other manufacturers' systems also require minimum speed. If the minimum speed is not reached, the system will not engage, resulting in test failures. GM respectfully recommends adopting a minimum activation speed before testing to assure it is reached when evaluating the system.

Without a minimum activation speed, rear park assist may not function properly because rear automatic braking could defeat rear park assist.

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.

Please refer to our response to Question 3.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

GM does not have any recommendations at this time.

Traffic Jam Assist System Confirmation Test

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.

The draft research test procedures concentrate predominantly on the longitudinal control of the TJA feature on a straight road, with no exercising or definition regarding the lateral control during these tests for the SV. There is also little definition in the proposed testing regarding what would constitute the acceptance criteria. NHTSA may want to include evaluations for curved roadways and/or lane change maneuvers.

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?

In general, the draft research test procedures do not appear to contain elements that could potentially confound TJA system operation and/or test results. However, operation of the GVT in these scenarios could potentially cause jerky responses that might produce test-to-test variation. Consider matching the validity criteria to the suppliers of the various GVT platforms.

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.

In general, the draft research test procedure is clearly written and understandable. GM respectfully offers the following suggestions, which may help improve the clarity of this test procedure:

- Section 5.3.5.1 states 0.25m lateral deviation, but in LCC mode, that system determines lane position, not the driver.
- In Section 5.3.6.1, Figure 4, SOV cut out to reveal stopped POV, robotic path programming requirements aren't very clear. This concern also applies to Figure 6 in Section 5.3.7.2
- Vehicle loading was documented to be GVWR for brake burnish, but not explicitly called out for other testing.
- We suggest clarifying whether the turn signal must be used for POV or SV during tests.

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.

The ranges of test speeds, speed combinations, and speed increments specified for the draft research test procedure are reasonable for the TJA use cases.

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?

In GM's experience with ADAS testing, seven test samples are adequate for proper data analysis. It provides enough data to verify repeatability of the feature performance.

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

GM does not have any recommendations at this time.

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.

GM does not have any recommendations at this time.